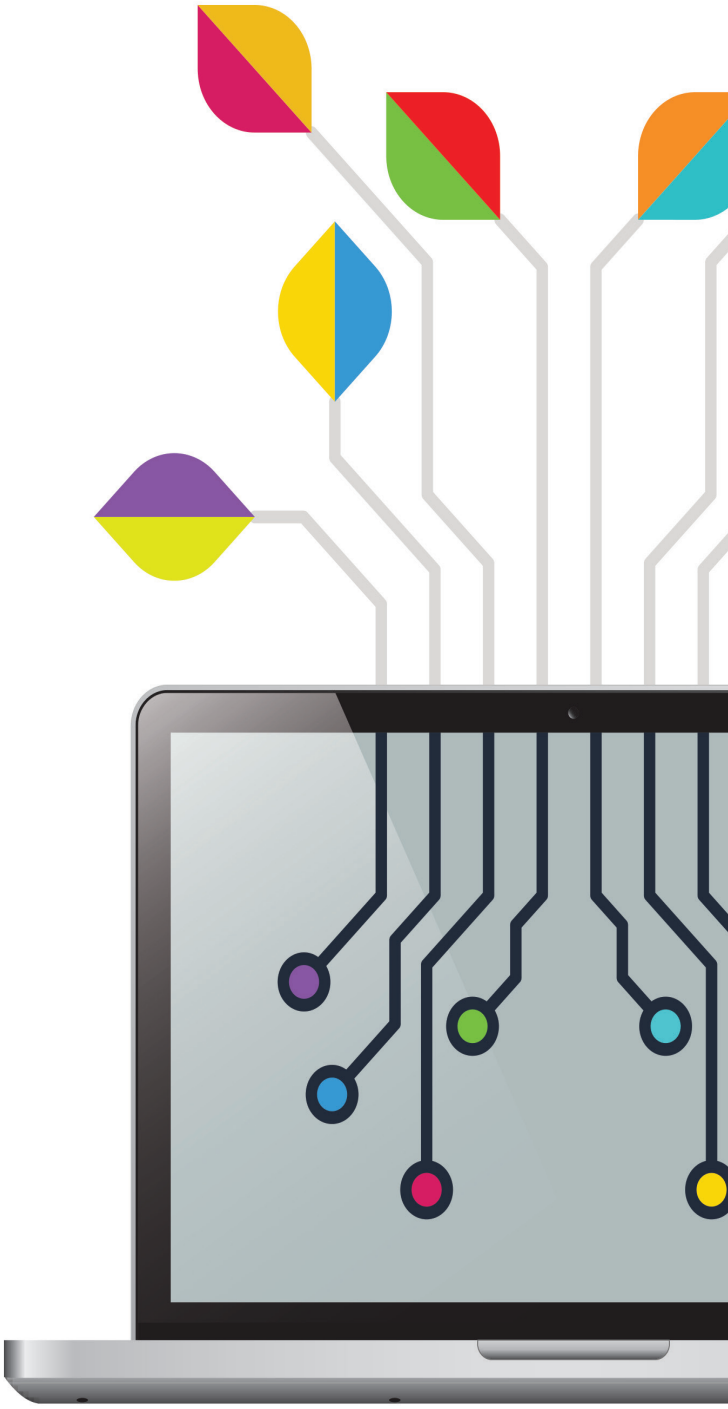
BTEC

Pearson BTEC Level 3 National Extended Diploma in Computing



Specification

First teaching from September 2016

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Issue 4

Pearson

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Edexcel, BTEC and LCCI qualifications

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About Pearson

Pearson is the world's leading learning company, with 35,000 employees in more than 70 countries working to help people of all ages to make measurable progress in their lives through learning. We put the learner at the centre of everything we do, because wherever learning flourishes, so do people. Find out more about how we can help you and your learners at qualifications.pearson.com

This specification is Issue 4. Key changes are sidelined. We will inform centres of any changes to this issue. The latest issue can be found on our website.

References to third-party material made in this specification are made in good faith. We do not endorse, approve or accept responsibility for the content of materials, which may be subject to change, or any opinions expressed therein. (Material may include textbooks, journals, magazines and other publications and websites.)

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Welcome

With a track record built over 30 years of learner success, BTEC Nationals are widely recognised by industry and higher education as the signature vocational qualification at Level 3. They provide progression to the workplace either directly or via study at a higher level. Proof comes from YouGov research, which shows that 62% of large companies have recruited employees with BTEC qualifications. What's more, well over 100,000 BTEC students apply to UK universities every year and their BTEC Nationals are accepted by over 150 UK universities and higher education institutes for relevant degree programmes either on their own or in combination with A Levels.

Why are BTECs so successful?

BTECs embody a fundamentally learner-centred approach to the curriculum, with a flexible, unit-based structure and knowledge applied in project-based assessments. They focus on the holistic development of the practical, interpersonal and thinking skills required to be able to succeed in employment and higher education.

When creating the BTEC Nationals in this suite, we worked with many employers, higher education providers, colleges and schools to ensure that their needs are met. Employers are looking for recruits with a thorough grounding in the latest industry requirements and work-ready skills such as teamwork. Higher education needs students who have experience of research, extended writing and meeting deadlines.

We have addressed these requirements with:

- a range of BTEC sizes, each with a clear purpose, so there is something to suit each learner's choice of study programme and progression plans
- refreshed content that is closely aligned with employers' and higher education needs for a skilled future workforce
- assessments and projects chosen to help learners progress to the next stage. This means some are set by you to meet local needs, while others are set and marked by Pearson so that there is a core of skills and understanding that is common to all learners. For example, a written test can be used to check that learners are confident in using technical knowledge to carry out a certain job.

We are providing a wealth of support, both resources and people, to ensure that learners and their teachers have the best possible experience during their course. See *Section 10* for details of the support we offer.

A word to learners

Today's BTEC Nationals are demanding, as you would expect of the most respected applied learning qualification in the UK. You will have to choose and complete a range of units, be organised, take some assessments that we will set and mark, and keep a portfolio of your assignments. But you can feel proud to achieve a BTEC because, whatever your plans in life – whether you decide to study further, go on to work or an apprenticeship, or set up your own business – your BTEC National will be your passport to success in the next stage of your life.

Good luck, and we hope you enjoy your course.

Collaborative development

Students completing their BTEC Nationals in Computing will be aiming to go on to employment, often via the stepping stone of higher education. It was, therefore, essential that we developed these qualifications in close collaboration with experts from professional bodies, businesses and universities, and with the providers who will be delivering the qualifications. To ensure that the content meets providers' needs and provides high-quality preparation for progression, we engaged experts. We are very grateful to all the university and further education lecturers, teachers, employers, professional body representatives and other individuals who have generously shared their time and expertise to help us develop these new qualifications.

BCS, the Chartered Institute for IT, recognise that these qualifications are fit for purpose with regard to progression towards a professional career in IT or towards continuing education in Information Technology.

In addition, universities, professional bodies and businesses have provided letters of support confirming that these qualifications meet their entry requirements. These letters can be viewed on our website.

Summary of Pearson BTEC Level 3 National Extended Diploma in Computing specification Issue 3 and 4 changes

Summary of changes made between previous issues and this current issue	Page number
Inclusion of Near Pass grade information for External assessments. Inclusion of text to further clarify Synoptic assessment	Throughout
Wording has been added to the Qualification and unit content section to clarify that references in units to regulation, legislation, policies and regulatory/standards organisations can be adapted and updated to reflect changes and variations within the UK.	Page 7
The wording under the synoptic assessment section has been revised to reference synoptic assessment tasks within units.	Page 8
A sentence has been added to the External assessment summary table to clarify the percentage of external assessment within the qualification.	Page 13
Wording has been revised to reference the specific synoptic assessment task/s within units that have been identified for this qualification.	Page 13
Wording has been revised in the Links to other units section in Units 1, 3, 4, 7, 10, 20 and 24.	Pages 28, 50, 60, 70, 101, 207 and 247
Example tables in Section 9 have been updated to reflect the Near Pass grade.	Section 9

If you need further information on these changes or what they mean, contact us via our website at: qualifications.pearson.com/en/support/contact-us.html.

Contents

Introduction to BTEC National qualifications for the computing sector

This specification contains the information you need to deliver the Pearson BTEC Level 3 National Extended Diploma in Computing. The specification signposts you to additional handbooks and policies. It includes all the units for this qualification.

This is part of the suite of Computing qualifications offered by Pearson. In the suite there are qualifications that focus on different progression routes, allowing learners to choose the one best suited to their aspirations.

All qualifications in the suite share some common units and assessments, allowing learners some flexibility in moving between sizes. The qualification titles are given below.

Some BTEC National qualifications provide a broad introduction that gives learners transferable knowledge and skills. These qualifications are for post-16 learners who want to continue their education through applied learning. The qualifications prepare learners for a range of higher education courses and job roles related to a particular sector. They provide progression either by meeting entry requirements in their own right or by being accepted alongside other qualifications at the same level and adding value to them.

In the computing sector these qualifications are:

Pearson BTEC Level 3 National Certificate in Computing (180 GLH) 603/0446/7

Pearson BTEC Level 3 National Extended Certificate in Computing (360 GLH) 601/7341/5

Pearson BTEC Level 3 National Foundation Diploma in Computing (510 GLH) 601/7343/9

Pearson BTEC Level 3 National Diploma in Computing (720 GLH) 603/0445/5

Pearson BTEC Level 3 National Extended Diploma in Computing (1080 GLH) 601/7342/7.

Some BTEC National qualifications are for post-16 learners wishing to specialise in a specific industry, occupation or occupational group. The qualifications give learners specialist knowledge and skills, enabling entry to an Apprenticeship or other employment, or progression to related higher education courses. Learners taking these qualifications must have a significant level of employer involvement in their programmes.

In the computing sector these qualifications are:

Pearson BTEC Level 3 National Diploma in Computer Science (720 GLH) 601/7338/5

Pearson BTEC Level 3 National Diploma in Computing for Creative Industries (720 GLH) 601/7340/3

Pearson BTEC Level 3 National Diploma in Computer Systems and Network Support (720 GLH) 601/7339/7

Pearson BTEC Level 3 National Diploma in Business Information Systems (720 GLH) 601/7337/3.

This specification signposts all the other essential documents and support that you need as a centre in order to deliver, assess and administer the qualification, including the staff development required. A summary of all essential documents is given in *Section 7*. Information on how we can support you with this qualification is given in *Section 10*.

The information in this specification is correct at the time of publication.

Total Qualification Time

For all regulated qualifications, Pearson specifies a total number of hours that it is estimated learners will require to complete and show achievement for the qualification: this is the Total Qualification Time (TQT). Within TQT, Pearson identifies the number of Guided Learning Hours (GLH) that we estimate a centre delivering the qualification might provide. Guided learning means activities, such as lessons, tutorials, online instruction, supervised study and giving feedback on performance, that directly involve teachers and assessors in teaching, supervising and invigilating learners. Guided learning includes the time required for learners to complete external assessment under examination or supervised conditions.

In addition to guided learning, other required learning directed by teachers or assessors will include private study, preparation for assessment and undertaking assessment when not under supervision, such as preparatory reading, revision and independent research.

BTEC Nationals have been designed around the number of hours of guided learning expected. Each unit in the qualification has a GLH value of 60, 90 or 120. There is then a total GLH value for the qualification.

Each qualification has a TQT value. This may vary within sectors and across the suite depending on the nature of the units in each qualification and the expected time for other required learning.

The following table shows all the qualifications in this sector and their GLH and TQT values.

Qualifications, sizes and purposes at a glance

Title	Size and structure	Summary purpose
Pearson BTEC Level 3 National Certificate in Computing	180 GLH (235 TQT) Equivalent in size to 0.5 of an A Level. 2 units, both mandatory, of which 1 is external. Mandatory content (100%). External assessment (50%).	This qualification is designed to be an introduction to the computing sector through applied learning. The qualification supports progression to higher education when taken as part of a programme of study that includes other vocational or general qualifications.
Pearson BTEC Level 3 National Extended Certificate in Computing	360 GLH (465 TQT) Equivalent in size to one A Level. 4 units of which 3 are mandatory and 2 are external. Mandatory content (83%). External assessment (58%).	This qualification is designed to support learners who are interested in learning about the computing sector alongside other fields of study, with a view to progressing to a wide range of higher education courses, not necessarily in the computing sector. It is designed to be taken as part of a programme of study that includes other appropriate BTEC Nationals or A Levels.
Pearson BTEC Level 3 National Foundation Diploma in Computing	510 GLH (670 TQT) Equivalent in size to 1.5 A Levels. 6 units of which 4 are mandatory and 2 are external. Mandatory content (76%). External assessment (41%).	This qualification is designed to support learners who wish to study computing as a one-year, full-time course, or for those wishing to take it alongside another area of complementary or contrasting study, as part of a two-year, full-time study programme. If taken as part of a programme of study that includes other appropriate BTEC Nationals or A Levels, it supports progression to higher education.
Pearson BTEC Level 3 National Diploma in Computing	720 GLH (960 TQT) Equivalent in size to two A Levels. 8 units of which 6 are mandatory and 3 are external. Mandatory content (83%). External assessment (46%).	This qualification is designed to support learners who want an in-depth study of the computing sector as part of a 16–19 study programme. This programme may include other BTEC Nationals or A Levels to support progression to higher education courses in computing areas before entering employment. The additional qualification(s) studied allow learners either to give breadth to their study programme by choosing a contrasting subject, or to give it more focus by choosing a complementary subject.
Pearson BTEC Level 3 National Extended Diploma in Computing	1080 GLH (1435 TQT) Equivalent in size to three A Levels. 13 units of which 7 are mandatory and 4 are external. Mandatory content (67%). External assessment (42%).	This qualification is designed to support learners who are interested in a two-year, full-time course that meets entry requirements for a course in computer-related study at higher education. The qualification enables learners to explore a choice of sector areas, enabling progression to either higher education or employment in the computing sector.

Title	Size and structure	Summary purpose
Pearson BTEC Level 3 National Diploma in Computer Science	720 GLH (975 TQT) Equivalent in size to two A Levels. 10 units of which 6 are mandatory and 2 are external. Mandatory content (67%). External assessment (33%).	This qualification is designed to support learners who want a strong core study of computer science to enable progression to roles in the computing industry or progression to higher education, with a focus on the computing sector. This qualification is designed to meet the Tech Bacc measure when studied alongside Level 3 mathematics and the Extended Project Qualification (EPQ).
Pearson BTEC National Diploma in Computing for Creative Industries	720 GLH (970 TQT) Equivalent in size to two A Levels. 10 units of which 6 are mandatory and 2 are external. Mandatory content (67%). External assessment (33%).	This qualification is designed to support learners who want a strong core study of computer science to enable progression to roles in the computing industry or progression to higher education, with a focus on the computing sector. This qualification is designed to meet the Tech Bacc measure when studied alongside Level 3 mathematics and the Extended Project Qualification (EPQ).
Pearson BTEC National Diploma in Computer Systems and Network Support	720 GLH (995 TQT) Equivalent in size to two A Levels. 10 units of which all are mandatory and 2 are external. Mandatory content (100%). External assessment (33%).	This qualification is designed to support learners who want a strong core study of computer science to enable progression to roles in the computing industry or progression to higher education, with a focus on the computing sector. This qualification is designed to meet the Tech Bacc measure when studied alongside Level 3 mathematics and the Extended Project Qualification (EPQ).
Pearson BTEC National Diploma in Business Information Systems	720 GLH (990 TQT) Equivalent in size to two A Levels. 10 units of which all are mandatory and 2 are external. Mandatory content (100%). External assessment (33%).	This qualification is designed to support learners who want a strong core study of computer science to enable progression to roles in the computing industry or progression to higher education with a focus on the computing sector. This qualification is designed to meet the Tech Bacc measure when studied alongside Level 3 mathematics and the Extended Project Qualification (EPQ).

Structures of the qualifications at a glance

This table shows all the units and the qualifications to which they contribute. The full structure for this Pearson BTEC Level 3 National in Computing is shown in *Section 2*. **You must refer to the full structure to select units and plan your programme.**

Key

	Unit assessed externally	M	Mandatory units	O	Optional units
CC	Creative Computing	CS	Computer Science	CSNS	Computer Systems and Network Suppport
BIS	Business Information Systems				

Unit (number and title)	Unit size (GLH)	Certificate (180 GLH)	Extended Certificate (360 GLH)	Foundation Diploma (510 GLH)	Diploma (720 GLH)	Extended Diploma (1080 GLH)	Diploma (720 GLH)			
							CC	CS	CSNS	BIS
1 Principles of Computer Science	120		M	M	M	M	M	M	M	M
2 Fundamentals of Computer Systems	90	M	M	M	M	M				
3 Planning and Management of Computing Projects	120				M	M	M	M	M	M
4 Software Design and Development Project	120					M				
5 Building Computer Systems	60						M	M	M	M
6 IT Systems Security	60						M	M	M	M
7 IT Systems Security and Encryption	90	M	M	M	M	M				
8 Business Applications of Social Media	90			M	M	M				
9 The Impact of Computing	90				M	M				
10 Human-computer Interaction	60		O	O	O	O	M	O		M
11 Digital Graphics and Animation	60		O	O	O	O	O			
12 Digital Audio	60				O	O	O			
13 Digital Video	60				O	O	O			
14 Computer Games Development	60		O	O	O	O	O			
15 Website Development	60		O	O	O	O	O	O		
16 Object-oriented Programming	60				O	O		O		

continued overleaf

Unit (number and title)	Unit size (GLH)	Certificate (180 GLH)	Extended Certificate (360 GLH)	Foundation Diploma (510 GLH)	Diploma (720 GLH)	Extended Diploma (1080 GLH)	Diploma (720 GLH)			
							CC	CS	CSNS	BIS
17 Mobile Apps Development	60		O	O	O	O		O		
18 Relational Database Development	60				O	O		O		M
19 Computer Networking	60				O	O				
20 Managing and Supporting Systems	60		O	O	O	O			M	
21 Virtualisation	60				O	O			M	
22 Systems Analysis and Design	60		O	O	O	O	O	M		M
23 Systems Methodology	60				O	O				M
24 Software Developmet	60						M	M		
25 Web Application Development	60							O		
26 Programmable Devices and Controllers	60							O	M	
27 3D Modelling	60						O			
28 Computer Forensics	60							O	M	
29 Network Operating Systems	60								M	
30 Communication Technologies	60								M	
31 Large-scale Data Systems	60									M
32 Business Process Modelling Tools	60									M

Qualification and unit content

Pearson has developed the content of the new BTEC Nationals in collaboration with employers and representatives from higher education and relevant professional bodies. In this way, we have ensured that content is up to date and that it includes the knowledge, understanding, skills and attributes required in the sector.

Each qualification in the suite has its own purpose. The mandatory and optional content provides a balance of breadth and depth, while retaining a degree of choice for individual learners to study content relevant to their own interests and progression choices. Also, the content may be applied during delivery in a way that is relevant to local employment needs.

The proportion of mandatory content ensures that all learners are following a coherent programme of study and acquiring the knowledge, understanding and skills that will be recognised and valued. Learners are expected to show achievement across mandatory units as detailed in *Section 2*.

BTEC Nationals have always required applied learning that brings together knowledge and understanding (the cognitive domain) with practical and technical skills (the psychomotor domain). This is achieved through learners performing vocational tasks that encourage the development of appropriate vocational behaviours (the affective domain) and transferable skills. Transferable skills are those such as communication, teamwork, research and analysis, which are valued in both higher education and the workplace.

Our approach provides rigour and balance, and promotes the ability to apply learning immediately in new contexts. Further details can be found in *Section 2*.

Centres should ensure that delivery of content is kept up to date. In particular units may include reference to regulation, legislation, policies and regulatory/standards organisations. This is designed to provide guidance on breadth and depth of coverage and may be adjusted to update content and to reflect variations within the UK.

Assessment

Assessment is specifically designed to fit the purpose and objective of the qualification. It includes a range of assessment types and styles suited to vocational qualifications in the sector. There are three main forms of assessment that you need to be aware of: external, internal and synoptic.

Externally-assessed units

Each external assessment for a BTEC National is linked to a specific unit. All of the units developed for external assessment are of 90 or 120 GLH to allow learners to demonstrate breadth and depth of achievement. Each assessment is taken under specified conditions, then marked by Pearson and a grade awarded. Learners are permitted to resit external assessments during their programme. You should refer to our website for current policy information on permitted retakes.

The styles of external assessment used for qualifications in the computing suite are:

- examinations – all learners take the same assessment at the same time, normally with a written outcome
- set tasks – learners take the assessment during a defined window and demonstrate understanding through completion of a vocational task.

Some external assessments include a period of preparation using set information. External assessments are available once or twice a year. For detailed information on the external assessments please see the table in *Section 2*. For further information on preparing for external assessment see *Section 5*.

Internally-assessed units

Most units in the sector are internally assessed and subject to external standards verification. This means that you set and assess the assignments that provide the final summative assessment of each unit, using the examples and support that Pearson provides. Before you assess you will need to become an approved centre, if you are not one already. You will need to prepare to assess using the guidance in *Section 6*.

In line with the requirements and guidance for internal assessment, you select the most appropriate assessment styles according to the learning set out in the unit. This ensures that learners are assessed using a variety of styles to help them develop a broad range of transferable skills. Learners could be given opportunities to:

- write up the findings of their own research
- use case studies to explore complex or unfamiliar situations
- carry out projects for which they have choice over the direction and outcomes
- demonstrate practical and technical skills using appropriate tools/processes etc.

You will make grading decisions based on the requirements and supporting guidance given in the units. Learners may not make repeated submissions of assignment evidence. For further information see *Section 6*.

Synoptic assessment

Synoptic assessment requires learners to demonstrate that they can identify and use effectively, in an integrated way, an appropriate selection of skills, techniques, concepts, theories and knowledge from across the whole sector as relevant to a key task. BTEC learning has always encouraged learners to apply their learning in realistic contexts using scenarios and realistic activities that will permit learners to draw on and apply their learning. For these qualifications we have formally identified units which contain a synoptic assessment task. Synoptic assessment must take place after the teaching and learning of other mandatory units in order for learners to be able to draw from the full range of content. The synoptic assessment gives learners an opportunity to independently select and apply learning from across their programmes in the completion of a vocational task. Synoptic tasks may be in internally or externally assessed units. The particular unit that contains the synoptic tasks for this qualification is shown in the structure in *Section 2*.

Language of assessment

Assessment of the internal and external units for these qualifications will be available in English. All learner work must be in English. A learner taking the qualifications may be assessed in British or Irish Sign Language where it is permitted for the purpose of reasonable adjustment.
For information on reasonable adjustments see *Section 7*.

Grading for units and qualifications

Achievement in the qualification requires a demonstration of depth of study in each unit, assured acquisition of a range of practical skills required for employment or progression to higher education, and successful development of transferable skills. Learners achieving a qualification will have achieved across mandatory units, including external and synoptic assessment.

Units are assessed using a grading scale of Distinction (D), Merit (M), Pass (P), Near Pass (N) and Unclassified (U). The grade of Near Pass is used for externally-assessed units only. All mandatory and optional units contribute proportionately to the overall qualification grade, for example a unit of 120 GLH will contribute double that of a 60 GLH unit.

Qualifications in the suite are graded using a scale of P to D*, **or** PP to D*D*, **or** PPP to D*D*D*. Please see *Section 9* for more details. The relationship between qualification grading scales and unit grades will be subject to regular review as part of Pearson's standards monitoring processes on the basis of learner performance and in consultation with key users of the qualification.

UCAS Tariff points

The BTEC Nationals attract UCAS points. Please go to the UCAS website for full details of the points allocated.

1 Qualification purpose

Pearson BTEC Level 3 National Extended Diploma in Computing

In this section you will find information on the purpose of this qualification and how its design meets that purpose through the qualification objective and structure. We publish a full 'Statement of Purpose' for each qualification on our website. These statements are designed to guide you and potential learners to make the most appropriate choice about the size of qualification suitable at recruitment.

The content of this qualification has been developed in consultation with academics to ensure that it incorporates the most up-to-date knowledge and skills to enable progression to higher education.

In addition, employers and professional bodies have been consulted on the content development to corroborate its relevance with current industry practice used in computing and related occupational disciplines.

Who is this qualification for?

The Pearson BTEC Level 3 National Extended Diploma in Computing is equivalent in size to three A Levels and would normally be the only qualification in a learner's study programme.

It is designed to be offered to 16–19 learners who are interested in progressing to further study in higher education computing-related disciplines.

The qualification provides learners with a broad base of knowledge of the computing sector. The optional units enable learners to explore their own choice of areas for further study. Learners could also progress to employment in the computing sector.

What does this qualification cover?

The objective of this qualification is to provide learners with the opportunity to develop knowledge and skills in managing networks, the design and development of websites, the development of databases and digital graphics and animation, enabling learners to progress to further study of the sector.

Initially, learners study seven core units:

- Unit 1: Principles of Computer Science
- Unit 2: Fundamentals of Computer Systems
- Unit 3: Planning and Management of Computer Projects
- Unit 4: Software Design and Development Project – (Synoptic)
- Unit 7: IT Systems Security and Encryption
- Unit 8: Business Applications of Social Media
- Unit 9: The Impact of Computing.

The mandatory content is equivalent in size to three A Levels. Higher education representatives have confirmed that it is appropriate to allow learners a wide range of optional units in the final third of the qualification so that they can explore their own choice of areas for further study.

The optional units have been designed to support progression to ICT courses and link with relevant sector areas such as creative, computer science, networking support systems, and business systems.

What could this qualification lead to?

In addition to the computing sector-specific content outlined above, the requirements of the qualification enables learners to develop the transferable and higher order skills which are highly regarded by higher education providers and employers. For example, the study of computing particularly encourages development of analysis skills, including investigating, categorising and prioritizing; the synthesis skills of adapting, constructing and integrating; and the evaluation skills of assessing, interpreting and validating.

This qualification carries UCAS points and is recognised by higher education providers as meeting admission requirements to many relevant courses. The combination of the mandatory content and the optional units enables learners to explore a range of areas for further study, for example:

- MSci or BSc (Hons) in Computer Science
- BSc (Hons) in Information Technology Practitioner
- BA (Hons) in Creative Digital Media
- BSc (Hons) Business Information Systems
- BSc (Hons) Computer Systems and Networks.

Some university courses may require the achievement of specific units and learners should always check the entry requirements for degree programmes with specific higher education providers.

This qualification has attracted support from the BCS, the Chartered Institute for IT, as being fit for purpose with regard to progression towards a professional career in roles such as a software engineer, business analyst, systems analyst, network engineer, technical consultant, web developer and software tester.

How does the qualification provide employability skills?

In the BTEC National units there are opportunities during the teaching and learning phase to give learners practice in developing employability skills. Where employability skills are referred to in this specification, we are generally referring to skills in the following three main categories:

- **cognitive and problem-solving skills**: use critical thinking, approach non-routine problems applying expert and creative solutions, use systems and technology
- **intrapersonal skills**: communicating, working collaboratively, negotiating and influencing, self-presentation
- **interpersonal skills:** self-management, adaptability and resilience, self-monitoring and development.

There are also specific requirements in some units for assessment of these skills where relevant. For example, where learners are required to undertake real or simulated activities.

How does the qualification provide transferable knowledge and skills for higher education?

All BTEC Nationals provide transferable knowledge and skills that prepare learners for progression to university. The transferable skills that universities value include:

- the ability to learn independently
- the ability to research actively and methodically
- being able to give presentations and being active group members.

BTEC learners can also benefit from opportunities for deep learning where they are able to make connections among units and select areas of interest for detailed study. BTEC Nationals provide a vocational context in which learners can develop the knowledge and skills required for particular degree courses, including:

- reading technical texts
- effective writing
- analytical skills
- creative development
- preparation for assessment methods used in degrees.

2 Structure

Qualification structure

Pearson BTEC Level 3 National Extended Diploma in Computing

Mandatory units

There are seven mandatory units, three internal and four external. Learners must complete and achieve at Near Pass grade or above in all mandatory external units and achieve a Pass or above in all mandatory internal units.

Optional units

Learners must complete six optional units. The optional units are grouped. Learners take a maximum of two units from any group.

Pearson BTEC Level 3 National Extended Diploma in Computing				
Unit number	**Unit title**	**GLH**	**Type**	**How assessed**
	Mandatory units – learners complete and achieve all units			
1	Principles of Computer Science	**120**	**Mandatory**	External
2	Fundamentals of Computer Systems	**90**	**Mandatory**	External
3	Planning and Management of Computing Projects	**120**	**Mandatory**	External
4	Software Design and Development Project	**120**	**Mandatory and Synoptic**	External
7	IT Systems Security and Encryption	**90**	**Mandatory**	Internal
8	Business Applications of Social Media	**90**	**Mandatory**	Internal
9	The Impact of Computing	**90**	**Mandatory**	Internal
	Optional units group A – learners complete 0 – 2 units			
10	Human-computer Interaction	**60**	**Optional**	Internal
11	Digital Graphics and Animation	**60**	**Optional**	Internal
12	Digital Audio	**60**	**Optional**	Internal
13	Digital Video	**60**	**Optional**	Internal
14	Computer Games Development	**60**	**Optional**	Internal
	Optional units group B – learners complete 0 – 2 units			
15	Website Development	**60**	**Optional**	Internal
16	Object-oriented Programming	**60**	**Optional**	Internal
17	Mobile Apps Development	**60**	**Optional**	Internal
18	Relational Database Development	**60**	**Optional**	Internal
	Optional units group C – learners complete 0 – 2 units			
19	Computer Networking	**60**	**Optional**	Internal
20	Managing and Supporting Systems	**60**	**Optional**	Internal
21	Virtualisation	**60**	**Optional**	Internal
	Optional units group D – learners complete 0 – 2 units			
22	Systems Analysis and Design	**60**	**Optional**	Internal
23	Systems Methodology	**60**	**Optional**	Internal

External assessment

This is a summary of the type and availability of external assessment, which is of units making up 42% of the total qualification GLH. See *Section 5* and the units and sample assessment materials for more information.

Unit	Type	Availability
Unit 1: Principles of Computer Science	• Written examination set and marked by Pearson. • 90 marks. • Two hours.	**Jan and May/June.** **First assessment: May/June 2017**
Unit 2: Fundamentals of Computer Systems	• Written examination set and marked by Pearson. • 80 marks. • 1 hour and 45 minutes.	**Jan and May/June.** **First assessment: May/June 2017.**
Unit 3: Planning and Management of Computer Projects	• A task set and marked by Pearson and completed under supervised conditions. • There are two supervised assessment periods. Part A is a maximum of three hours in a one week period and Part B is a maximum of two hours in a three day period. Both periods are timetabled by Pearson. • Completed using a computer and submitted electronically. • 66 marks.	**Dec/Jan and May/June** **First assessment: Dec/Jan 2018.**
Unit 4: Software Design and Development Project	• A task set and marked by Pearson and completed under supervised conditions. • The supervised assessment period is a maximum of six hours and can be arranged over a number of sessions in a period timetabled by Pearson. • Completed using a computer and submitted electronically. • 68 marks.	**Dec/Jan and May/June** **First assessment: May/June 2018.**

Synoptic assessment

The mandatory synoptic assessment requires learners to apply learning from across the qualification to the completion of a defined vocational task. Within the assessment for *Unit 4: Software Design and Development Project* learners complete a project applying the software development cycle to a computer problem.

In delivering the unit you need to encourage learners to draw on their broader learning so they will be prepared for the assessment.

Learners complete the task using knowledge and understanding from their studies of the sector and apply both transferable and specialist knowledge and skills.

Employer involvement in assessment and delivery

You are encouraged to give learners opportunities to be involved with employers.
See *Section 4* for more information.

3 Units

Understanding your units

The units in this specification set out our expectations of assessment in a way that helps you to prepare your learners for assessment. The units help you to undertake assessment and quality assurance effectively.

Each unit in the specification is set out in a similar way. There are two types of unit format:

- internal units
- external units.

This section explains how the units work. It is important that all teachers, assessors, internal verifiers and other staff responsible for the programme review this section.

Internal units

Section	Explanation
Unit number	The number is in a sequence in the sector. Numbers may not be sequential for an individual qualification.
Unit title	This is the formal title that we always use and it appears on certificates.
Level	All units are at Level 3 on the national framework.
Unit type	This shows if the unit is internal or external only. See structure information in *Section 2* for full details.
GLH	Units may have a GLH value of 120, 90 or 60 GLH. This indicates the numbers of hours of teaching, directed activity and assessment expected. It also shows the weighting of the unit in the final qualification grade.
Unit in brief	A brief formal statement on the content of the unit that is helpful in understanding its role in the qualification. You can use this in summary documents, brochures etc.
Unit introduction	This is designed with learners in mind. It indicates why the unit is important, how learning is structured, and how learning might be applied when progressing to employment or higher education.
Learning aims	These help to define the scope, style and depth of learning of the unit. You can see where learners should be learning standard requirements ('understand') or where they should be actively researching ('investigate'). You can find out more about the verbs we use in learning aims in *Appendix 2*.
Summary of unit	This new section helps teachers to see at a glance the main content areas against the learning aims and the structure of the assessment. The content areas and structure of assessment are required. The forms of evidence given are suitable to fulfil the requirements.
Content	This section sets out the required teaching content of the unit. Content is compulsory except when shown as 'e.g.'. Learners should be asked to complete summative assessment only after the teaching content for the unit or learning aim(s) has been covered.

Section	Explanation
Assessment criteria	Each learning aim has Pass and Merit criteria. Each assignment has at least one Distinction criterion. A full glossary of terms used is given in *Appendix 2*. All assessors need to understand our expectations of the terms used. Distinction criteria represent outstanding performance in the unit. Some criteria require learners to draw together learning from across the learning aims.
Essential information for assignments	This shows the maximum number of assignments that may be used for the unit to allow for effective summative assessment, and how the assessment criteria should be used to assess performance.
Further information for teachers and assessors	The section gives you information to support the implementation of assessment. It is important that this is used carefully alongside the assessment criteria.
Resource requirements	Any specific resources that you need to be able to teach and assess are listed in this section. For information on support resources see *Section 10*.
Essential information for assessment decisions	This information gives guidance for each learning aim or assignment of the expectations for Pass, Merit and Distinction standard. This section contains examples and essential clarification.
Links to other units	This section shows you the main relationship among units. This section can help you to structure your programme and make best use of materials and resources.
Employer involvement	This section gives you information on the units that can be used to give learners involvement with employers. It will help you to identify the kind of involvement that is likely to be successful.

External units

Section	Explanation
Unit number	The number is in a sequence in the sector. Numbers may not be sequential for an individual qualification.
Unit title	This is the formal title that we always use and it appears on certificates.
Level	All units are at Level 3 on the national framework.
Unit type	This shows if the unit is internal or external only. See structure information in *Section 2* for full details.
GLH	Units may have a GLH value of 120, 90 or 60 GLH. This indicates the numbers of hours of teaching, directed activity and assessment expected. It also shows the weighting of the unit in the final qualification grade.
Unit in brief	A brief formal statement on the content of the unit.
Unit introduction	This is designed with learners in mind. It indicates why the unit is important, how learning is structured, and how learning might be applied when progressing to employment or higher education.
Summary of assessment	This sets out the type of external assessment used and the way in which it is used to assess achievement.
Assessment outcomes	These show the hierarchy of knowledge, understanding, skills and behaviours that are assessed. Includes information on how this hierarchy relates to command terms in sample assessment materials (SAMs).
Essential content	For external units all the content is obligatory, the depth of content is indicated in the assessment outcomes and sample assessment materials (SAMs). The content will be sampled through the external assessment over time, using the variety of questions or tasks shown.
Grade descriptors	We use grading descriptors when making judgements on grade boundaries. You can use them to understand what we expect to see from learners at particular grades.
Key terms typically used in assessment	These definitions will help you analyse requirements and prepare learners for assessment.
Resources	Any specific resources that you need to be able to teach and assess are listed in this section. For information on support resources see *Section 10*.
Links to other units	This section shows the main relationship among units. This section can help you to structure your programme and make best use of materials and resources.
Employer involvement	This section gives you information on the units that can be used to give learners involvement with employers. It will help you to identify the kind of involvement that is likely to be successful.

Index of units

This section contains all the units developed for this qualification. Please refer to *pages 5–6* to check which units are available in all qualifications in the computing sector.

Unit 1: Principles of Computer Science

Level: **3**

Unit type: **External**

Guided learning hours: **120**

Unit in brief

This unit covers the principles that underpin all areas of computer science. It will develop your computational-thinking skills and you will apply those skills to solve problems.

Unit introduction

Problem solving is an essential skill in all areas of life. To be successful, professionals need to be able to analyse the needs of individuals and organisations, and to evaluate the suitability and effectiveness of current ways of working in order to develop solutions that improve or enhance processes and/or outcomes.

In this unit, you will explore the logical and structured ways that computer systems process data to develop programs, processes and systems that solve specific problems. You will examine the features of effective computer programming and apply accepted computing and programming paradigms. You will analyse, develop and evaluate algorithms and computer code, and propose and apply solutions to ensure that computer systems are fit for purpose. To complete the assessment task within this unit, you will need to draw on your learning from across your programme.

In this unit, you will develop the computational-thinking skills to effectively analyse a problem, break it down into its component parts, and design and evaluate solutions. These skills are required for progression to computing-related higher education courses or to the workplace as a computing professional.

Summary of assessment

This unit is assessed through a written examination set and marked by Pearson.

The examination is two hours in length. During the supervised assessment period, learners will be assessed on their ability to apply their computational-thinking skills to solve problems.

The number of marks for the unit is 90.

The assessment availability is January and May/June each year. The first assessment availability is May/June 2017.

Sample assessment materials will be available to help centres prepare learners for assessment.

Assessment outcomes

AO1 Demonstrate knowledge and understanding of computing facts, terms, standards, concepts and processes

Command words: complete, draw, give, identify, name, state

Marks: ranges from 1 to 5 marks

AO2 Apply knowledge and understanding to communicate understanding of computing facts, terms, standards, concepts and processes

Command words: calculate, complete, demonstrate, describe, draw, explain, produce

Marks: ranges from 1 to 5 marks

AO3 Select and use computing technologies and procedures to explore outcomes and find solutions to problems in context

Command words: calculate, demonstrate, develop, explain, produce

Marks: ranges from 1 to 6 marks

AO4 Analyse data and information related to computer science in order to predict outcomes and present solutions

Command words: analyse, demonstrate, discuss, produce, write

Marks: ranges from 6 to 12 marks

AO5 Evaluate technologies, procedures, outcomes and solutions to make reasoned judgements and make decisions

Command words: evaluate, produce, write

Marks: ranges from 6 to 12 marks

Essential content

The essential content is set out under content areas. Learners must cover all specified content before the assessment.

A Computational thinking

Application of the thinking skills involved in analysing problems and processes, to identify solutions that can be developed into computer programs.

A1 Decomposition

- Identifying and describing problems and processes.
- Breaking down problems and processes into distinct steps.
- Describing problems and processes as a set of structured steps.
- Communicating the key features of problems and processes to others.

A2 Pattern recognition

- Identifying common elements or features in problems or systems.
- Identifying and interpreting common differences between processes or problems.
- Identifying individual elements within problems.
- Describing patterns that have been identified.
- Making predictions based on identified patterns.

A3 Pattern generalisation and abstraction

- Identifying information that is necessary to solve an identified problem.
- Filtering out information that is not needed to solve an identified problem.
- Representing parts of a problem or system in general terms by identifying:
  - variables
  - constants
  - key processes
  - repeated processes
  - inputs
  - outputs.

A4 Algorithm design

- Describing a step-by-step strategy to solve a problem.

B Standard methods and techniques used to develop algorithms

Techniques used to design solutions to problems.

B1 Structured English (pseudocode)

Produce, apply and interpret pseudocode statements to describe computing tasks or processes and solve problems.

- Interpreting pseudocode:
  - apply processes to calculate outcomes
  - evaluate the structure and logic of given code against given requirements
  - suggest improvements to logical structures and processes.
- Developing pseudocode:
  - improve the effectiveness and efficiency of code
  - identify and fix errors within code.

- Producing pseudocode – learners must be familiar with the listed terms and their application. Unfamiliar pseudocode will be given with definitions for application in the examination context:
  - sequence
  - structure:
    - hierarchy
    - indentation
  - operations:
    - BEGIN
    - END
    - INPUT
    - OUTPUT
    - PRINT
    - READ
    - WRITE
  - decisions:
    - IF
    - THEN
    - ELSE
    - ELSEIF (ELIF)
    - WHEN
  - repetition:
    - FOR
    - REPEAT UNTIL
    - WHILE
    - WHILE NOT.

B2 Flowcharts using standard symbols

Interpret, produce and develop flowcharts using appropriate British Computer Society (BCS) symbols to describe a system or solution.

- Process.
- Decisions.
- Input/output.
- Connectors.
- Start/end.

C Programming paradigms

Use of standard structures and conventions to build and develop accurate, efficient and effective computer code to fulfil identified criteria and solve problems.

C1 Handling data within a program

Selecting, applying, using and interpreting common data-handling techniques and structures provided within programming languages to process data.

- Defining and declaring constants and variables:
  - alphanumeric strings
  - arrays
  - Boolean
  - characters
  - date/time
  - floating point (real)
  - integers
  - objects
  - records
  - sets
  - strings.

- Managing variables:
  - local and global variables
  - naming conventions.

C2 Arithmetic operations

Selecting, applying, using and interpreting general mathematical expressions within computing structures to process data.

- Mathematical operators:
  - +
  - –
  - / (DIV)
  - *
  - %/MOD/modulo/rem.
- Relational operators (=, <, >, <>, <=, >=).
- Boolean operators (NOT, AND, OR).
- Date/time.

C3 Built-in functions

Selecting, applying, using and interpreting common functions provided within programming languages to perform specific tasks to process data.

- Arithmetic functions:
  - random
  - range
  - round
  - truncation.
- String handling functions:
  - concatenation
  - length
  - position
  - string conversion:
    - integer/float to string
    - string to integer/float.
- General functions:
  - input
  - open
  - print
  - range.

C4 Validating data

Selecting, applying, using and interpreting validation techniques to analyse and improve the accuracy and validity of data.

- Validation check techniques:
  - data type
  - range
  - constraints
  - Boolean.
- Post-check actions.

C5 Control structures

Selecting, applying, using and interpreting common programming control structures to analyse and improve the effectiveness of code.

- Loops:
  - REPEAT
  - FOR
  - WHILE
  - BREAK.
- Branches:
  - IF
  - THEN
  - ELSE
  - ELSEIF (ELIF).
- Function calls:
  - defining functions
  - declaring arguments
  - calling functions.

C6 Data structures

Selecting, applying, using and interpreting common data structures within a computer program to store and process data.

- Lists.
- Arrays:
  - single dimensional arrays
  - multi-dimensional arrays.
- Records.
- Sets.

C7 Common/standard algorithms

Selecting, applying, using and interpreting standard algorithms within a computer program to store and process data.

- Sorting:
  - bubble sort
  - quick sort
  - insertion sort.
- Searching:
  - serial/linear search
  - binary search.
- Other standard algorithms:
  - count occurrences
  - input validation.
- Using stacks and queues to implement sorting and searching:
  - Last In First Out (LIFO)
  - First In First Out (FIFO).

D Types of programming and mark-up languages

The features, applications, impact and implications of using programming and mark-up languages (C family, Visual Basic, HTML5 or subsequent version, Python 3.4 or subsequent version) to develop code.

D1 Procedural programming

- Interpret, analyse and evaluate the use of code written using procedural programming paradigms in terms of:
  - structure:
    - statements
    - blocks
    - procedures
    - functions/sub-routines
  - control structures:
    - sequence
    - conditional
    - iterative.
- Interpret, debug and use code written using procedural paradigms.

D2 Object-orientated programming

- Interpret, analyse and evaluate the use of code written using object orientated programming paradigms in terms of:
  - structure:
    - classes
    - objects/instances
  - features:
    - inheritance
    - encapsulation
    - polymorphism and overloading
    - data hiding
    - reusability.
- Interpret, debug and use code written in Python 3.4 or subsequent version and C family derived.

D3 Event driven programming

- Interpret, analyse and evaluate the use of code written using event driven programming paradigms in terms of:
  - structure:
    - main loop
    - callback function
    - sub-routines
  - features:
    - events
    - event handlers
    - event loops
    - service orientated processing
    - time driven
    - trigger functions.
- Interpret, debug and use code written in Visual Basic.

D4 Coding for the web

Interpret, analyse and evaluate the use of code written for web languages in terms of:

- the characteristics, features and implications of mark-up and web languages in relation to:
  - performance
  - platform independence
  - power
  - protocols
  - security
- the uses, applications and implications of mark-up and web languages
- interpret, debug, and use code in the mark-up language HTML5
- the uses, applications and implications of client side processing and scripting
- the uses, applications and implications of server side processing and scripting
- issues and implications of implementing code on a web platform.

D5 Translation

The issues and implications of translating code between programming languages including:

- reasons for translating code from one language to another
- benefits of translating code from one language to another
- drawbacks of translating code from one language to another
- the implications of translating code and the impact on:
  - users
  - organisations
  - developers
- alternative ways to implement current code base.

Grade descriptors

To achieve a grade a learner is expected to demonstrate these attributes across the essential content of the unit. The principle of best fit will apply in awarding grades.

Level 3 Pass

Learners are able to use problem-solving skills to develop a solution to given problems in context. Learners use standard programming constructs to demonstrate an understanding of how data is handled in a computer program. Learners are able to construct, propose, develop and explain solutions to a problem and demonstrate an understanding of data validation and error checking.

Level 3 Distinction

Learners are able to analyse and interpret given problems and develop a detailed and complex solution in response. Learners demonstrate an in-depth understanding of programming constructs and a thorough understanding of how data is handled in a computer program.

Key terms typically used in assessment

The following table shows the key terms that will be used consistently by Pearson in our assessments to ensure students are rewarded for demonstrating the necessary skills.

Please note: the list below will not necessarily be used in every paper/session and is provided for guidance only.

Command or term	Definition
Analyse	Learners examine in detail, a scenario or problem to discover its meaning or essential features. Learners will break down the problem into its parts and show how they interrelate. There is no requirement for any conclusion.
Calculate	Learners apply some form of mathematical or computational process.
Complete	Learners complete a diagram or process. Can apply to problems/solutions of varying complexity.
Demonstrate	Learners illustrate and explain how an identified computer system or process functions. May take the form of an extended writing response, a diagram or a combination of the two.
Describe	Learners provide an account of something, or highlight a number of key features of a given topic. May also be used in relation to the stages of a process.
Develop	Learners provide a solution to a problem, typically using an existing system or structure that must be improved or refined.
Discuss	Learners investigate a problem or scenario, showing reasoning or argument.

Command or term	Definition
Draw	Learners represent understanding through the use of a diagram or flowchart.
Evaluate	Learners review and synthesise information to provide a supported judgement about the topic or problem. Typically a conclusion will be required.
Explain	Learners make a series of linked points and/or justify or expand on an identified point.
Identify	Learners assess factual information, typically when making use of given stimuli. Requires a single word or short sentence answer.
Produce	Learners provide a solution that applies established constructs to a given computing problem.
State, name, give	Learners assess factual information. Requires a single word or short sentence answer.
Write	Learners produce a solution, or a mechanism used as part of a solution, to a given computing problem.

Links to other units

This assessment for this unit should draw on knowledge, understanding and skills developed from:

- Unit 2: Fundamentals of Computer Systems
- Unit 3: Planning and Management of Computing Projects
- Unit 4: Software Design and Development Project
- Unit 5: Building Computer Systems
- Unit 6: IT Systems Security
- Unit 7: IT Systems Security and Encryption
- Unit 8: Business Applications of Social
- Unit 9: The Impact of Computing
- Unit 10: Human-computer Interaction
- Unit 18: Relational Database Development
- Unit 20: Managing and Supporting Systems
- Unit 21: Virtualisation
- Unit 22: Systems Analysis and Design
- Unit 23: Systems Methodology
- Unit 24: Software Development
- Unit 26: Programmable Devices and Controllers
- Unit 28: Computer Forensics.

Employer involvement

Centres may involve employers in the delivery of this unit if there are local opportunities. There is no specific guidance related to this unit.

Unit 2: Fundamentals of Computer Systems

Level: **3**

Unit type: **External**

Guided learning hours: **90**

Unit in brief

Learners study the fundamental principles of how computer systems work, including the role of hardware and software, the way components of a system work together and how data in a system is used.

Unit introduction

Knowing how and why computer components, and the data they use, perform in certain ways has a significant impact on the work of all computing professionals. In technical support roles, understanding how different parts of a system integrate facilitates accurate identification of problems and efficient solutions. Professional programmers use their understanding of the way the computer operates to develop more efficient software solutions.

In this unit, you will explore the relationship between hardware and software as part of a computer system. You will examine the way computer components work both individually and together to store and process data, and the way in which data is transmitted and used in computer systems. You will explore the impact that computing systems have on organisations and individuals.

In this unit, you will apply the fundamental principles of computers to all areas of computing. This is essential for progression to a computing-related higher education course or for entry to the workplace as a computing professional.

Summary of assessment

This unit is assessed through a written examination set and marked by Pearson.

The examination is one hour and 45 minutes in length. During the supervised assessment period, learners will be assessed on their knowledge and understanding of how computer systems work, including the role of hardware and software, the way components of a system work together and how data in a system is used.

The number of marks for the unit is 80.

The assessment availability is twice a year in January and May/June. The first assessment availability is May/June 2017.

Assessment outcomes

AO1 Demonstrate knowledge and understanding of computing facts, terms, standards, concepts and processes

Command words: complete, draw, give, identify, name, state

Marks: ranges from 1 to 5 marks

AO2 Apply knowledge and understanding of computing facts, terms, standards, concepts and processes to real-life scenarios

Command words: calculate, complete, demonstrate, describe, draw, explain, produce

Marks: ranges from 1 to 5 marks

AO3 Select and use computing technologies and procedures to explore likely outcomes and find solutions to problems in context

Command words: calculate, demonstrate, develop, explain, produce

Marks: ranges from 1 to 6 marks

AO4 Analyse and evaluate data, information, technologies and procedures in order to recommend and justify solutions to computing problems

Command words: analyse, demonstrate, discuss, produce, write

Marks: ranges from 6 to 12 marks

AO5 Make connections between the application of technologies, procedures, outcomes and solutions to resolve computing problems

Command words: evaluate, produce, write

Marks: ranges from 6 to 12 marks

Essential content

The essential content is set out under content areas. Learners must cover all specified content before the assessment.

A Hardware and software

The concepts and implications of the use of, and relationships between, hardware and software that form computer systems.

A1 Computer hardware in a computer system

- Types of computer systems:
  - multi-functional devices
  - personal computers
  - mobile devices
  - servers.
- The purpose, features and uses of internal components used in:
  - multi-functional devices
  - personal computers
  - mobile devices
  - servers.
- Factors affecting the choice, use and performance of internal components.
- The hardware used in computer systems:
  - input devices
  - output devices
  - storage devices.
- How the features of hardware can affect their performance and the performance of a computer system.
- Factors affecting choice of hardware:
  - user experience – ease of use, performance, availability, accessibility
  - user needs
  - compatibility
  - cost
  - efficiency
  - implementation – timescales, testing, migration to new system
  - productivity
  - security.
- Data storage and recovery systems:
  - redundant array of independent disks (RAID)
  - network attached storage (NAS).

A2 Computer software in a computer system

- Operating systems:
  - types of operating system:
    - real-time operating system
    - single-user single task
    - single-user multi-tasking
    - multi-user

  - the role of the kernel in controlling and managing system components and tasks:
    - program execution
    - interrupts
    - modes
    - memory management
    - multi-tasking
    - disk access
    - file systems
    - device drivers
  - the role of the operating system in managing:
    - networking
    - security
  - factors affecting the choice and use of user interfaces:
    - graphical
    - command line
    - menu based
  - factors affecting the choice of operating system
  - factors affecting the use and performance of an operating system.
- Utility software:
  - the purpose, features and uses of utility software
  - factors affecting the choice, use and performance of utility software.
- Application software:
  - the purpose, features and uses of application software
  - factors affecting the choice, use and performance of application software.
- The principles and implications of open source operating systems and software.

A3 Data processing

- The use, features and implications of computer systems for data processing.
- The role of hardware in collecting data.
- The role of software in collecting data.
- Data processing functions:
  - aggregation
  - analysis
  - conversion
  - reporting
  - sorting
  - validation.
- The impact on individuals and organisations of using and storing data across multiple computer systems:
  - access
  - cost
  - implementation
  - productivity
  - security.
- Backup and data recovery procedures.

B Computer architecture

The implications of computer architecture models and the impact of the relationships between their component parts.

B1 Approaches to computer architecture

- The features and characteristics of different computer architecture models:
  - stored program model:
    - Von Neumann architecture
    - Harvard architecture
  - cluster computing
  - uniform memory access and non-uniform memory access.
- Use and application of emulation.
- Factors affecting the choice of different architecture models.
- The impact of using different architecture models.

B2 The concepts of microarchitecture

- Instruction cycles.
- Execution speeds:
  - factors affecting execution speeds
  - methods of increasing execution speed
  - implications of execution speeds.
- The use and choice of instruction sets.
- Pipelining.
- Cache.
- Registers.
- Multi-processing and multi-threading.
- The features and implications of embedded and mobile central processing unit (CPU) architecture.
- The features and implications of microcomputer CPU architecture.
- The features and implications of server CPU architecture.

B3 Registers and register handling

- Types of register:
  - general purpose register
  - special registers:
    - accumulator
    - instruction register
    - memory address register (MAR)
    - memory data register (MDR)
    - program counter.
- The function and purpose of general and special registers and their impact on the way computer systems perform.
- The role of interrupts in a computer system.

C How data is represented by computer systems

The characteristics, concepts and implications of computer data representation methods.

C1 Number systems

- The use and interpretation of number systems used in computer systems, including:
  - units of digital data (bit, byte, kilobyte and multiples of these)
  - binary
  - binary coded decimal (BCD).
- The use of binary arithmetic (including BCD) to perform calculations: addition, subtraction, multiplication and division.
- The use of binary to represent negative and floating point numbers.

C2 Text representation

- The purpose and implications of using codes to represent character sets.
- The features and uses of common character sets:
  - ASCII
  - UNICODE.

C3 Image representation

- How bitmap/raster image data is stored and represented in a computer system.
- The impact of image resolution on the way images are stored and represented.
- The impact of sample/bit depth on the way that image data is stored and images are displayed.
- The effects of compression on image data.

D How data is organised on computer systems

The characteristics and implications of methods of organising data in computer systems, and its impact on computer processes.

D1 Data structures

- The features, applications and implications of data types used in computer systems:
  - stack
  - queue
  - array
  - list.
- The use and application of data types in computer software.
- The use and implications of data types in computer hardware.

D2 Indices and matrices

Matrix representation in computer systems:

- the relationship between matrices and arrays
- mathematical operations using matrices
- single, two- and multi-dimensional arrays
- row-major and column-major order.

E How data is transmitted by computer systems

The concepts, processes and implications of data transmission in and between computer systems.

E1 Transmitting data

- Types of communication channel:
  - simplex
  - half-duplex
  - full-duplex
  - point-to-point
  - multi-drop.
- Methods of connecting devices and transmitting data across and between computer systems.
- The selection of connection methods to fulfil specified tasks and functions.
- Asynchronous and synchronous data transmission.
- Parallel and serial transmission.
- Use of packet data in transmitting data:
  - contents of a data packet
  - the role of components of a data packet
  - packet switching.
- Protocols used to govern and control data transmission.

- The features, applications and implications of encryption
  - simple encryption ciphers:
    - Caesar cipher
    - Vigenère cipher
  - encryption used in computer systems:
    - symmetric key encryption
    - public key encryption.
- Types of compression:
  - lossy
  - lossless.
- The applications and implications of data compression.

E2 Error detection

- Methods used to detect errors in data transmission:
  - parity schemes
  - checksum
  - repetition schemes
  - cyclic redundancy check (CRC).
- The concepts, implications and applications of error detection.

E3 Error correction

- Commonly-used error correction systems:
  - automatic repeat request (ARQ)
  - forward error correction (FEC).
- The concepts, implications and applications of error correction systems.

F The use of logic and data flow in computer systems

The use, application and interpretation of logical processes and diagrams to represent data flow and relationships in and between computer systems.

F1 Boolean logic

- The use, application and interpretation of Boolean logic to identify data flow and solve problems.
- The use, application and interpretation of Boolean logic to identify logical structures, represent data flow and solve problems.

F2 Flow charts and system diagrams

- The use, application and interpretation of flow charts and diagrams to represent data flow in and between computer systems.
- The use, application and interpretation of flow charts and diagrams to solve problems.

Grade descriptors

To achieve a grade a learner is expected to demonstrate these attributes across the essential content of the unit. The principle of best fit will apply in awarding grades.

Level 3 Pass

Learners are able to apply knowledge and understanding of key computing concepts to a range of familiar vocational contexts. They are able to use knowledge of computing to deconstruct problems in common situations and apply standard conventions to produce solutions with interpretation. Leaners are able to identify the impact of effective and ineffective computer systems and recommend ways in which a system can be developed and/or improved (using given structures and criteria).

Level 3 Distinction

Learners are able to analyse complex information, data and situations, in vocational contexts, in order to draw conclusions and make valid observations. They are able to synthesise knowledge and understanding of computing to deconstruct problems, drawing on various sources of information to develop effective solutions with justification. Learners are able to evaluate the effectiveness of computer systems to make justified recommendations on their development and future actions that can be taken.

Key terms typically used in assessment

The following table shows the key terms that will be used consistently by Pearson in our assessments to ensure students are rewarded for demonstrating the necessary skills.

Please note: the list below will not necessarily be used in every paper/session and is provided for guidance only.

Command or term	Definition
Analyse	Learners examine in detail, a scenario or problem to discover its meaning or essential features. Learners will break down the problem into its parts and show how they interrelate. There is no requirement for any conclusion.
Calculate	Learners apply some form of mathematical or computational process.
Complete	Learners complete a diagram or process. Can apply to problems/solutions of varying complexity.
Demonstrate	Learners illustrate and explain how an identified computer system or process functions. May take the form of an extended writing response, a diagram or a combination of the two.
Describe	Learners provide an account of something, or to highlight a number of key features of a given topic. May also be used in relation to the stages of a process.
Develop	Learners provide a solution to a problem, typically using an existing system or structure that must be improved or refined.
Discuss	Learners investigate a problem or scenario, showing reasoning or argument.
Draw	Learners represent understanding through the use of a diagram or flow chart.
Evaluate	Learners review and synthesise information to provide a supported judgement about the topic or problem. Typically a conclusion will be required.
Explain	Learners make a series of linked points and/or justify or expand on an identified point.
Identify	Learners assess factual information, typically when making use of given stimuli. Requires a single word or short sentence answer.
Produce	Learners provide a solution that applies established constructs to a given computing problem.
Write	Learners produce a solution, or a mechanism used as part of a solution, to a given computing problem.

Links to other units

This mandatory unit supports most of the other units in the qualification and, in particular, the following mandatory units:

- Unit 3: Planning and Management of Computer Projects
- Unit 4: Software Design and Development Project
- Unit 7: IT Systems Security and Encryption
- Unit 9: The Impact of Computing.

Employer involvement

Centres may involve employers in the delivery of this unit if there are local opportunities. There is no specific guidance related to this unit.

Unit 3: Planning and Management of Computing Projects

Level: **3**

Unit type: **External**

Guided learning hours: **120**

Unit in brief

Learners study how project planning and management concepts are applied to computing projects.

Unit introduction

A project is created for the purpose of delivering one or more business products according to an agreed business case. Good planning and management skills are essential to ensure that an end product can be delivered on time, within budget and to the required specification.

This unit explores the business case needed for the initial approval of a computing solution to meet organisational needs. It will provide you with the skills associated with project planning and management: task scheduling, budgeting, risk management, time management, quality management, and communication with all stakeholders throughout the life cycle of the project. To complete the assessment task within this unit, you will need to draw on your learning from across your programme.

In this unit, you will apply project planning and management techniques to a computing project scenario. This will develop your knowledge and understanding of the role of a computing project management professional, and support your progression to higher education studies.

Summary of assessment

This unit is assessed through a task set and marked by Pearson.

The set task will be completed under supervised conditions in two sessions during the assessment period timetabled by Pearson. Part A will last three hours and Part B will last two hours.

The set task will assess learners' ability to plan and manage a computing project. Information about the project is released to learners at the start of each session.

The number of marks for the unit is 66.

The assessment availability is December/January and May/June each year. The first assessment availability is December 2017/January 2018.

Sample assessment materials will be available to help centres prepare learners for assessment.

Assessment outcomes

AO1 Demonstrate knowledge and understanding of the project planning and management concepts, processes and life cycle

AO2 Apply knowledge and understanding of computing management tools, techniques and procedures to explore outcomes and find solutions to problems

AO3 Analyse data and information; recognise patterns, correlations and connections in order to solve problems and predict outcomes

AO4 Evaluate project planning and management tools, techniques, procedures, outcomes and solutions to make reasoned judgements and decisions

AO5 Be able to plan a computing project and manage it throughout its life cycle, with appropriate justification

Essential content

The essential content is set out under content areas. Learners must cover all specified content before the assessment.

A Project management concepts

The key factors, processes and stages that make up a typical computing project.

A1 Costs and timescales

How key factors can be used to determine project viability and measure progress and success:

- project budget
- setting milestones and deadlines
- interim reviews.

A2 Quality and deliverables

- Application of current quality standards and subsequent iterations:
  - ISO/IEC 25010:2011 as a benchmark for software development
  - World Wide Web Consortium (W3C®) for website design and functionality standards.
- Defining success criteria and using SMART (specific, measurable, achievable, realistic, timebound) objectives to define project outcomes.
- Customer requirements in terms of functional requirements and non-functional requirements.
- Product description or product breakdown structure, to describe the product to be delivered.

A3 Risk

- Identifying typical project risks:
  - external risks
  - internal risks.
- The risk management cycle:
  - identification of risks
  - assessing the severity of risks:
    - 3-point scale for impact and probability
    - impact multiplied by probability formula
  - planning – accept the risk, plan contingency or avoid the risk
  - monitor and control the risks through the project.
- Handling issues: when a risk occurs and is dealt with using the plan.

A4 Benefits

The key benefits of a project for the organisation and stakeholders and establishing a measurement of success.

- Business benefits:
  - saving money
  - maintaining or increasing profits
  - improving services
  - growing the business
  - increasing market share
  - improving productivity.
- Expected return on investment as:
  - justification for the project
  - a forecast of project success.

A5 The project life cycle

Following the life cycle to start, plan, manage and deliver a project.

- Conception and start up:
  - project mandate
  - client requirements
  - project feasibility.
- Definition of the project:
  - set up project team
  - create the Project Initiation Document (PID).
- Planning:
  - timescales
  - costs
  - quality management
  - risk management and controls.
- Launch and execution:
  - carrying out the plan
  - monitoring activity
  - checking progress.
- Closure:
  - handover of the product
  - user acceptance testing
  - disbanding project team.
- Post-project evaluation:
  - reviewing the project against success criteria.

A6 Professionalism

- The codes of conduct developed by professional bodies and their impact on how a project is planned and managed in an ethical way:
  - Association for Project Management (APM)
  - British Computer Society (BCS)
  - Project Management Institute (PMI).
- Communication and presentation for project planning and management activities:
  - appropriate for target audience
  - conveys intended meaning
  - effective use of graphics to support meaning
  - use of fluent English and appropriate technical language
  - appropriate tone for project documentation.

B Starting up a computing project

Gathering the key information needed to run a successful project, production of the PID and obtaining authorisation for the project kick-off.

B1 Interpreting the business case

The business case as a driver of the project:

- reasons for the project
- options that should be considered
- expected business benefits
- timescale, including major milestones
- budget available
- major risks.

B2 Stakeholders

Identification of anyone with an interest in the project and allocation of their project responsibilities.

- Key stakeholder responsibilities:
  - project manager – responsible for defining, planning, controlling and leadership
  - technical teams – responsible for performing the project tasks
  - team managers – responsible for following company policies and providing resources
  - project sponsor – provides the authority and guidance, and maintains the priority of the project in the organisation
  - client – provides the product requirements and project finance.
- Other stakeholders:
  - suppliers – provide materials and equipment
  - contractors – contribute specialist work
  - general public – may be affected by the project.

B3 Identifying assumptions and constraints

- Dealing with assumptions as low-level risks documented at the outset.
- Constraints:
  - deadlines and the time available
  - funds for the project, including contingency
  - availability of staff when required
  - availability of required equipment
  - technical expertise in the project team
  - limitations of technology.

B4 The Project Initiation Document (PID)

- Production of a PID to contain the key management information:
  - document details
  - approvals
  - distribution
  - purpose of PID
  - project background, including how the project fits into the organisation
  - objectives, written as SMART targets
  - scope, a statement of what is and what is not included in the project
  - the business case
  - assumptions
  - constraints
  - risk management strategy
  - deliverables
  - project quality strategy
  - stakeholders
  - representation of the project management team structure as an organisation chart indicating roles
  - project plan
  - communication plan
  - document management.
- Communication and presentation requirements in the PID.

C Project planning

The process of creating and updating the plans to ensure that the project is completed on time, in budget and to specification.

C1 Scheduling and milestones

- Work breakdown structure.
- Task scheduling and precedence, including serial and parallel scheduling of tasks.
- Critical path analysis to identify spare capacity in time schedule.
- Gantt charts as a planning and progress tracking tool.
- Selection and use of project planning software tools.

C2 Resources and budgeting

- Resource requirements and allocation:
  - people and their work allocation
  - equipment and materials
  - allocation of work and material resources to tasks
  - pro rata costing.
- Application of estimation techniques to forecast project duration and cost:
  - bottom-up
  - parametric, using simplified function point analysis
  - top-down.
- Budget planning and cash flow to organise resource usage.
- Use of appropriate software tools: spreadsheets and project planning software.

C3 Risk management strategy

- Risk analysis process:
  - use of impact and probability to calculate severity
  - use of a risk matrix to classify risks as green, amber or red.
- Contingency planning for major risks.
- Documenting risks using a standard template.
- Recording issues:
  - use of an issues log
  - cross-referencing to the risk matrix.

C4 Quality management

Use and application of quality management project processes, techniques and procedures.

- Defect removal:
  - desk checking and proofreading
  - peer review
  - inspection and walkthrough.
- Testing strategy:
  - unit testing against unit specifications
  - integration testing against designs
  - systems testing against requirements
  - regression testing.
- Use of quality standards as an external benchmark.

C5 Communications

Identification of appropriate communication methods and frequency requirements.

- Methods for project team communication:
  - meetings and one-to-one discussions
  - memos and notices
  - telephone conversations and video conferences
  - emails and instant messaging
  - online forums, discussion groups and news groups
  - collaborative working tools.
- Devising a communication plan:
  - frequency of communication
  - target audience
  - agendas and minutes
  - communication and presentation requirements.

D Executing and monitoring a project

Running a live project, keeping track of progress and dealing with problems or changes to the project.

D1 The waterfall software development life cycle model

Use of the model to inform the stages of a project plan.

- Requirements analysis.
- Design.
- Construction and testing.
- Acceptance testing.
- Implementation and delivery.

D2 Monitoring and tracking progress

- Project baseline and variance.
- Monitoring and recording progress.
- Checkpoint reports as a way of recording milestones achieved.
- Monitoring risk and managing issues.
- Recording quality management activity.

D3 Managing issues

Categorisation of issues, taking action and recording activity as part of the risk management process.

- Categorising issues:
  - request for change
  - off-specification
  - problem or concern.
- Management by exception: reporting unforeseen issues to the project sponsor and the potential impact on the project.
- Recording lessons learned.

D4 Change management

The management of project changes triggered by the occurrence of an issue.

- Impact on the project:
  - entire project
  - stage(s) of project.
- Change of scope for:
  - requirements and effects on quality
  - costs
  - timescales.

- Development changes, handling modifications to designs.
- Dealing with faults:
  - defects in analysis and design documentation
  - software errors.
- The change management process:
  - change request submitted by project manager
  - review of the change request by management team
  - assessing feasibility of the change of scope
  - approval or rejection by management team
  - implementation of change by project team.

D5 Implementation strategy

Product delivery options as agreed with the client.

- Choice dependent on size and complexity of system:
  - direct changeover
  - parallel running
  - pilot changeover
  - user acceptance testing as part of the quality and review process.

E Project closure and post-project review

E1 Closing a live project

Completing a project in an organised and controlled way.

- Moving into operation and maintenance phase.
- Assessing the benefits delivered and plan to review again later.
- Closing down risk log, issue log, quality log.
- Summarising and reviewing the lessons learned.

E2 Review of project success

Determining a project's success in terms of key factors, SMART objectives and views of stakeholders.

- Review of lessons learned.
- Review project performance against the baseline and project objectives.
- Review of final cost, delivery date and quality of product delivered.
- Review feedback from key stakeholders:
  - sponsor
  - clients
  - end users
  - development team.
- Methods to obtain feedback and their advantages and disadvantages:
  - interviews
  - questionnaires
  - surveys
  - observation of resulting processes.
- Recommendations for future actions based on the outcome of the post-project review.
- Communication and presentation requirements for reviews.

Grade descriptors

To achieve a grade a learner is expected to demonstrate these attributes across the essential content of the unit. The principle of best fit will apply in awarding grades.

Level 3 Pass

Learners are able to use their knowledge of project planning, management concepts and processes and the application of problem-solving skills to show the documenting of project planning and management requirements. These are limited in scope and may be incomplete.

Learners are able to use planning and management documentation, and demonstrate an understanding of their completion and development to a minimal level of acceptability in order to support an organisation's project. Their evaluation of a given project planning and management scenario is limited in scope and may be incomplete.

Level 3 Distinction

Learners demonstrate that they can evaluate a given project planning and management problem, and develop a detailed and complex project planning and management documented solution to effectively meet all project scenario requirements. Learners demonstrate an in-depth understanding of project planning and management documentation requirements and are able to show that they fully understand how these are used to produce an effective project solution. They are able to evaluate their solution in order to make justified recommendations on project development and future actions.

Key terms typically used in assessment

The following table shows the key terms that will be used consistently by Pearson in our assessments to ensure students are rewarded for demonstrating the necessary skills.

Please note: the list below will not necessarily be used in every paper/session and is provided for guidance only.

Command or term	Definition
Function point	A way of measuring the amount of work taken to implement part of a software system, for example it might take 10 developer hours to implement a search function.
Gantt chart	A bar chart which provides a graphical illustration of a schedule that helps to plan, coordinate and track all the tasks in a project against a baseline.
Lessons learned	A summary report which brings together any insights gained during a project that can be usefully applied on future projects. This includes factors and actions that supported success, and learning from what did not go well.
Modules	Part of a large software system that carries out a specific business role; for example different departments will use different modules within a full system, i.e. Human Resources will use a payroll module to calculate staff wages. During development each module is likely to be built and tested independently, often by different groups of developers and testers.
Operating system	Software that manages computer hardware and software resources, and also provides common services for computer programs.
Project kick-off	The official launch of the project; the point at which details of the project are promoted. The kick-off will only happen after some initial investigation to establish that the project is viable, such as: Can the client afford it? Can it be done in the timescale? Is it technically possible?
Regression testing	A type of software testing that seeks to uncover new software bugs, or regressions in existing functional and non-functional areas of a system after changes, such as enhancements, patches or configuration changes have been made to them.
Resource list	A list of all the staff, equipment and raw materials required for a project, along with their associated costs. Staff will usually have an hourly rate or annual salary, while equipment and materials will usually be fixed costs.

Command or term	Definition
Server	Hardware and software that provides centrally managed services on a computer network, such as a database or email system.
Stakeholder	Anyone with an interest in the project. Can include those who have an interest in or can affect/are affected by the computing project. They can be internal or external, and at senior or junior levels.

Links to other units

This assessment for this unit should draw on knowledge, understanding and skills developed from:

- Unit 1: Principles of Computer Science
- Unit 2: Fundamentals of Computer Systems
- Unit 4: Software Design and Development Project
- Unit 5: Building Computer Systems
- Unit 6: IT Systems Security
- Unit 7: IT Systems Security and Encryption
- Unit 8: Business Applications of Social Media
- Unit 9: The Impact of Computing.

This unit would relate to teaching of:

- Unit 10: Human-computer Interaction
- Unit 16: Object-orientated Programming.

Employer involvement

This unit would benefit from employer involvement in the form of:

- guest speakers
- technical workshops hosted by staff from local organisations/businesses
- opportunities for observation of organisational/business application during work experience.

Unit 4: Software Design and Development Project

Level: **3**

Unit type: **External**

Guided learning hours: **120**

Unit in brief

Learners study the knowledge and skills involved in the design, creation and evaluation of software using Python (3.4 or a later version) or C family programming languages.

Unit introduction

In the computing industry there is a demand for computing professionals who can decompose complex problems and develop appropriate solutions. Problem-solving skills are essential for a software developer, as software design and development problems often require complex solutions in order to create robust software that is fit for purpose.

In this unit, you will explore the skills necessary to design and create software. You will explore standard conventions and ways of working to create solutions to problems. You will examine a given scenario and develop effective design solutions to produce software. Finally, you will evaluate each stage of the development process and the effectiveness of your software solution. To complete the assessment task within this unit, you will need to draw on your learning from across your programme.

These skills are required for progression to computing-related higher education courses or to the workplace as a computing professional.

Summary of assessment

This unit is assessed through a task set and marked by Pearson.

The set task will be completed under supervised conditions for a maximum of six hours in a one-week period set by Pearson which can be arranged over a number of sessions.

The set task will assess learners' ability to design, create and evaluate software using Python (3.4 or a later version) or one of the C family programing languages.

The number of marks for the unit is 68.

The assessment availability is December/January and May/June each year. The first assessment availability is May/June 2018.

Sample assessment materials will be available to help centres prepare learners for assessment.

Assessment outcomes

AO1 Demonstrate knowledge and understanding of computer coding paradigms and the software development life cycle

AO2 Apply knowledge and understanding of computer coding paradigms and the software development life cycle to design and create a software product to meet a client brief

AO3 Analyse information about computing problems and data from test results to optimise the performance of a software solution throughout the development life cycle

AO4 Evaluate evidence to make informed judgements about the success of a software product's design and performance

AO5 Be able to develop a software solution to meet a client brief with appropriate justification

Essential content

The essential content is set out under content areas. Learners must cover all specified content before the assessment.

A Software development life cycle

A1 Stages of software development

Selecting and applying the different stages of the software development life cycle to a problem in order to give the optimum result.

- Software development life cycle:
  - conception
  - analysis
  - design
  - implementation
  - testing
  - evaluation.
- Determination of scope and size.
- How to apply each stage of development to get the best results.

B Standard methods and techniques to develop designed solutions

Techniques used to design solutions to problems.

B1 Flow chart and use of standard symbol conventions

Selecting and using software tools for developing flow charts to describe a system or solution.

- Use of British Computer Society (BCS) symbols:
  - processes
  - decisions
  - inputs/outputs
  - connectors
  - start/end.

B2 Structured English (pseudocode)

Pseudocode statement development to describe computing tasks, processes and its use to solve problems.

- Writing pseudocode:
  - sequence
  - structure:
    - hierarchy
    - indentation
  - operations:
    - BEGIN
    - END
    - INPUT
    - OUTPUT
    - PRINT
    - READ
    - WRITE
  - decisions:
    - IF
    - THEN
    - ELSE
    - ELSEIF(ELIF)
    - WHEN

  - repetition:
    - FOR
    - REPEAT UNTIL
    - WHILE
    - WHILE NOT.
- Developing pseudocode:
  - improving the effectiveness and efficiency of pseudocode
  - identifying and fixing errors in pseudocode.

B3 Test data

Select appropriate tests and test data to produce test plans for an identified solution.

- What to test:
  - functionality
  - stability
  - usability.
- Choice of test data:
  - normal test data
  - abnormal test data
  - extreme test data.
- Expected test results from a range of testing methods.

C Software design considerations

Selecting and applying design concepts to develop accurate, efficient and effective solutions.

C1 Design concepts

- Selecting and applying common good practice design concepts:
  - compatibility
  - extensibility
  - efficiency
  - informative
  - fault recovery
  - high maintainability
  - modularity
  - reliability
  - reusability
  - robustness
  - correctness
  - usability.
- The features, impact and implications of embedding poorly designed solutions:
  - rigidity
  - fragility
  - immobility
  - inconsistency
  - dissatisfied users.

C2 Code readability

- The features, applications, impact and implications of adopting code readability when developing code:
  - maintainability
  - naming conventions
  - indentation
  - commenting/code annotation.

- Factors which contribute to the quality of code:
  - efficiency
  - readability
  - robustness
  - usability
  - portability.

D Programming paradigms

Standard structures and conventions in Python 3.4 (or later version) and C family programming languages and their use to build and develop accurate, efficient and effective computer code to fulfil identified criteria and solve problems.

D1 Handling data in a program

Selecting, using and interpreting common data-handling techniques and structures provided in programming languages to process data.

- Defining and declaring constants and variables:
  - alphanumeric strings
  - arrays
  - Boolean
  - characters
  - date/time
  - floating point (real)
  - integers
  - objects
  - records
  - sets.
  - strings
- Managing variables:
  - local and global variables
  - naming conventions.

D2 Arithmetic operations

Selecting, applying, using and interpreting mathematical expressions in computing structures to process data.

- Mathematical operators: +, –, / (DIV), *, %/MOD/modulo/rem.
- Relational operators: =, <, >, <>, <=, >=
- Boolean operators: NOT, AND, OR.
- Date.
- Time.

D3 Built-in functions

Selecting, using and interpreting common functions and pre-defined libraries provided in programming languages to perform specific tasks to process data.

- Arithmetic functions:
  - random
  - range
  - round
  - truncation.

- String handling functions:
  - concatenation
  - length
  - position
  - string conversion:
    - integer to string
    - float to string
    - string to integer
    - string to float.
- General functions:
  - input
  - open
  - print
  - range.
- Built-in library use to add functionality.

D4 Validating data

Selecting, using and interpreting validation techniques to analyse and improve the accuracy and validity of data.

- Validation check techniques:
  - data type
  - range
  - constraints
  - Boolean.
- Post-check actions.
- Case statements.

D5 Control structures

Selecting, using and interpreting common programming control structures to analyse, develop and improve the effectiveness of code.

- Loops:
  - REPEAT
  - FOR
  - WHILE
  - BREAK.
- Branches:
  - IF
  - THEN
  - ELSE
  - ELSEIF (ELIF).
- Function calls:
  - defining functions
  - declaring arguments
  - calling functions.

D6 Data structures

Selecting and using common data structures in a computer program to store and process data.

- Lists.
- Arrays:
  - single dimensional arrays
  - multi-dimensional arrays.
- Records.
- Sets.

E Evaluating a software development project

The characteristics, concepts, impact and implications of testing methodologies to monitor and evaluate the design, the software created, testing processes and success of the solution.

E1 Evaluation of design

Evaluating the design against the scenario requirements.

- Appropriate application of BCS symbols to the flow chart.
- Appropriate application of pseudocode.
- Coverage of functionality requirements and identification of any omissions.
- Identification of design strengths and potential further improvements to meet the scenario requirements.
- The strengths and weaknesses of using a flow chart versus using pseudocode for a specific scenario and the reasons why.

E2 Evaluation of software testing

Applying test data to ensure that the software solution gives the correct output and is robust and the associated record keeping of testing and outcomes.

- Different types of testing:
  - normal test data
  - abnormal test data
  - extreme test data.
- Recording of actual results and analysis.
- Commenting on results.
- Test records:
  - completion of test records
  - taking of and storing screenshots of tests.
- Making use of testing outcomes.
- Using iterative processes to improve accuracy, readability and robustness.
- Determining which tests were successfully met and which test data issues were not resolved.
- Identifying own learning and skill requirements arising from the testing process.

E3 Evaluation of the software

Evaluating the software outcome against the requirements of the brief.

- Strengths and weaknesses of the software:
  - solution fitness for purpose
  - intuitiveness and ease of use
  - constraints of the programming language used
  - maintainability of the program
  - extent to which software meets the brief's requirements
  - maintainability of the software.
- Identifying of own learning and skill requirements arising from the software development process.

Grade descriptors

To achieve a grade a learner is expected to demonstrate these attributes across the essential content of the unit. The principle of best fit will apply in awarding grades.

Level 3 Pass

Learners are able to use their knowledge and understanding of software design and development to design, develop and build software in response to client requirements.

Learners are able to use standard programming constructs and demonstrate an understanding of how to design and develop a basic solution, which is supported by evidence of testing and evaluation.

Level 3 Distinction

Learners demonstrate that they can analyse and interpret information related to a given problem and develop a detailed solution to meet all scenario requirements. Learners demonstrate an in-depth understanding of programming constructs and show that they fully understand how data is handled in a computer program. They produce an optimised solution which provides accurate results with evidence of thorough testing and evaluation, supported by justification.

Key terms typically used in assessment

The following table shows the key terms that will be used consistently by Pearson in our assessments to ensure students are rewarded for demonstrating the necessary skills.

Please note: the list below will not necessarily be used in every paper/session and is provided for guidance only.

Command or term	Definition
Annotation	A term used in computer programming to refer to documentation and comments that may be found on code logic. For those who will use the code or modify the code at a later date, it can provide a rationale behind the logic or an explanation of how the logic accomplishes its purpose or goal.
C family	A family of programming languages that includes all languages that are descendants of the C programming language.
Coding conventions	Guidelines for a programming language that recommend programming style, practices and methods for each aspect of a piece of program written in this language. May cover: file organisation, indentation, comments, declarations, statements, white space, naming conventions, programming practices, programming principles, programming rules of thumb, architectural best practices, etc.
Evaluate	A review and synthesis of each stage of software design and development processes and outcomes to provide a supported judgement about the quality. Typically a conclusion will be required.
Flow chart	A formalised graphic representation to show the logic sequence of the program and define relationships.
Logical operators	Used primarily to determine the flow of a program through the use of selection (if statements and iteration (looping)).
Program	A list of instructions that tell a computer what to do. It is also used to refer to the software product that is provided to meet a client's brief.
Pseudocode	An informal high-level description of the operating principle of a computer program or other algorithm. It uses the structural conventions of a programming language, but is intended for human reading rather than machine reading.
Python (3.4 or later version)	Python is a programming language. For the purposes of learners' assessment, the version of Python used must be 3.4 or a later version.

Command or term	Definition
Quality of a program	The reliability, robustness, usability, efficiency/ performance and maintainability of a software product.
Test data	Data that has been specifically identified for use and is used in the testing of a program.
Test log	Used to plan and record program testing and to record the outcomes of testing and the changes made to solve problems.

Links to other units

This assessment for this unit should draw on knowledge, understanding and skills developed from:

- Unit 1: Principles of Computer Science
- Unit 2: Fundamentals of Computer Systems
- Unit 3: Planning and Management of Computing Projects
- Unit 7: IT Systems Security and Encryption
- Unit 8: Business Applications of Social
- Unit 9: The Impact of Computing.

Employer involvement

This unit would benefit from employer involvement in learning delivery in the form of:

- guest speakers
- technical workshops hosted by staff from local organisations/businesses
- opportunities for observation of organisational/business application during work experience.

Unit 7: IT Systems Security and Encryption

Level: **3**

Unit type: **Internal**

Guided learning hours: **90**

Unit in brief

Learners will study IT system security threats and the methods used to protect against them. Learners undertake activities to protect IT systems from security threats, including data encryption.

Unit introduction

Our increasing reliance on computer systems makes us vulnerable to a range of attacks from cyber criminals. On a global scale, some conflicts reveal that IT systems are a now a target. As IT system security defences become more robust, attack methods become more sophisticated. IT professionals require a good understanding of current security threats and of how to apply appropriate protection methods for any given situation. They also need to comply with legal requirements at all times.

In this unit, you will investigate the many different types of security attack, the vulnerabilities that exist and techniques that can be used to defend the IT systems of organisations. Many organisations run complex IT networks and need them to be secure while providing a safe environment for their employees to work, sharing some data and keeping other data private. You will learn about the complexities of configuring and supporting these networks. You will also explore how encryption can be used to protect data. You will plan and apply suitable protection to an IT system and test it to ensure the protection is effective. You will configure an IT system's access control settings to control user access to various IT system resources, including files, folders and printers. Finally, you will review the protection that you have applied to an IT system and consider how effective it might be in defending the system from attack. To complete the assessment task within this unit, you will need to draw on your learning from across your programme.

It is important that all IT professionals have a good understanding of security issues and how to defend IT systems against increasingly sophisticated attacks. This unit will prepare you for professional practice as well as entry to a higher education programme that contains elements of cyber security.

Learning aims

In this unit you will:

A Understand current IT security threats, information security and the legal requirements affecting the security of IT systems

B Investigate cryptographic techniques and processes used to protect data

C Examine the techniques used to protect an IT system from security threats

D Implement strategies to protect an IT system from security threats.

Summary of unit

Learning aim	Key content areas	Recommended assessment approach
A Understand current IT security threats, information security and the legal requirements affecting the security of IT systems	**A1** Threat types **A2** Computer network-based threats **A3** Information security **A4** Legal requirements **A5** Impact of security breaches	A report explaining different IT security threats, their potential impact on organisations and the principles of information security and why organisations must adhere to legal requirements when considering security. A report explaining the principles and uses of cryptography, and an assessment of the impact of encryption and security protection, in general, on security and legal issues. An evaluation of the effectiveness of different protection techniques.
B Investigate cryptographic techniques and processes used to protect data	**B1** Cryptographic principles **B2** Cryptographic methods **B3** Applications of cryptography	
C Examine the techniques used to protect an IT system from security threats	**C1** Physical security **C2** Policies and procedures **C3** Software-based protection	Detailed testing documentation explaining how protection techniques can help defend an organisation and a plan showing the protection to be applied to a system to meet specific requirements. Annotated photographic/video evidence of protection measures applied to an IT system. Completed review of the protected IT system. Annotated photographic/video evidence of improvements and optimisations being made to an IT system. Written or audio/video recorded justification of planning decisions and an evaluation of the protected IT system. A report evaluating the plan and the protected system against the requirements.
D Implement strategies to protect an IT system from security threats	**D1** Group policies **D2** Anti-malware protection **D3** Firewall configuration **D4** Wireless security **D5** Access control **D6** Testing and reviewing protection applied to an IT system **D7** Skills, knowledge and behaviours	

Content

Learning aim A: Understand current IT security threats, information security and the legal requirements affecting the security of IT systems

A1 Threat types

Current security threats and techniques (which are continually evolving), including:

- internal threats, e.g. employee actions, data theft, accidental loss, unintentional disclosure or damage to data, unsafe practices (use of external flash storage, visiting untrusted websites, downloading/uploading files to/from the internet, users overriding security controls, file sharing apps and bring your own device (BYOD))
- external threats, e.g. data theft, destruction, withholding and/or disruption of systems (by competitors, cyber criminals, governments, terrorists) for political purposes or financial gain
- physical threats, e.g. theft of equipment or data, malicious damage to equipment or data, damage or destruction by fire, flood, terrorist action or other disaster
- social engineering and software-driven threats, techniques used to obtain secure information (software that has a malicious intent), e.g. malware, viruses, worms, Trojan horses, ransomware, spyware, adware, rootkits and backdoors.

A2 Computer network-based threats

- Passive threats, including wiretapping, port scanning and idle scanning.
- Active threats, including denial-of-service attack, spoofing, man in the middle, Address Resolution Protocol (ARP) poisoning, smurf attack, buffer overflow, heap overflow, format string attack, Structured Query Language (SQL) injection and cyber attack.
- Cloud computing security risks.

A3 Information security

- Principles of confidentiality, integrity and availability of information.
- Unauthorised access or modification of information.
- Principle of minimal access to information or lowest required access permission to be able to maximise protection.
- Deliberate or accidental loss of information.
- The need to protect intellectual property from theft or malicious damage, e.g. personal information, bank account details, employment details.

A4 Legal requirements

Legislation must be current and applicable to England, Wales or Northern Ireland, as appropriate to where the qualification is being taught.

- Data protection legislation and the requirements it places on organisations to keep data about stakeholders secure.
- Computer misuse legislation and its definitions of illegal practices and applications.
- Copyright, designs and patents legislation and its requirements in terms of protecting software products and digital media such as music and films.
- Telecommunications (Lawful Business Practice) (Interception of Communications) regulations and their requirement to allow companies to monitor employee communication using IT systems and other uses of the internet while at work.
- Fraud legislation and its requirement to deal with services using IT-based methods to steal information for fraudulent purposes.
- Legal liability and contractual obligations.

A5 Impact of security breaches

A serious security breach is likely to result in one or more of the following:

- operational impact on an organisation of the loss of data or service
- financial impact of loss of service, such as an e-commerce website
- damage to reputation
- legal consequences of data privacy breaches
- forensics research requirements to identify data lost, stolen or copied.

Learning aim B: Investigate cryptographic techniques and processes used to protect data

B1 Cryptographic principles

- The principles and uses of encryption, including digital rights management (DRM); password storing and salts; obfuscation and steganography; secure transactions; two-factor authentication; file, folder, disk encryption; encryption of communication data, e.g. police, mobile phone.
- Legal and ethical issues.
- Computational hardness assumption.

B2 Cryptography methods

Key cryptography methods, e.g.:

- shift ciphers, one-time pads, hash functions (e.g. MD4, MD5, SHA-2 SHA-3), block ciphers, stream ciphers
- cryptographic primitives, e.g. pseudo random functions, one-way functions
- cryptographic salts and their use in storing passwords
- encryption algorithms, e.g. RSA, DES, 3DES
- mathematical principles, integer factorisation, prediction of prime numbers.

B3 Applications of cryptography

The types and application of cryptography, including:

- symmetric key encryption
- public key encryption
- key exchanges (Diffe-Hellman)
- digital certificates (including certificate authorities)
- HTTPS protocol
- virtual private networks (VPNs)
- Generic Routing Encapsulation (GRE) tunnels
- encryption of data on Wi-Fi networks.

Learning aim C: Examine the techniques used to protect an IT system from security threats

Protection techniques, to include physical security, policies and procedures, software-based protection and regular audit of security.

C1 Physical security

- Building and computer/network room security, e.g. door locks, card key entry, closed circuit television (CCTV), voice control and biometrics such as facial recognition, fingerprint and iris scans, DNA identification technology.
- Servers, routers, switches kept in a secure location with controlled access.
- Backing up data, e.g. full backup, differential and incremental backups, use of a fire safe and off-site storage of data.
- IT disaster recovery plans for use when an organisation's IT systems become unavailable.

C2 Policies and procedures

Relevant policies and procedures, including:

- organisational policies and their application, including internet and email use policies, security and password procedures, staff responsibilities, training of staff on IT security issues, disciplinary procedures
- security audits and their application to check compliance of policies and procedures
- default 'factory settings' and 'reset' options are removed from hardware and software configuration
- any known backdoors are removed
- management of patches for hardware (firmware) and software (operating systems, security applications)
- installation of applicable security updates, including rollout management, minimising disruption, sandbox testing of updates and establishing potential risks
- any rules created do not impede normal business operation for an individual and the organisation:
  - ingress and egress of expected network traffic
  - server interconnectivity
  - time based, allowing/preventing resource access
  - allowing external access to internal servers
  - allowing data interchange between suppliers, business partners, external cloud-based solutions
  - the impact of aggressive email filters
  - use of different software by different individuals.

C3 Software-based protection

- Anti-virus software and detection techniques, including virus signatures, heuristic techniques used to identify potentially suspicious file content, techniques for dealing with identified threats.
- Software and hardware firewalls and the filtering techniques they use, including packet filtering, inbound and outbound rules, and network address translation.
- Intrusion detection systems (IDSs), including setting signatures, establishing requirements, traffic monitoring.
- Domain management, including prevention of unintended devices joining a system.
- User authentication, including user log-on procedures, strong passwords, text and graphical passwords, biometric authentication, two-step verification, security tokens (e.g. USB-based keys), knowledge-based authentication (e.g. question and response pairs), Kerberos network authentication for Windows® and Linux®-based systems, certificate-based authentication.
- Access controls and the methods they use to restrict authorised/unauthorised users access to resources (user groups and the access rights allocated to them such as folders, files and physical resource such as printers), e.g. Windows NTFS file permissions, Linux octal file permissions.

Learning aim D: Implement strategies to protect an IT system from security threats

D1 Group policies

- Tools for managing a set of IT systems.

D2 Anti-malware protection

- Installation of anti-malware software, configuration of anti-malware scanning schedules.

D3 Firewall configuration

Hardware and/or operating system-embedded firewalls, including configuration of:

- inbound and outbound rules to control network connections that are allowed and prevent all other unauthorised connections
- firewall events and interpretation of log entries.

D4 Wireless security

- Wireless encryption methods, e.g. Wired Equivalent Privacy (WEP), Wi-Fi Protected Access (WPA), WPA2.
- Configuration of wireless router security settings.

D5 Access control

- Design and implementation of hardware and software access control regimes, including permission settings on files, folders and resources.
- Defining legitimate users and groups, and the resources they need to access and the levels of access they need (read, modify, delete).
- Defining password policies, including length, complexity, age and reuse for desktop and server computers.
- White listing of applications' trusted signed binaries.
- Data hiding when viewing logs and visibility of sensitive data.
- Defining users with special privileges, e.g. administrator rights and when these are used.

D6 Testing and reviewing protection applied to an IT system

- Firewall testing to check the firewall blocks unauthorised traffic and allows legitimate traffic through.
- Systematically test 'allowed' and 'blocked' entry points.
- Run system scans of all relevant hardware and software on a secured system using common testing tools.
- Network testing tools, including scanners, security-based operating system distribution, sniffers.
- Viewing and interpreting activity logs.
- Judging the effectiveness of protection and making recommendations for further improvements.

D7 Skills, knowledge and behaviours

- Planning and recording, including the setting of relevant targets with timescales, and how and when feedback from others will be gathered.
- Reviewing and responding to outcomes, including feedback from IT professionals and users, e.g. effectiveness of protection, degree to which the protection hinders the system's everyday use.
- Demonstrate own behaviours and their impact on outcomes, including professionalism, etiquette, being supportive of others, timely and appropriate leadership, accountability.
- Evaluating outcomes to help inform high-quality, justified recommendations and decisions.
- Documenting processes and outcomes, e.g. diary notes, planning documents, witness testimonies and discussion notes or recordings.
- Communication skills, including:
  - conveying intended meaning, e.g. written (email, design documentation, recording documentation, reports, visual aids for use in presentations use); verbal communication requirements (one-to-one and group informal and formal situations)
  - use of tone and language for verbal and written communications to convey intended meaning and make a positive and constructive impact on the audience, e.g. positive and engaging tone, technical/vocational language suitable for intended audience, avoidance of jargon.
  - responding constructively to the contributions of others, e.g. being supportive, managing contributions so all have the opportunity to contribute, responding to objections, managing expectation, resolving conflict.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Understand current IT security threats, information security and the legal requirements affecting the security of IT systems</td><td rowspan="4">AB.D1 Evaluate the effectiveness of the techniques used to protect organisations from security threats while taking account of the principles of information security and legal requirements.</td></tr>
<tr><td>A.P1 Explain the different security threats that can affect the IT systems of organisations.
A.P2 Explain the principles of information security when protecting the IT systems of organisations.
A.P3 Explain why organisations must adhere to legal requirements when considering IT systems security.</td><td>A.M1 Assess the impact that IT security threats can have on organisations' IT systems and business while taking account of the principles of information security and legal requirements.</td></tr>
<tr><td colspan="2">Learning aim B: Investigate cryptographic techniques and processes used to protect data</td></tr>
<tr><td>B.P4 Explain the principles and uses of cryptography to secure and protect data.</td><td>B.M2 Analyse how the principles and uses of cryptography impact the security and protection of data.</td></tr>
<tr><td colspan="2">Learning aim C: Examine the techniques used to protect an IT system from security threats</td><td rowspan="4">CD.D2 Evaluate the plan and the effectiveness of the protected IT system against requirements.
CD.D3 Demonstrate individual responsibility and effective self-management in the planning and protection of an IT system.</td></tr>
<tr><td>C.P5 Explain how protection techniques can help defend an organisation from security threats.
C.P6 Produce a plan to protect an IT system that meets organisational and legislative requirements.</td><td>C.M3 Justify the choice of protection techniques used to defend the IT systems of an organisation, showing how its IT system will be protected from security threats.</td></tr>
<tr><td colspan="2">Learning aim D: Implement strategies to protect an IT system from security threats</td></tr>
<tr><td>D.P7 Perform tasks to protect the IT system to meet requirements given in the plan.
D.P8 Review the extent to which the organisation's IT system has been protected.</td><td>D.M4 Enhance the protection of the IT system to meet requirements given in the plan.</td></tr>
</table>

Essential information for assignments

The recommended structure of assessment is shown in the unit summary with suitable forms of evidence. *Section 6* gives information on setting assignments and there is further information on our website.

There is a maximum number of two summative assignments for this unit. The relationship of the learning aims and criteria is:

Learning aims: A and B (A.P1, A.P2, A.P3, B.P4, A.M1, B.M2, AB.D1)

Learning aims: C and D (C.P5, C.P6, D.P7, D.P8, C.M3, D.M4, CD.D2, CD.D3)

Further information for teachers and assessors

Resource requirements

As IT security is a very fast-moving discipline, regular research will be needed to keep learning delivery up to date – for example any changes to legislation applicable to IT security and the protection of IT systems and organisations.

For this unit, learners must have access to hardware and software resources that will allow them to apply security protection measures. Examples include computer systems, laptops or a virtualised environment, providing that they do not compromise the security of other 'live' systems. Learners may also need access to networking hardware such as a switch, wireless access point and router.

Essential information for assessment decisions

Learning aims A and B

For distinction standard, learners will provide comprehensive evidence that they have fully investigated and considered how effective security protection measures are likely to be in defending the IT systems of organisations against the security threats that they have been examining. Learners must discuss the protection techniques that are likely to be effective and those that are not, explaining why each technique would or would not be effective. They will make links between the effects of the security threats identified in their investigation, the effectiveness of the protection, the legal requirements (for example to keep personal data secure) and the information security requirements, as listed in the unit content. The evidence will demonstrate high-quality written or oral communication through the use of accurate and fluent technical vocabulary, which supports a well-structured and considered response that clearly connects chains of reasoning.

For merit standard, learners will provide a clear, balanced assessment of the potential impact of a wide range of IT security threats to organisations that rely on IT systems. Learners will refer to real-life examples of how security breaches have impacted on organisations.

Learners must provide a clear, balanced analysis of how the principles and uses of cryptography impact on the security and protection of data. For example, encryption techniques can have different strengths of protection, with the risk that some are more vulnerable than others. The evidence must be technically accurate and demonstrate good-quality written communication.

For pass standard, learners will provide detailed explanations of the various IT security threats, including why IT systems are vulnerable or not, as the case may be. Learners must cover internal, external, physical, social engineering and software threats. They also need to cover the principles of information security and the legal requirements that apply to an organisation's IT systems. For example, learners could explain how access control methods can help organisations comply with data protection and privacy laws and organisational requirements for confidentiality. They could also explain how company IT policies can make it clear to employees that employers have the right to monitor their emails and internet use at work. When covering the principles and uses of cryptography, learners will provide detailed technical explanations. The evidence may have some inaccuracies.

Learning aims C and D

For distinction standard, learners will draw on, and show synthesis of, knowledge across the learning aims to evaluate their plan, measure the effectiveness of the security protection methods applied to the IT system and refer to how their solution met the stated requirements. For example, learners have chosen to apply specific access controls for certain users, they would need to show how effective this measure is in terms of granting access to the right users and preventing access to others. Learners must also include what they have done differently where measures have been ineffective. Evidence must include results of testing carried out on the security that has been applied, as well as a review of planning against the implementation of the protection.

Learners will articulate their arguments and views concisely and professionally, and evaluate concepts, ideas and actions to reach reasoned and valid conclusions when justifying planning and implementing decisions in the protection of an IT system. They will demonstrate individual responsibility for their own work (for example identifying potential issues and resolving these, reviewing their work and making improvements, keeping their work safe and secure and showing responsible use of quoted materials) and effective self-management when planning and applying security protection methods to an IT system, including how they have handled breaches. They can also show awareness of how this is managed by organisations – for example, Product Security Incident Response Teams (PSIRTs). Learners must provide evidence of their methods of working, which can be diary notes, planning documents, witness testimonies, and discussion notes or recordings.

For merit standard, learners will provide a clear, reasoned justification of choices they have made in the planning of the security protection techniques they intend to use. This must include technical reasons why they selected particular protection methods and configurations and rejected others. Learners also need to show that they have carried out tasks that improve the protection provided and minimise the impact of the protection techniques on overall system performance and usability. This could include tasks such as setting scheduled virus scans and updates at appropriate times, adjusting firewall settings to unblock legitimate programs, and adjusting shared folder permissions and password policies to balance protection and convenience.

For pass standard, learners will produce a detailed, realistic plan that clearly shows what they intend to do to protect the IT system from a range of IT security threats. They must provide evidence of implementing the plan on a mock-up or virtualised system. Learners will provide a completed test plan to show that the IT system and its protection have been tested to ensure that the protection is effective and does not hinder the normal use of the system. The system must provide levels of access to folders as required by the organisation. Learners also need to provide evidence that the protected system has been reviewed by others, considering the protection provided and the usability of the system. The evidence could take the form of a written review or a video recorded discussion of the system. Learners must produce a solution that meets the requirements of the plan, although some minor issues may persist.

Links to other units

This assessment for this unit should draw on knowledge, understanding and skills developed from:

- Unit 1: Principles of Computer Science
- Unit 2: Fundamentals of Computer Systems
- Unit 3: Planning and Management of Computing Projects
- Unit 4: Software Design and Development Project
- Unit 8: Business Applications of Social
- Unit 9: The Impact of Computing.

Employer involvement

This unit would benefit from employer involvement in the form of:

- guest speakers
- technical workshops involving staff from local organisations/businesses
- contribution of design/ideas to unit assignment/scenario/case study/project materials, including own organisation/business materials as exemplars where appropriate
- feedback from staff from local organisations/businesses on plans/designs/items developed
- opportunities for observation of organisational/business application during work experience
- support from local organisation/business staff as mentors.

Unit 8: Business Applications of Social Media

Level: **3**

Unit type: **Internal**

Guided learning hours: **90**

Unit in brief

Learners will explore how organisations use social media to promote their products and/or services, and implement social media activities for an organisation to meet its business requirements.

Unit introduction

Social media websites are a popular way for people to communicate and share information with friends and family. People spend a lot of time on social media websites and they give organisations opportunities to interact with people, for example to promote their products or services and to provide customer service. You may be familiar with social media for personal use and in this unit you will discover how it can be used in an organisational context.

You will explore different social media websites, the ways in which they can be used and the potential pitfalls when using them for organisational purposes. You will develop a plan to use social media strategies within an organisation to achieve its specific business aims and objectives. You will then implement the plan, developing and posting content and interacting with others. Finally, you will collect data on the organisation's use of social media and review the effectiveness of your efforts.

Understanding how to use social media to support an organisation's business requirements is useful for employment in computing and in a variety of other sectors. Also, social media skills are closely linked with web and mobile applications development. This unit gives you a starting point for progression to roles such as social media specialist, content developer and web developer.

Learning aims

In this unit you will:

A Explore the impact of social media on the ways in which organisations promote their products and services

B Develop a plan to use social media in an organisation to meet its business requirements

C Implement the use of social media in an organisation.

Summary of unit

Learning aim	Key content areas	Recommended assessment approach
A Explore the impact of social media on the ways in which organisations promote their products and services	**A1** Social media websites **A2** Organisational uses of social media for business purposes **A3** Risks and issues	A report that explores how an organisation can use social media to raise its profile and promote products and services.
B Develop a plan to use social media in an organisation to meet its business requirements	**B1** Social media planning processes **B2** Organisational requirements **B3** Content planning and publishing **B4** Developing an online community **B5** Developing a social media policy **B6** Reviewing and refining plans	Documentation showing the planning, preparation and implementation of the use of social media in an organisation, which meets identified business requirements. Established social media pages dedicated to the organisation, which fulfil the requirements given in the plan, accompanied by supporting documentation. Statistical data generated by social media websites, including an analysis of how it was used to optimise the use of social media. A report showing the assessment of search engine rankings. A report evaluating the use of social media in an organisation against the plan, showing how well it meets the business requirements.
C Implement the use of social media in an organisation	**C1** Creating accounts and profiles **C2** Content creation and publication **C3** Implementation of online community building **C4** Data gathering and analysis **C5** Search engine optimisation **C6** Skills, knowledge and behaviours	

Content

Learning aim A: Explore the impact of social media on the ways in which organisations promote their products and services

A1 Social media websites

- Developments in social media affect the way organisations promote products and services:
  - social media websites are constantly evolving and new features are introduced regularly
  - features, structure and target audience of different social media websites, e.g. Facebook®, Twitter®, LinkedIn®, Google+™ and YouTube®.
- How organisations can use social media websites to support their business aims and needs, including:
  - creating an image or brand
  - promoting products and services
  - communicating with customers
  - customer service
  - resolving queries and managing issues.
- Features of social media websites tailored to organisational needs, including:
  - advertising
  - website and mobile device integration
  - relationship to search engine optimisation (SEO)
  - profile on the sites, describing the organisation to visitors
  - usage data indicating the profile of followers and effectiveness of posts, e.g. Facebook Insights, Twitter Analytics and Google Analytics
  - audience profiles (age, gender, income) of social media websites.

A2 Organisational use of social media for business purposes

- Posting different content formats, e.g.
  - text
  - images
  - video
  - links
  - polls
  - quizzes.
- Content focus and meaning, e.g. information, promotion, humour, special offers and customer service.
- Developing an audience and encouraging people to follow or 'like' the organisation through the creation and use of engaging content.
- Keywords and their use in posted content.
- Developing contacts by following and linking to relevant organisations and individuals, and sharing content posted by others.
- Direct and indirect advertising.
- Links to commercial information, e.g. organisation's website, e-commerce websites.
- Relationship between the social media website and an organisation's website, e.g. using:
  - social media buttons on the organisation's website
  - organisation's website links within social media posts
  - social media news feeds on the organisation's website.

A3 Risks and issues

- Negative comments on social media sites and damage to reputation.
- Time constraints on social media interaction, return on time investment.
- Unforeseen consequences of posted content.
- Increased vulnerability to cyber criminals.

Learning aim B: Develop a plan to use social media in an organisation to meet its business requirements

B1 Social media planning processes

Processes to consider when planning the potential use of social media in an organisation, including:

- the specific requirements of the organisation
- content planning and publishing
- developing online communities
- enforcing social media policies.

B2 Organisational requirements

Working with a client to set requirements for the use of social media and the potential benefits for the organisation when compared to traditional promotional methods.

- Establishing timescales and responsibilities for the use of social media within an organisation.
- Identifying criteria for measuring the successful use of social media within an organisation.
- Selection of social media websites to use by matching site profiles to requirements, in terms of an organisation's business use of social media.
- Identifying targets for the use of social media, number of followers, 'likes' and 'shares'.

B3 Content planning and publishing

Planning posts and other content to be published on social media websites, including:

- identifying a target audience, e.g.
  - age
  - gender
  - interest
  - income
- linking type of content to target audience to ensure it is engaging
- researching keywords (e.g. Google Adwords) and creating keyword strategies to help users identify content
- researching the best time to publish content and creating a publishing schedule (type of content, frequency, day and time).

B4 Developing an online community

Working with a client to develop a strategy to encourage online community building, including:

- use of promotional techniques, e.g.
  - requesting feedback
  - surveys
  - special offers or initiatives
  - creating links between social media websites and the organisation's website
- monitoring social media website streams and responding to queries, requests and complaints.

B5 Developing a social media policy

Working with a client to create a social media policy applicable to an organisation's business needs, including:

- the organisation's philosophy (identifying and reflecting this in posted content)
- promotion of honesty and respect in posted content
- ways to ensure confidentiality of information
- methods of dealing with security issues
- separation of company and personal content
- legal and ethical considerations.

B6 Reviewing and refining plans

Working with a client and other relevant stakeholders to improve the quality, effectiveness and appropriateness of the plans, including:

- gathering feedback from a client and potential users
- communicating with a client, e.g. email, verbal communication
- scheduling and documenting meetings
- agreeing and adjusting timescales
- refining ideas and solutions.

Learning aim C: Implement the use of social media in an organisation

Selection and use of appropriate social media website tools and techniques to implement a plan.

C1 Creating accounts and profiles

- Sign-up, creation and administration of social media website organisational accounts.
- Creation and set-up of a profile for the organisation.
- Customisation and configuration of the organisation's profile, including privacy settings, colour schemes, images, text and other assets that follow branding guidelines.

C2 Content creation and publication

- Carry out research in order to produce engaging content for the intended target audience.
- Produce, publish and manage content.
- Improve visibility of published content.
- Methods to encourage audience interaction, e.g. use of images, phrasing of text content, timing of posts to coincide with times when followers are online.
- Integration of information across the organisation's website and social media websites.
- Adapting and testing content on different device platforms, e.g. mobile phones, tablets and notebooks.

C3 Implementation of online community building

- Implementation of an online community building strategy, including:
  - use of hashtags, sharing and tagging
  - finding and joining groups and contributing information
  - following people and other organisations or businesses.
- Monitoring and responding to comments, importance of prompt responses.
- Using tools and techniques to automate content posting.

C4 Data gathering and analysis

Gathering and interpreting data on social media websites using dedicated tools, e.g. Facebook Insights, Twitter Analytics, Google Analytics and TweetReach™.

- Identifying interaction relating to individual posts.
- Identifying audience profiles, e.g. age, location.
- Monitoring number of 'likes' and 'shares'.
- Comparison of intended target audience versus actual audience.
- Identification of posts and types of content that create the highest levels of interaction.

C5 Search engine optimisation

- Principles of search engine optimisation, including:
  - keyword research and strategy
  - website URL and content
  - significance of regular updates
  - importance of inbound links and ways of developing them
  - timescales for achieving change in search engine rankings.
- Monitoring website interaction.

- Social media links to search engine optimisation, including:
  - social media profiles
  - use of keywords in content
  - use of social media to encourage visitors to the company website
  - importance of search engine rankings linked to a social media service (Google+).

C6 Skills, knowledge and behaviours

- Planning and recording, including the setting of relevant targets with timescales; how and when feedback from others, such as customers and social media followers, will be gathered.
- Reviewing and responding to outcomes, including the use of feedback from others, e.g. customers and social media followers who can provide feedback on the quality and suitability of the features against the organisation's business requirements.
- Demonstrate own behaviours and their impact on outcomes, including professionalism, etiquette, being supportive of others, timely and appropriate leadership, accountability and individual responsibility.
- Evaluating outcomes to help inform high-quality, justified recommendations and decisions.
- Evaluating targets to obtain insights into own performance.
- Media and communication skills, including:
  - the ability to convey intended meaning, e.g. written (email, design documentation, recording documentation, reports, visual aids for use in presentations); verbal communication requirements (one to one and group, informal and formal situations)
  - use of tone and language for verbal and written communications to convey intended meaning and make a positive and constructive impact on the audience, e.g. positive and engaging tone, technical/vocational language suitable for intended audience, avoidance of jargon
  - responding constructively to the contributions of others, e.g. supportive, managing contributions so all have the opportunity to contribute, responding to objections, managing expectation, resolving conflict.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Explore the impact of social media on the ways in which organisations promote their products and services</td><td rowspan="2">A.D1 Evaluate the organisational use of social media to interact with customers and promote products or services to a target audience.</td></tr>
<tr><td>A.P1 Explain the different ways in which an organisation can use social media to promote products or services to a target audience.
A.P2 Explain the audience profiles of different social media websites.</td><td>A.M1 Assess the different ways in which an organisation can use social media to promote products or services to a target audience.</td></tr>
<tr><td colspan="2">Learning aim B: Develop a plan to use social media in an organisation to meet its business requirements</td><td rowspan="4">BC.D2 Evaluate the plan and use of social media in an organisation against its business requirements.
BC.D3 Demonstrate individual responsibility, creativity, and effective self-management in the planning and use of social media in an organisational context.</td></tr>
<tr><td>B.P3 Produce a plan to use social media in an organisation to meet its business requirements.
B.P4 Review the plan with others in order to identify and inform improvements.</td><td>B.M2 Justify planning decisions made, showing how the plan will fulfil its purpose and the organisation's business requirements.</td></tr>
<tr><td colspan="2">Learning aim C: Implement the use of social media in an organisation</td></tr>
<tr><td>C.P5 Produce business-related content for an organisation, using appropriate features of social media that meet the requirements of the plan.
C.P6 Review data obtained on social media usage and interaction.
C.P7 Assess the extent to which social media content and format improved search engine rankings.</td><td>C.M3 Optimise the content, format and features of social media that meet the requirements of the plan.</td></tr>
</table>

Essential information for assignments

The recommended structure of assessment is shown in the unit summary, along with suitable forms of evidence. *Section 6* gives information on setting assignments and there is further information on our website.

There are a maximum number of two summative assignments for this unit. The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aims: B and C (B.P3, B.P4, C.P5, C.P6, C.P7, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to a variety of social media websites that will allow them to plan and implement the use of the social media features.

Essential information for assessment decisions

Learning aim A

For distinction standard, learners will produce a comprehensive, well-balanced evaluation of how an organisation uses social media to support its business requirements, making realistic and well-explained business-related observations on the benefits and disadvantages, while considering its target customers or audience. Learners will provide real-life, relevant examples of how organisations have used social media effectively and how some organisations have not managed the risks involved effectively. Learners must articulate their arguments fluently and their views concisely, providing an evaluation that makes reasoned, valid judgements.

The evidence will demonstrate high-quality written/oral communication through the use of accurate and fluent technical vocabulary, which supports a well-structured and considered response that clearly connects chains of reasoning.

For merit standard, learners will present a reasoned and well-explained assessment of a range of different ways in which an organisation can use social media to interact with the target audience for its products and/or services. The assessment will be balanced and supported by clear examples. Learners will focus their comments on the organisation's business uses of the social media sites. The evidence must be technically accurate and demonstrate good-quality written or oral communication.

For pass standard, learners will provide detailed information, supported by real-life examples, covering all the ways that organisations can use social media to support their business requirements (as listed in the unit content). They will research the different audience profiles for the main social media sites and explain how the different sites appeal to their different audiences, and relate it to how different organisations can use social media. The evidence may have some inaccuracies and include a limited range of examples.

Learning aims B and C

For distinction standard, learners will draw on, and show synthesis of, knowledge across the learning aims in order to evaluate both the plan to use social media and its implementation. Learners also need to show that they have considered the legal and ethical implications of the material they have posted on social media sites. Learners must provide a reasoned and realistic review of the outcomes, identifying the positive and negative aspects. For example, they can explain why some things they planned to do did not happen or did not work out as they expected. Learners will make reasoned, appropriate suggestions as to how the use of social media could be improved in the future. They will undertake a detailed examination of the data collected on the interaction achieved and the profile of the people who have interacted with their social media posts. This information will link clearly to a discussion of how well this matches their intentions. For example, learners may discover that the age and location profile of the people interacting with their posts does not match the target audience of the organisation concerned. In this case, they would need to discuss possible reasons for the mismatch and how this issue could be resolved.

Learners will take individual responsibility for their own work, for example identifying potential issues and resolving them, reviewing their work and making improvements, keeping their work safe and secure and showing responsible use of quoted materials. Learners will show creativity, for example, through taking innovative approaches to problem solving and through the originality of their solution. The evaluation of behaviours will consider learners' use of 'soft skills' in relation to the vocational context of the project, such as liaising with clients and time management.

Learners will evaluate their own behaviours throughout the project and the impact they have on the outcomes. Learners will refer to tangible evidence to support their evaluation, such as meeting notes, correspondence and time plans.

For merit standard, learners will provide a clear, accurate and well-reasoned justification of the choices they made in the planning of the use of social media. Learners will show a clear link to the organisation's business requirements. The usage data collected by learners will also assess how effective each of their posts have been in achieving their stated aim and how effective they have been in encouraging interaction with the audience. Learners also need to show that they have considered the legal and ethical implications of the material they have posted on social media sites. Learners will apply their knowledge through selection and application of appropriate tools and techniques to optimise the effectiveness of their future posts and other social media features. They will make accurate and reasoned suggestions as to how the outcomes could be improved if the task were to be repeated.

For pass standard, learners will produce a plan that meets the organisation's business requirements and identifies the target audience. The plan will also identify timescales and key words, and include a content posting schedule. Learners will show an awareness of legal and ethical implications of the content they plan to post.

Learners will review their plan, and ask others, such as the client/employer and customers/audience, to assist them in this process and provide evidence of their review.

Learners will select a variety of social media websites and implement their plan and interact with their followers. Some simulation may be required in order to provide the interaction, and fellow learners can play the role of 'customers' for each other. Learners can provide evidence in the form of annotated screenshots showing how they have implemented the plan they have created.

Learners must collect a range of data using features, such as Facebook Insights, Google Analytics and Twitter Analytics, showing the interaction that individual posts have created and the profile of their audience. This data will be used to optimise their future posts, for example by adjusting the wording, content and timing of posts, as well as demonstrating the use of any other new features.

Learners will assess the degree to which the content they developed, and social media websites they post to, is likely to improve, or has improved, the search engine ranking for the organisation, for example by the use of appropriate key words. The assessment may be unbalanced or contain some inaccuracies.

Links to other units

This unit links to:

- Unit 9: The Impact of Computing
- Unit 15: Website Development.

Employer involvement

This unit would benefit from employer involvement in the form of:

- guest speakers
- technical workshops involving staff from local organisations/businesses
- contribution of design/ideas to unit assignment/scenario/case study/project materials, including own organisation/business materials as exemplars where appropriate
- feedback from staff from local organisations/businesses on plans/designs/items developed
- opportunities for observation of organisational/business application during work experience
- support from local organisation/business staff as mentors.

Unit 9: The Impact of Computing

Level: **3**

Unit type: **Internal**

Guided learning hours: **90**

Unit in brief

Learners will study the impact that developments in computing have on organisations and wider society, and develop a plan to implement a technology development.

Unit introduction

The rapid development of computer technology over the past 50 years or so has had a tremendous impact on the lives of individuals and on the ways in which organisations work. Computer technology has created completely new business opportunities, revolutionising the world of work. As someone working in computing development, it is important that you understand the impact of computer technology.

In this unit, you will develop an understanding of the positive and negative impacts of computing development on an organisation or business when it implements a new system. You will consider the general impact on individuals and society as a whole, and the potential impacts of computing development in the future. You will then develop a plan to implement a computing technology development in an organisation and review the plan you have developed.

This unit is relevant to anyone working in computing, as an understanding of the impact of changes in technology is crucial. It will be of particular relevance to those progressing to higher education and pursuing careers in software development, as a software developer or programmer, who need to appreciate how the systems they are developing can impact an organisation.

Learning aims

In this unit you will:

A Understand the impact of developments in computing on an organisation

B Investigate the impact of developments in computing technology

C Develop a plan to implement a computing technology development in an organisation

D Review a plan to implement a computing technology development in an organisation.

Summary of unit

Learning aim	Key content areas	Recommended assessment approach
A Understand the impact of developments in computing on an organisation	**A1** Hardware and software developments **A2** Changing markets and new opportunities **A3** Emerging technologies **A4** Big data, data warehousing and data mining **A5** Issues and risks	A report with evidence of research on the impact of developments in computing on an organisation and on society as a whole. Recordings of interviews with stakeholders, planning documents.
B Investigate the impact of developments in computing technology	**B1** Social impacts **B2** Employment and business impacts **B3** Environmental impacts **B4** Ethical issues	
C Develop a plan to implement a computing technology development in an organisation	**C1** Information gathering **C2** Implementation planning **C3** Managing risk	A plan for implementing the computer technology, incorporating relevant documentation such as annotated diagrams and evidence of feedback from others (recording of discussions or written feedback). Recorded or written evaluations of the plan and the working practices.
D Review a plan to implement a computing technology development in an organisation	**D1** Obtaining feedback **D2** Review and analysis **D3** Skills, knowledge and behaviours	

Content

Learning aim A: Understand the impact of developments in computing on an organisation

A1 Hardware and software developments

The increasing power of hardware and sophistication of software.

- Focus on mobile rather than desktop computing.
- Maintaining or improving the competitive edge.
- Regular upgrading of hardware to take advantage of more sophisticated software and improved energy management.
- Developments in cloud and hybrid cloud technologies.

A2 Changing markets and new opportunities

- Decline in some traditional market sectors and developments in others.
- The need for organisations and businesses to develop and change to take advantage of new markets and opportunities.
- Balancing growth in some areas against decline in others, e.g. traditional retail, analogue music and photography versus digital.
- Potential provided by developments in IT for cost reductions, improved customer service.
- Opportunities and challenges represented by 'big data'.

A3 Emerging technologies

- Internet of things (IoT) – ubiquitous computing and the opportunities and challenges it represents.
- Increasing integration and sophistication of applications.
- Increasing automation, e.g. robotics, exoskeletons, rehabilitation robotics.
- Current developments.

A4 Big data, data warehousing and data mining

The use and analysis of large amounts of data to extract useful information.

- Big data characteristics and features:
  - volume – the quantity of data that is generated
  - velocity – the speed of generation of data
  - variety – the mixture of data to be processed
  - storage – large datasets, use of cloud computing
  - processing – real-time data analysis, use of parallel processing.
- Key features of a data warehouse:
  - subject orientation – data organised by subject
  - data denormalisation for simplification and to improve performance
  - non-volatility: stable data storage medium
  - large amounts of historical data use
  - use of queries (planned and ad hoc) to retrieve large amounts of data
  - both planned and ad hoc queries are common
  - controlling of data load.
- Data mining:
  - the methods used to automatically search large stores of data to discover patterns and trends beyond simple analysis
  - use of sophisticated mathematical algorithms to segment the data and evaluate the probability of future events.

A5 Issues and risks

- Security considerations and the dangers inherent in extensive reliance on computing for every aspect of life:
  - the attractiveness of systems to criminals or terrorists, e.g. data theft or destruction, fraud, denial of service, blackmail
  - difficulty of maintaining compatibility with existing internal systems
  - difficulty of maintaining compatibility with external systems
  - increasing complexity of IT systems controlling mission critical applications, e.g. transportation systems, energy generation and distribution, military systems
  - difficulties associated with ensuring complex systems are reliable, fully tested and fail 'safe'.
- Changes in working practices:
  - remote working
  - office practices, such as bring your own device (BYOD)
  - upskilling of workforce to make use of more complex systems
  - reduction in low skilled jobs due to automation
  - working styles, focus on desk-based jobs, move away from traditional manufacturing jobs.
- Increasing reliance on IT and the need to protect against failure, disaster recovery planning, consequences of failure.
- Information overload and the difficulty and expense of processing large quantities of data, danger of and consequences of data duplication.

Learning aim B: Investigate the impact of developments in computing technology

B1 Social impacts

Changes in the way people communicate.

- Increasing reliance on social networking for human interaction.
- Consequences in terms of lack of social skills and increasing isolation.
- Health and age-related issues.
- Ease with which contacts can be maintained, reduction in geographical barriers.

B2 Employment and business impacts

- Increased home working and its benefits, e.g. reduced travel time, flexibility and disadvantages, e.g. lack of human interaction, isolation.
- Reduction in the number of unskilled or low skilled jobs.
- Creation of new markets and opportunities.

B3 Environmental impacts

- Electricity consumption and its environmental impact.
- Improvements in computing power per kilowatt of electricity, balanced by increasing use of hardware.
- Increasing amounts of electronic waste materials creating pressure on landfill.
- Need to recycle dangerous chemicals, heavy metals found in batteries and other components.
- Issues relating to the export of waste electronic equipment for recycling to the developing world.

B4 Ethical issues

- Unequal access, the 'digital divide' between those with and without network access (developing world countries and remote areas).
- Difficulties experienced by older people and people with disabilities in coping with changes in technology.
- Privacy issues as increasing amounts of data are collected about every aspect of an individual's life and habits.
- Considerations relating to access to personal data and how it should be protected.
- Legal and ethical considerations applicable to the equivalent legislation in England, Wales and Northern Ireland, e.g. copyright, computer misuse, data protection.
- Risk of the loss of control of personal data stored online, e.g. photos, videos, emails and instant messages.
- Potential dangers of artificial intelligence, e.g. possibility of smart systems or robots that could outwit human intelligence.
- Dangers and ethical issues inherent in robot weapon systems.
- Negative aspects of internet use:
  - personal internet use problems, e.g. pornography, revenge pornography, cyberbullying and trolling, the 'darknet' (peer-to-peer sharing of illegal materials)
  - availability of illegal material and material that breaches copyright, e.g. films, videos, music
  - use of the internet by terrorists and extremists to recruit members, communicate and spread propaganda.

Learning aim C: Develop a plan to implement a computing technology development in an organisation

C1 Information gathering

Investigation of the planned implementation of a new development.

- Identify suitable sources of information.
- Use of information gathering techniques, e.g. interviews, meetings, data analysis and observation for collecting information from various stakeholders, e.g. employees, suppliers, customer, general public.
- Suitability, benefits and drawbacks of different information gathering methods.

C2 Implementation planning

Use of requirements analysis to identify the project parameters.

- What the new or updated product is intended to achieve.
- Identifying the scope of the implementation.
- Boundaries and constraints (cost, timescales, hardware platform, compatibility with existing systems).
- Identifying the system's basic inputs, outputs and processes.
- Considering alternative solutions.
- Creating an outline implementation plan, with tasks and milestones.
- Methods of monitoring progress.

C3 Managing risk

Planning to reduce the risks associated with the implementation of the technology development.

- Training of users and support staff.
- Support mechanisms, e.g. online support, helplines and outsourcing support.
- Quality assurance procedures, e.g. project and technical reviews, module and integration testing.
- Disaster recovery planning and procedures.

Learning aim D: Review a plan to implement a computing technology development in an organisation

D1 Obtaining feedback

- Reviewing the plans for implementation with others, e.g. stakeholders, subject experts.
- Obtaining feedback, e.g. interviews, questionnaires, meetings.
- Researching, investigating and reviewing similar implementation projects.

D2 Review and analysis

- Reviewing feedback collected and drawing conclusions. Suggesting improvements and further development.
- Reviewing ethical impacts on environment, employment and wider society.
- Privacy issues:
  - compliance with legal requirements of Data Protection legislation
  - whether security measures are sufficient to protect personal data
  - whether there are sufficient measures in place to ensure personal data is accurate and up to date.
- Impact assessment – carrying out assessment of the potential impact of the implementation on health and safety, environment, security.
- Risk assessment – vulnerability of system to attack, attractiveness to criminals or terrorists, health and safety issues.

D3 Skills, knowledge and behaviours

- Planning and recording, including the setting of relevant targets with timescales, how and when feedback from others will be gathered.
- Reviewing and responding to outcomes, including the use of feedback from others.
- Demonstrate own behaviours and their impact on outcomes, including professionalism, etiquette, supportive of others, timely and appropriate leadership, accountability.
- Evaluating outcomes to help inform high-quality, justified recommendations and decisions.
- Communication skills, including:
  - the ability to convey intended meaning, e.g. written (email, design documentation, recording documentation, reports, visual aids for use in presentations); verbal communication requirements (one to one and group, informal and formal situations)
  - use of tone and language for verbal and written communications to convey intended meaning and make a positive and constructive impact on the audience, e.g. positive and engaging tone, technical/vocational language suitable for intended audience, avoidance of jargon.
  - responding constructively to the contributions of others, e.g. supportive, managing contributions so all have the opportunity to contribute, responding to objections, managing expectation, resolving conflict.

Assessment criteria

Pass	Merit	Distinction
Learning aim A: Understand the impact of developments in computing on an organisation		
A.P1 Explain the impact that developments in computing have had on an organisation. **A.P2** Explain the likely impact of an emerging technology on organisations.	**A.M1** Analyse the risks related to implementing a new computer system in an organisation.	**A.D1** Evaluate the impact that implementing a new computer system can have on an organisation. **B.D2** Evaluate the impact that the implementation of a specific development in computing technology has had on wider society.
Learning aim B: Investigate the impact of developments in computing technology		
B.P3 Assess the potential ethical and environmental impacts of developments in technology. **B.P4** Explain how lack of understanding or access to IT can disadvantage certain groups of people.	**B.M2** Analyse the benefits and disadvantages of the social impact of computing technology developments.	
Learning aim C: Develop a plan to implement a computing technology development in an organisation		
C.P5 Produce information from a variety of stakeholders to explain the potential impact of a suggested computing technology development implementation on an identified organisation. **C.P6** Develop a plan to implement a technology development within an identified organisation and to manage the associated risks.	**C.M3** Analyse the scope, boundaries and constraints of a computing technology development implementation plan for an identified organisation.	**CD.D3** Use feedback to evaluate the plan to implement a computing technology development in an identified organisation and the suggested improvements. **CD.D4** Demonstrate individual responsibility and effective self-management in the development and review of a plan to implement a computing technology development.
Learning aim D: Review a plan to implement a computing technology development in an organisation		
D.P7 Review a plan to implement a computing technology development in an organisation, considering feedback from others and identifying possible improvements. **D.P8** Review the potential social impacts of a plan to implement a computing technology development in an organisation.	**D.M4** Justify the choices made to manage the risks associated with a computing technology development implementation within an organisation.	

Essential information for assignments

The recommended structure of assessment is shown in the unit summary along with suitable forms of evidence. *Section 6* gives information on setting assignments and there is further information on our website.

There is a maximum number of two summative assignments for this unit. The relationship of the learning aims and criteria is:

Learning aims: A and B (A.P1, A.P2, B.P3, B.P4, A.M1, B.M2, A.D1, B.D2)

Learning aims: C and D (C.P5, C.P6, D.P7, D.P8, C.M3, D.M4, CD.D3, CD.D4)

Further information for teachers and assessors

Resource requirements

There are no specific additional resources for this unit.

Essential information for assessment decisions

Learning aims A and B

For distinction standard, learners will provide a clear and balanced evaluation of the impact of a technology development on both the organisation where the technology development is implemented and on society in general. The chosen technology development must be significant enough in scope to have sufficient impact, particularly on society in general. For example, an organisation upgrading a computer system may not have much impact on society, but a bank closing all its branches and replacing them with online access only would have an impact on society. Learners' evaluations of the impacts must cover the positive and negative consequences in relation to a technology development and reach a reasoned conclusion. Learners must articulate their arguments fluently and their views concisely, providing an evaluation that makes reasoned, valid judgements. The evidence will demonstrate high-quality written/oral communication through the use of accurate and fluent technical vocabulary, which supports a well-structured and considered response that clearly connects chains of reasoning.

For merit standard, learners will provide a detailed, clear, well-reasoned and balanced analysis. The analysis will fully cover the issues given in the unit content, using up-to-date, real-world examples. The evidence must be technically accurate and demonstrate good quality written or oral communication.

For pass standard, learners will provide well-explained examples of how technology has impacted on an organisation and on individuals. Learners must explain the relevant impacts and also why they occur. In terms of emerging technologies, learners can do some 'future gazing' – that is, looking at a technology in its early stages and discussing what impact it is likely to have on organisations as it develops and become widely adopted. Typical examples might be robotics and artificial intelligence. Learners need to research the technology of their choice and support their discussion with quotes from their research. The evidence may have some inaccuracies and the review of the impacts may be unbalanced.

Learning aims C and D

For distinction standard, learners will draw on, and show synthesis of, knowledge across the learning aims to develop and evaluate their plan for implementation of a computing technology development. Learners will collect feedback from at least two stakeholders about the potential impact of their implementation plan for the technology development. Depending on their choice of development, this might include feedback from the general public. Learners must produce an evaluation of their plan, which must be informed by the feedback they have received. Learners' review of their plan must be reasoned and realistic. They will also provide a reasoned evaluation of possible improvements to the plan.

Learners must demonstrate individual responsibility (for example identifying potential issues and resolving these, reviewing their work and suggesting improvements, keeping their work safe and secure, showing responsible use of quoted materials) and effective self-management when developing and evaluating the technology plan for an organisation.

Evaluation of behaviours will consider the learners' use of 'soft skills' in relation to the vocational context of the project, such as managing and liaising with other members of the team or clients, and time management. Learners will evaluate their own behaviours throughout the project and the impact these had on the outcomes. Learners will refer to tangible evidence to support their evaluation, such as meeting notes, correspondence and time plans.

For merit standard, learners will provide a clear, balanced analysis of what is included in the technology development (its scope), and the boundaries, i.e. what is excluded from the plan. They must also explain any relevant constraints that restrict the plan. Learners must provide a clear, well-reasoned justification of why they chose the particular risk management methods, what alternatives they considered and reasons why these alternatives were rejected.

For pass standard, learners will gather feedback on the potential impact of the implementation of the suggested development. Learners should seek the views of at least two people who could be considered as stakeholders in the development. This could be, for example, people who work with the existing system or members of the public who would be affected by the new development. They can record the comments the stakeholders make, either in writing or by audio recording the interview. As with learning aims A and B, the choice of the technology for the development must allow sufficient material for meaningful investigation, development and review. For learning aims C and D, learners may use the same technology development used for learning aims A and B, or a different one. As well as planning the stages of the implementation, learners will also consider how any risks associated with the development can be managed.

Learners will obtain feedback from at least two other people (preferably also stakeholders) on the plan they have developed. Learners will use this feedback to help support their review of the plan. They will make realistic suggestions regarding the improvements that could be made to the plan. Learners must also review the wider social impacts of their plan to implement a technology development. They will refer to potential impact on employees, customers and the general public, although the review may be unbalanced and make limited use of supporting examples.

Links to other units

This unit links to:

- Unit 1: Principles of Computer Science
- Unit 2: Fundamentals of Computer Systems
- Unit 6: IT Systems Security
- Unit 7: IT Systems Security and Encryption
- Unit 8: Business Applications of Social Media.

Employer involvement

This unit would benefit from employer involvement in the form of:

- guest speakers
- technical workshops involving staff from local organisations/businesses
- contribution of design/ideas to unit assignment/scenario/case study/project materials, including own organisation/business materials as exemplars where appropriate
- feedback from staff from local organisations/businesses on plans/designs/items developed
- opportunities for observation of organisational/business application during work experience
- support from local organisation/business staff as mentors.

Unit 10: Human-computer Interaction

Level: **3**

Unit type: **Internal**

Guided learning hours: **60**

Unit in brief

Learners will examine the underlying principles of human-computer interaction (HCI) and develop a HCI solution to meet client requirements.

Unit introduction

Ongoing technological developments are aimed at producing graphical user interfaces that are safe, user-friendly and more intuitive. As a result, there are increasingly more sophisticated ways in which users can interact with electronic devices, beyond the traditional mouse and keyboard. As a software developer, you need to understand how to make the interaction between the user and the computer as natural and efficient as possible. Significant amounts of research in the field of HCI continues to inform how systems can achieve this goal.

In this unit, you will consider how technology has evolved to improve the communication between the device and the user. You will explore the implications of using various interfaces, by applying HCI principles to justify your decision making. You will also develop a solution to a HCI-based scenario, by using an appropriate programming language or software/hardware tools. Finally, you will plan and monitor your own skills, knowledge and behaviours during your development of graphical user interfaces and demonstrate how this will inform future personal and professional development. To complete the assessment task within this unit, you will need to draw on your learning from across your programme.

As a computing professional, you will need to understand the theoretical and practical skills that are involved in HCI. These skills are required to enable software developers and designers to produce an interface that is not only usable, but gives a competitive advantage in the technology industry. This unit will prepare you for a software development role as a designer or for higher education computing courses.

Learning aims

In this unit you will:

A Examine the factors affecting the development of human-computer interaction

B Investigate the human-computer interaction requirements of an identified client

C Develop a human-computer interaction solution to meet client requirements.

Summary of unit

Learning aim	Key content areas	Recommended assessment approach
A Examine the factors affecting the development of human-computer interaction	**A1** Developments in electronic devices **A2** User development factors **A3** Use of HCI in society, and its impact **A4** Design principles of HCI	A report detailing the developments in HCI and the effect it has had on society.
B Investigate the human-computer interaction requirements of an identified client	**B1** Requirements for a HCI solution **B2** Schematic design documentation for a HCI solution.	A practical activity involving designing and preparing HCI schematics. The evidence will include: • user interfaces (evidenced with annotated screenshots) using software development tools to accurately represent design schematics • completed test plans and evidence of optimisation in the form of annotated screenshots. An evaluation of the strengths and weakness of the hardware-based solution or interfaces, and potential improvements in design.
C Develop a human-computer interaction solution to meet client requirements	**C1** Content preparation for a human–computer interface **C2** Developing a HCI solution **C3** Testing an interaction solution **C4** Reviewing the development process and outcomes **C5** Skills, knowledge and behaviours	

Content

Learning aim A: Examine the factors affecting the development of human-computer interaction

A1 Developments in electronic devices

How developments in computing impact on the way humans interact with electronic devices.

- Origins of computing, e.g. uses of early computers, types of user, interaction methods.
- Command line interfaces.
- Evolution of graphical user interfaces.
- Command line interfaces versus graphical user interfaces.
- Sense orientation:
  - graphical
  - speech
  - touch.
- Developments in user interaction with computing:
  - evolution of the workstation to surface computing
  - screens
  - keyboards
  - pointing devices
  - speech recognition
  - virtual reality, augmented reality
  - artificial intelligence systems
  - modern gaming/gestures
  - 3D interfaces
  - thought input.

A2 User development factors

How the interaction between the computer system and the user is affected by the type of intended user(s) and their needs.

- Types of user:
  - expert users
  - regular users
  - occasional users
  - beginner/novice users.
- Ergonomics.
- Health and safety.
- Demographics:
  - age
  - education
  - cultural issues
  - globalisation
  - local information systems.
- Accessibility, e.g. responding to the needs of users with restricted motor skills.

A3 Use of HCI in society and its impact

- Uses of HCI, e.g. self-checkout systems, domestic appliances with embedded computers, gaming.
- Ways in which people interact with systems, e.g. touchscreens, mouse, voice recognition, bespoke input devices.

- Impact of HCI on:
  - usability of systems
  - social interaction
  - cultural impacts
  - commerce, e.g. working patterns and styles, deskilling, retraining needs
  - economies.
- Assistive technologies, e.g. eye gaze system, braille, screen magnifiers, avatars for sign language.

A4 Design principles of HCI

The use and implications of design principles in HCI.

- The difference between recognition and recall.
- Screen design for intuitive data entry.
- Menu selection.
- Perception:
  - gestalt laws of perception.
  - colour, to include trichromatic system and luminance.
  - gross 3D shapes.
- Shneiderman's rules of interface design:
  - consistency
  - use of shortcuts
  - informative feedback
  - design dialog to yield closure
  - error handling
  - reversal of actions
  - support internal locus of control
  - reduce short-term memory load.
- Behavioural models:
  - keystroke level model
  - throughput
  - Fitts's law
  - key action model
  - Buxton's three state model
  - Guiard's model.

Learning aim B: Investigate the human-computer interaction requirements of an identified client

B1 Requirements for a HCI solution

- Tasks to be performed.
- Input required, e.g. mouse, touchscreen, voice.
- Output required, e.g. graphics, animations, audio feedback, physical feedback.
- User needs, e.g. accessibility considerations, purpose of system, environmental factors.

B2 Schematic design documentation for a HCI solution

Documentation needed to develop a solution and record relevant aspects, including:

- generation of ideas, e.g. mood boards, client/designer meetings
- presenting a solution:
  - client requirements
  - hardware and software requirements
  - visualisation/interface design, e.g. storyboarding, flow charts
  - technical specification, e.g. file formats required, bandwidth limitations, target platform
  - technical designs, e.g. algorithms, example code, wiring diagrams

  - consideration of design rules
  - supporting documentation, e.g. meeting notes, research, user profiling
  - advantages and disadvantages of proposed solution
- alternative solutions with comparison to the proposed solution and advantages and disadvantages of the alternatives
- methods of obtaining feedback to improve designs, e.g. user testing, client meetings.

Learning aim C: Develop a human-computer interaction solution to meet client requirements

C1 Content preparation for a human-computer interface

Selection and application of appropriate processing and editing techniques to prepare resources to meet client needs.

- Creating unique content, e.g. sounds, images, control code.
- Use of content created by others:
  - permissions
  - acknowledging sources
  - legal and ethical considerations applicable to the equivalent legislation in England, Wales and Northern Ireland, e.g. using content created by others.
- Optimisation, e.g. file size, image size.
- Alternate formats for screen orientation, e.g. landscape, portrait.
- File formats, i.e. compatibility, performance, quality.
- Compression requirements for items such as images, possible constraints, file size and image quality.

C2 Developing a HCI solution

Application of HCI design principles to meet client requirements.

- Primary interface implementation, e.g. standard icons, menus, window layout.
- Implementing alternative interfaces, e.g. mobile version, adaptive for user needs.
- Software integration, e.g. event handling, coding to add functionality, applying interface to intended program.
- Hardware integration, e.g. bespoke controllers, recognising keystrokes, adaptive technologies, coding to control connected hardware.
- Supporting documentation.

C3 Testing an interaction solution

- Identifying how and what to test, e.g. producing a test plan, choosing test data, test user identification.
- Types of testing, e.g. effectiveness, functionality, performance.
- Obtaining feedback from others, e.g. questionnaires, interviews, checklists.
- Making improvements and/or refinements to solutions in response to testing and feedback from others.

C4 Reviewing the development process and outcomes

Review of the success of development of a HCI solution, including:

- suitability for audience and purpose
- ease of use
- quality of the solution, e.g. reliability, usability, efficiency/performance, maintainability, portability
- constraints, e.g. time, sourcing hardware components, platform, compatibility
- legal and ethical considerations applicable to the equivalent legislation in England, Wales and Northern Ireland, e.g. accessibility requirements, copyright
- impact of design and development processes, e.g. input from others, decisions made
- strengths and weaknesses of the solution
- evaluation of how the implemented solutions could be improved to better meet the needs of the user and fulfil the identified needs.

C5 Skills, knowledge and behaviours

- Planning and recording, including the setting of relevant targets with timescales, how and when feedback from others will be gathered.
- Reviewing and responding to outcomes, including the use of feedback from others, e.g. IT professionals and users who can provide feedback on the quality of the HCI solution and its suitability against the original requirements.
- Demonstrate own behaviours and their impact on outcomes, including professionalism, etiquette, supportive of others, timely and appropriate leadership, accountability and individual responsibility.
- Evaluating outcomes to help inform high-quality, justified recommendations and decisions.
- Evaluating targets to obtain insights into own performance.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Examine the factors affecting the development of human-computer interaction</td><td rowspan="2">A.D1 Evaluate how developments in technology impact on the way HCI is used in society and interface design.</td></tr>
<tr><td>A.P1 Explain how the principles of HCI design impact on users and society.
A.P2 Explain how developments in technology impact on HCI.</td><td>A.M1 Analyse how developments in technology impact on the way HCI is used in society and in interface design.</td></tr>
<tr><td colspan="2">Learning aim B: Investigate the human-computer interaction requirements of an identified client</td><td rowspan="3">BC.D2 Evaluate the design and optimised HCI solution against the client's requirements.
BC.D3 Demonstrate individual responsibility, creativity and effective self-management in the design, development and review of a HCI solution.</td></tr>
<tr><td>B.P3 Produce designs for a HCI solution which meets client requirements.
B.P4 Review the designs of a HCI solution with others to identify and inform refinements.</td><td>B.M2 Justify the design decisions, explaining how they will meet client requirements.</td></tr>
<tr><td colspan="2">Learning aim C: Develop a human-computer interaction solution to meet client requirements</td></tr>
<tr><td>C.P5 Produce a tested HCI solution to meet client requirements.
C.P6 Review the extent to which the HCI solution meets client requirements.</td><td>C.M3 Optimise the HCI solution to meet client requirements.</td></tr>
</table>

Essential information for assignments

The recommended structure of assessment is shown in the unit summary along with suitable forms of evidence. *Section 6* gives information on setting assignments and there is further information on our website.

There is a maximum number of two summative assignments for this unit. The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aims: B and C (B.P3, B.P4, C.P5, C.P6, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to technological resources that will allow them to apply the practical principles of HCI. These may include:

- graphic software
- appropriate development/coding environment for producing interactive functionality, for example Visual basic®, Python®
- prototyping boards, for example Raspberry Pi®, Arduino®
- specialised input/output devices.

Essential information for assessment decisions

Learning aim A

For distinction standard, learners will provide comprehensive evidence that they have fully investigated the impact that the design principles of HCI have on how electronic devices (for example smartphones, tablets, games consoles and other consumer devices with embedded computers) are used. Learners must provide evidence that they have investigated and considered how developments in technology have changed the way users make use of and interact with computer systems, and the impact this has on society. Learners must consider the positive and negative effects that new technologies have on users and society. For example, learners could identify how radio-frequency identification (RFID) can be implanted within our bodies to automate tasks. This in itself has advantages, but leads to ethical concerns as well. The report will demonstrate high-quality written/oral communication through the use of accurate and fluent technical vocabulary, which supports a well-structured and considered response that clearly connects chains of reasoning.

For merit standard, learners will provide a detailed, clear analysis of how the design principles of HCI and the development of technologies have impacted on how users make use of, and interact with, electronic devices. Learners will explore historical and recent developments in technology to analyse how and why humans and computers interact in the way they do. Learners will provide sufficient examples to demonstrate an understanding of the scope of hardware- and software-based interaction. For example, mobile phone devices may use some form of voice control or biometric sensor (such as fingerprints) to access the device, but would also have an optimised graphical user interface that is specifically designed for that type of device. Learners will need to explore how these technological developments impact on HCI, and how user needs are met. The report will be technically accurate and demonstrate good quality written/oral communication.

For pass standard, learners will provide detailed explanations of the principles of HCI design and the impact that this has on users and on wider society. Learners will need to show evidence that they understand how different theories of HCI, such as Shneiderman's Eight Golden Rules of Interface Design, can be applied, and the impact that this will inevitably have. In addition, learners must explore how developments in technology have impacted on the way we use and interact with computer systems. The evidence may have some inaccuracies and the review of the impact may be unbalanced and supported by limited use of examples.

Learning aims B and C

Learners will provide evidence of planning, developing, implementing and testing a HCI solution to meet the requirements of an identified client. The focus of the HCI solution may vary, depending on the identified brief. For example, learners may choose to build and design a hardware-based solution that is designed to provide bespoke or assistive interaction with a computer system. Alternatively, learners may choose to design and create a graphical user interface (GUI) for a computer program or application that they have made themselves (or had provided for them as part of the client brief).

For distinction standard, learners will draw on, and show synthesis of, knowledge across the learning aims to evaluate how the decisions and processes applied throughout the planning, development and testing stages impacted on the effectiveness of the HCI solution. Learners will provide a detailed evaluation that fully explores the impact that the HCI solution they have developed has had on the aims and requirements of the client. Learners must explain how their solution fulfils the requirements, and they must evaluate each stage of the development process from the planning and development stage. Learners will make suitable and reasoned justifications of decisions made and suggestions for improvement in comparison to alternatives. Learners must clearly show how the needs of the user and feedback from others have been carefully analysed and used to influence improvements and inform further review. The evaluation will contain a systematic and accurate review of their own skills, performance and behaviours, and the impact that this had on the effectiveness of the products. Learners must also demonstrate individual responsibility and effective self-management when planning and applying their HCI solutions. This will be through the use of clear documentation of the process, for example meeting notes, feedback forms and annotated designs. Learners will take individual responsibility for their own work, such as identifying potential issues and resolving these, reviewing their work and making improvements, keeping their work safe and secure and showing responsible use of quoted materials. Learners will show creativity, for example, through taking innovative approaches to problem solving and through the originality of their solution. Learners will refer to tangible evidence to support their evaluation such as meeting notes, correspondence and time plans.

For merit standard, learners will provide a detailed explanation of how the decisions they ultimately made in the design of their HCI solution contributed to making an effective solution that fulfils the needs of the client. Learners must explain how their designs fulfil the fundamental principles of HCI, and how this helps in producing an effective solution to the problem outlined within the brief. Learners must provide evidence of eliciting and using feedback to improve the quality of their designs, including identifying how feedback has been used to improve the design, what has been rejected and a rationale for these decisions.

Learners will produce an optimised HCI solution. This must be a fully working solution and will contain minimal errors that do not impact on its intended use. Learners will provide evidence of implementation and refinement of the solution. Learners must demonstrate that the solution has been thoroughly tested, using a range of appropriate methods to identify errors and improve user experience.

Learners will provide a clear and balanced analysis of the success of their solution, considering how far the outcomes met the identified requirements (including associated legal and ethical issues). They must make accurate and reasoned suggestions as to how the final solution could be improved and will discuss alternative solutions that could be used if the task were to be repeated. Learners will produce an evaluation of how their skills and behaviours affected the outcomes of the project. Their evaluation should explain ways in which they might develop their skills and behaviours, identifying ways that this may result in improved project outcomes.

For pass standard, learners will apply understanding through the planning, development and testing of a HCI solution to meet identified requirements. Learners will provide a description of the tasks to be carried out and the related user requirements that will be supported by the HCI solution. Learners must identify the relevant input, output and processing requirements to support the HCI solution. Learners must provide a clear outline of the client requirements.

Learners will produce detailed plans for an HCI solution that will meet identified client requirements. Learner musts provide a detailed project brief and appropriate technical documentation containing appropriate visual and technical plans for the system. Learners must review their designs with others to identify improvements and refinements in order to develop a final set of designs.

Learners must provide documentation for the production, implementation and testing of their HCI solution, and should explain the decisions they made during the design and development process to ensure they met the project brief. Learners will produce a solution that is functional and meets the requirements of the client. However, some small issues may persist.

Learners must provide a review of their work, including feedback from others, in relation to the identified client requirements. The review will consider positive and negative aspects of the outcomes, although it may be unbalanced and/or superficial. Learners will make suggestions as to how the outcomes could be improved.

Links to other units

The assessment for this unit should draw on knowledge, understanding and skills developed from:

- Unit 1: Principles of Computer Science
- Unit 3: Planning and Management of Computing Projects
- Unit 5: Building Computer Systems
- Unit 6: IT Systems Security
- Unit 18: Relational Database Development
- Unit 22: Systems Analysis and Design
- Unit 23: Systems Methodology
- Unit 24: Software Development.

This unit would relate to teaching of:

- Unit 11: Digital Graphics and Animation
- Unit 12: Digital Audio
- Unit 13: Digital Video
- Unit 14: Computer Games Development.

Employer involvement

This unit would benefit from employer involvement in the form of:

- guest speakers
- technical workshops involving staff from local organisations/businesses
- contribution of design/ideas to unit assignment/scenario/case study/project materials, including own organisation/business materials as exemplars where appropriate
- feedback from staff from local organisations/businesses on plans/designs/items developed
- opportunities for observation of organisational/business application during work experience
- support from local organisation/business staff as mentors.

Unit 11: Digital Graphics and Animation

Level: **3**

Unit type: **Internal**

Guided learning hours: **60**

Unit in brief

Learners will study the principles, processes and implications of using digital formats to produce and process graphics and animation to meet identified requirements.

Unit introduction

Digital graphics and animation are widely used for a range of purposes, including creating special effects in television programmes and films, the making of cartoons and producing content for games and web pages for the purposes of education and simulation. Understanding how to plan, produce and manipulate digital content is crucial in ensuring that digital products match their intended purpose. As an animator, you will need to have determination, an eye for detail and the ability to plan and create high-quality digital graphics and animation products.

In this unit, you will cover the fundamental principles of digital graphics and animation. You will explore the implications of representing graphics in digital form and the processes and techniques used to develop effective digital graphics and animation. You will design, create, test and review digital graphics and animations, in readiness for inclusion in a digital product, to meet a range of identified requirements.

Through studying this unit you will apply skills and knowledge relevant to a variety of disciplines, including graphics, art and film making. You will develop the skills and knowledge that will be of benefit in a range of apprenticeships and higher education courses aimed at helping you to progress to employment in the creative computing industry, in a role such as a user interface developer or a cinematics artist.

Learning aims

In this unit you will:

A Investigate the purpose and principles of digital graphics and animation

B Design digital graphics and animation products to meet client requirements

C Develop digital graphics and animation products to meet client requirements.

Summary of unit

Learning aim	Key content areas	Recommended assessment approach
A Investigate the purpose and principles of digital graphics and animation	**A1** Digital image representation **A2** 3D image representation **A3** Digital animation techniques **A4** Uses and applications of digital graphics and animation	A report on the techniques used to produce, store and represent graphics and animation in digital format and the impact of using digital formats to produce these types of product.
B Design digital graphics and animation products to meet client requirements	**B1** Digital graphics and animation planning and design **B2** Design documentation **B3** Digital graphics and animation processes and techniques **B4** Reviewing and refining designs	A design specification showing the planning, preparation and design of digital graphics and animation products that meet client requirements. Digital graphics and animation files that fulfil the design specification accompanied by supporting development and testing documentation. A report evaluating the digital graphics and animations against the design specification.
C Develop digital graphics and animation products to meet client requirements	**C1** Digital graphics and animation processing techniques **C2** Testing digital graphics and animation **C3** Reviewing digital graphics and animation **C4** Quality characteristics **C5** Skills, knowledge and behaviours	

Content

Learning aim A: Investigate the purpose and principles of digital graphics and animation

A1 Digital image representation

Characteristics, application and implications of using digital data to represent digital images.

- Raster images:
  - 2D arrays
  - dimensions
  - sampling
  - colour modes
  - bit depth
  - resolution
  - compression (lossy, lossless).
- Vector images:
  - geometrical primitives (points, lines, curves, polygons)
  - paths
  - nodes
  - voxel.

A2 3D image representation

Principles and application of representing 3D images in digital format.

- Coordinate systems:
  - left- and right-handed
  - local
  - 3D world
  - 3D viewport
  - camera
  - geometrical primitives (points, lines, voxel).

A3 Digital animation techniques

Characteristics, application and implications of using digital animation techniques to create and process 2D and 3D animated images.

- Key frames.
- Tweening.
- Motion capture.
- Wire framing.
- Coordinate systems (2D and 3D).
- Environmental physics.
- Behavioural animation.

A4 Uses and applications of digital graphics and animation

Uses and applications of digital graphics and animation and the effect on content, format and characteristics.

- Target audience.
- Purpose, e.g. education, entertainment, illustration.
- Target platform.
- Target medium, e.g. digital, print.
- Interactivity.
- Legal and ethical considerations applicable to the equivalent legislation in England, Wales and Northern Ireland, e.g. privacy, security, use of content created by others.

Learning aim B: Design digital graphics and animation products to meet client requirements

B1 Digital graphics and animation planning and design

Techniques and processes to consider when planning and designing digital graphics and animation.

- Digital processing and editing techniques.
- Compression formats and techniques.
- Quality characteristics, e.g. image quality, compatibility, user experience, usability.

B2 Design documentation

- Requirements of the brief, including audience, purpose and client requirements.
- Organisation/company research.
- Legal and ethical considerations applicable to the equivalent legislation in England, Wales and Northern Ireland, e.g. licencing, data security, privacy.
- File naming and storage location.
- Sources of images.
- Product design:
  - characters
  - background imaging
  - sound and effects
  - scripts, storyboards, storylines, timeline storyboards, mood boards, mind maps
  - timings, key frames, frame numbering, frame naming and frame rates
  - perspectives
  - dope sheet for instructions for animation/filming
  - long sheet for running time and sequencing.
- Intended platform/media for delivery.
- Hardware requirements, to include:
  - specification of target platform (input, processing and output requirements)
  - specialist input devices, e.g. motion capture, virtual reality, laser scanning, CT scanner
  - specialist output devices, e.g. virtual reality, e-paper, holographic
  - locater devices, e.g. absolute or relative, direct or indirect, discrete or continuous.
- Software requirements, to include:
  - tools required
  - target file formats, types and sizes
  - product compatibility
  - codecs.
- Additional assets required for digital graphics and animation:
  - original photographs
  - images or logos that can be edited or transformed to become part of the digital character
  - sound files (music, sound effects, speech).
- Test plans to check correctness, presentation, compatibility and other quality characteristics.
- Technical constraints, e.g. file types, software licensing.

B3 Digital graphics and animation processes and techniques

Processes and techniques used in the editing and production of digital graphics and animation products and their implications.

- Mathematical principles and processes:
  - algorithms
  - composite transformations
  - coordinate systems
  - image arithmetic
  - rotation (2D and 3D)
  - scaling (2D and 3D)
  - translation (2D and 3D).
- Graphic processing and editing techniques:
  - translation
  - scaling
  - rotation
  - composite transformations
  - 3D viewing
  - file size, e.g. quality of image, frame disposal, auto crop.
- Compression formats and techniques.
- User experience:
  - quality
  - compatibility
  - usability
  - hardware requirements
  - software requirements.

B4 Reviewing and refining designs

Working with clients and others to improve the quality, effectiveness and appropriateness of designs.

- Gathering feedback from client(s) and potential users.
- Communicating with clients, e.g. email, verbal communication.
- Scheduling and documenting meetings.
- Agreeing and adjusting timescales.
- Refining ideas and solutions.
- Updating design specification documentation based on review and feedback.

Learning aim C: Develop digital graphics and animation products to meet client requirements

C1 Digital graphics and animation processing techniques

Selection and use of digital graphics and animation processing tools and techniques.

- Graphic tools:
  - freehand draw
  - grouping
  - colour balance
  - filters
  - selection
  - hue and saturation
  - masking
  - layering
  - retouching
  - opacity/transparency
  - editing and combining paths.

- Animation tools:
  - frame rates
  - onion skinning
  - tweening
  - transitions
  - camera angles
  - movement
  - picture duration
  - rendering.
- Storing digital graphics and animation:
  - file formats
  - compression
  - target device/platform
  - user requirements
  - quality characteristics.
- Storing and using other digital assets, e.g. audio, video.
- Hardware and software requirements.

C2 Testing digital graphics and animation

- Test digital graphics and animation for functionality, compatibility, stability and acceptance.
- Obtain feedback from others, e.g. effectiveness, presentation, and purpose.
- Make improvements to digital graphics and animation in response to testing and feedback from others.

C3 Reviewing digital graphics and animation

- Quality of digital graphics and animations.
- Suitability for audience and purpose.
- Suitability against the original requirements.
- Legal and ethical constraints applicable to the equivalent legislation in England, Wales and Northern Ireland, e.g. privacy, security, use of content created by others.
- Technical constraints.
- Strengths and potential improvements.
- Optimising digital graphics and animations, e.g. paltering frame rates, exporting to different file formats, updating/replacing assets, applying different tools or effects, using different compression methods.

C4 Quality characteristics

Quality characteristics of digital graphics and animation that can be measured against client requirements.

- Image quality.
- Sound quality.
- Special and visual effects.
- Accuracy.
- Compatibility.
- Usability.
- Stability.
- Functionality.
- Costs.

C5 Skills, knowledge and behaviours

- Planning and recording, including the setting of relevant targets with timescales, how and when feedback from others will be gathered.
- Reviewing and responding to outcomes, including the use of feedback from others, e.g. IT professionals and users who can provide feedback on the quality of the digital graphics and animation products and their suitability against the original requirements.
- Demonstrate behaviour and its impact on outcomes, including professionalism, etiquette, supportive of others, timely and appropriate leadership, accountability and individual responsibility.
- Evaluating outcomes to help inform high-quality, justified recommendations and decisions.
- Evaluating targets to obtain insights into own performance.
- Media and communication skills, including:
  - the ability to convey intended meaning, e.g. written (email, design documentation, recording documentation, reports, visual aids for use in presentations), verbal communication requirements (one to one and group, informal and formal, situations)
  - use of tone and language for verbal and written communications to convey intended meaning and make a positive and constructive impact on audience, e.g. positive and engaging tone, technical/vocational language suitable for intended audience, avoidance of jargon
  - responding constructively to the contributions of others, e.g. supportive, managing contributions so all have the opportunity to contribute, responding to objections, managing expectations, resolving conflict.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Investigate the purpose and principles of digital graphics and animation</td><td rowspan="2">A.D1 Evaluate how the representation of digital graphics and animation in digital format impact on their usability and accuracy.</td></tr>
<tr><td>A.P1 Explain the characteristics of digital graphics and animation and methods of processing them in digital format.
A.P2 Explain the impact of using different tools and techniques to process and manipulate digital graphics and animation in digital formats.</td><td>A.M1 Analyse how the representation of digital graphics and animation in digital format impact on their usability and accuracy.</td></tr>
<tr><td colspan="2">Learning aim B: Design digital graphics and animation products to meet client requirements</td><td rowspan="4">BC.D2 Evaluate the design and optimised digital graphics and animation products against client requirements.
BC.D3 Demonstrate individual responsibility, creativity, and effective self-management in the design, development and review of digital graphics and animation products.</td></tr>
<tr><td>B.P3 Produce designs for digital graphics and animation products that meet client requirements.
B.P4 Review the designs with others to identify and inform refinements.</td><td>B.M2 Justify decisions made, showing how the design will fulfil its purpose and client requirements.</td></tr>
<tr><td colspan="2">Learning aim C: Develop digital graphics and animation products to meet client requirements</td></tr>
<tr><td>C.P5 Produce digital graphics and animation products to meet client requirements.
C.P6 Test digital graphics and animation products for accuracy, functionality, compatibility and stability.
C.P7 Review the extent to which the digital graphics and animation products meets client requirements.</td><td>C.M3 Optimise digital graphics and animation products to meet client requirements.</td></tr>
</table>

Essential information for assignments

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There is a maximum number of two summative assignments for this unit. The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aims: B and C (B.P3, B.P4, C.P5, C.P6, C.P7, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to hardware and software resources that will allow them to use a selection of tools and techniques, as given in the unit content, to produce digital graphics and animation products.

There are a number of propriety and open source resources available, including:

- animation software (for example Adobe Flash®, Sketchbook Pro®, Blender™)
- image editing software (for example Photoshop®, Pencil, Synfig Studio)
- 3D-modelling software (for example 3D Studio Max®, Maya™, Modo™, ZBrush®, AutoCAD®, Cinema 4D™, Blender™).

Essential information for assessment decisions

Learning aim A

The evidence must include characteristics and techniques used for processing and creating graphics and animation in digital format. This must be supported by examples of how these are used. The evidence will include an analysis of how the different techniques could be used and the effect they would have on digital files, and, where appropriate, the effect on the user.

For distinction standard, learners will provide a clear and balanced evaluation of how the characteristics of digital image data impact on the use and representation of digital graphics and animation. The evidence will also include an analysis of how the techniques used to create and process digital graphics and animations affect their appropriateness, accuracy of representation and usability. The evidence will demonstrate high-quality written/oral communication through the use of accurate and fluent technical vocabulary, which supports a well-structured and considered response that clearly connects chains of reasoning.

For merit standard, learners will analyse how the tools, techniques and principles of digital image representation impact on the production and outcomes of digital graphics and animation and the products for which they are intended. Learners should consider how mathematical principles, such as geometry and co-ordinate systems, impact on the digital output and, where appropriate, the impact on the user. Learners will consider the implications of computational processes, such as compression, environmental physics and behavioural animation, and how they are used to produce and edit digital representations of objects and/or actions. Learners should also analyse how the intended uses and applications of digital images and animations, and relevant legal and ethical considerations, would impact on the choice of tools and processing techniques. The report will be technically accurate and demonstrate good quality written/oral communication.

For pass standard, learners will explain how digital data is used to represent image data and the impact this has on the way in which images are stored, manipulated and used. Learners must identify techniques used to create, edit and process digital graphics and animation, and explain how these techniques and processes affect digital images. Learners will identify some of the mathematical and computational processes that are used in digital graphic and animation production and the effect this has on digital images. Learners will explain how the intended uses and applications of digital products (including target audience, purpose and target platform) impact on the tools and techniques used to develop digital graphics and animation. Learners must demonstrate an understanding of the key legal and ethical considerations that affect the user and development of digital content. The evidence will discuss how file formats affect digital products and how these can be used. The evidence may have some inaccuracies and the review of the impact may be unbalanced.

Learning aims B and C

Learners must provide evidence of planning and developing a number of different digital graphics and at least one animation. Depending on client requirements, the products learners produce could be suitable for inclusion in a larger digital product. For example, the client may require content for an e-learning package that may include graphics for different purposes, such as navigation buttons, icons, illustrations assets for educational games, and animations such as animated banners, educational cartoons or cut-scenes in games. The digital graphics and animations should be of sufficient complexity to show the use of a range of appropriate processing techniques.

Learners should produce a range of digital images as well as a number of brief animations, or one extended animation of sufficient length and complexity, to demonstrate competency in the use of the skills and techniques listed in the unit content.

For distinction standard, learners will draw on, and show synthesis of, knowledge across the learning aims in evaluating how the decisions and processes, applied throughout the planning, development and testing stages, impacted on the effectiveness of the digital graphic and animations. Learners will make suitable and reasoned justifications of decisions made in comparison to alternative solutions.

Learners must provide a thorough evaluation of the effectiveness of the content produced against the design and client requirements. The evaluation will be supported by evidence from all stages of the planning, development and review processes in order to reach valid conclusions as to how the chosen processing techniques provided more appropriate digital content in comparison to alternatives. Learners will provide well-considered, justifiable suggestions for future improvements to the digital graphics and animation.

The evaluation must contain a systematic and accurate review of learners' skills and performance and the impact that this had on the effectiveness of the solutions. Evaluation of behaviours must consider learners' use of 'soft skills' in relation to the vocational context of the project, such as managing and liaising with other members of the team or clients and time management. Learners will evaluate their own behaviours throughout the project and the impact they have on the outcomes. Learners will take individual responsibility for their own work, for example identifying potential issues and resolving these, reviewing their work and making improvements, keeping their work safe and secure and showing responsible use of quoted materials. Learners will show creativity, for example, through evidence of taking innovative approaches to problem solving and through the originality of their solution. Learners will refer to tangible evidence to support their evaluation, such as meeting notes, correspondence and time plans.

For merit standard, learners will apply their knowledge through the selection and application of appropriate tools and techniques to plan, design, develop, test and optimise digital graphics and animations that effectively meet client requirements. The sourcing, development and testing stages must be well documented with clear justification of decisions and selections made throughout. Learners will make clear references to the client's requirements, target product and platform, and consider legal and ethical issues as appropriate.

Learners must provide a clear, accurate and robust justification of how the chosen mathematical and computational processing techniques will ensure the digital graphics and animations are appropriate for the use for which they were intended.

Learners will source a wide range of digital content in readiness for processing and editing with appropriate, dedicated editing software. The evidence will demonstrate accurate and appropriate use of 2D and 3D image creation and editing tools. Learners must produce digital content that is fully optimised for use in the identified target product and that fully meets the client's requirements.

For pass standard, learners will apply understanding through the planning, sourcing and processing of digital content to produce graphics and animations to meet identified requirements. Learners will explain the content (and related computing) requirements of an identified client. Learners should provide a project brief that clearly outlines the purpose of the digital graphics and animation. Depending on client requirements, the digital graphics and animation may be required for inclusion in another digital product. Learners will explain how digital graphics and animation techniques, as well as mathematical and computational processing methods, will be used to meet the client's requirements. The project brief should consider the appropriateness of different possible techniques and formats and the impact these would have on the user experience. Learners must show some awareness of the legal and ethical considerations related to sourcing and producing digital content.

Learners will source a range of digital content in preparation for processing with appropriate editing software. They must identify and source raw content that they will use and explain the reasons for choosing the elements that were used, and the editing decisions made during production and development. Learners will provide a clear record of the sources used and demonstrate an understanding of the implications of relevant legal and ethical issues in their selection and use of particular content.

Learners must provide documentation for the planning, development, production, and quality assurance of their digital graphics and animation, and must explain the decisions made during the project to ensure they met the project brief. Learners will produce a number of 2D and 3D images for inclusion in the specified digital product. Learners will produce content that meets the requirements of the client and that is appropriate for the identified product, however some small issues of optimisation and/or rendering may persist.

Learners must provide a review of whether their work meets the client's requirements, considering positive and negative aspects of the outcomes, although their review may be unbalanced and/or superficial. Learners will use relevant feedback, such as client feedback, to make suggestions regarding possible alternative solutions that could be implemented.

Links to other units

This unit links to:

- Unit 12: Digital Audio
- Unit 13: Digital Video
- Unit 14: Computer Games Development
- Unit 15: Website Development
- Unit 16: Object-oriented Programming
- Unit 17: Mobile Apps Development
- Unit 24: Software Development
- Unit 25: Web Application Development
- Unit 27: 3D Modelling.

Employer involvement

This unit would benefit from employer involvement in the form of:

- guest speakers
- technical workshops involving staff from local organisations/businesses
- contribution of design/ideas to unit assignment/scenario/case study/project materials, including own organisation/business materials as exemplars where appropriate
- feedback from staff from local organisations/businesses on plans/designs/items developed
- opportunities for observation of organisational/business application during work experience
- support from local organisation/business staff as mentors.

Unit 12: Digital Audio

Level: **3**

Unit type: **Internal**

Guided learning hours: **60**

Unit in brief

Learners study the principles and processes used to convert, store and manipulate audio signals and data. They will use techniques to process digital audio to meet identified requirements.

Unit introduction

Audio is used extensively in the digital arts, including web, gaming, music, film and television. The computing principles that underpin the use of digital audio have remained unchanged for many years and form a body of knowledge that, as an audio engineer, you will be able to draw on to achieve the highest quality creative results.

In this unit, you will learn about the computing principles relevant to digital audio representation, transfer and storage. You will develop your practical skills to produce suitable audio for a range of applications, including the use of processes to enhance and augment audio. You will investigate, design, create, test and evaluate digital audio to meet a range of identified requirements.

Through studying this unit, you will apply skills and knowledge that can prepare you for a range of apprenticeships or higher education courses, including sound recording, broadcast production and broadcast technology, eventually entering the workplace as a professional in the creative computing field, such as an audio digital signal processing engineer.

Learning aims

In this unit you will:

A Examine the principles that underpin digital audio

B Design digital audio to meet client requirements

C Develop digital audio to meet client requirements.

Summary of unit

Learning aim	Key content areas	Recommended assessment approach
A Examine the principles that underpin digital audio	**A1** Digital representation of audio **A2** Storing and using audio in digital form	A report on the techniques used to record, store and represent audio in digital format, the relationship between analogue sound and digital data and the implications of using digital formats to store and reproduce sound.
B Design digital audio to meet client requirements	**B1** Digital audio planning and design **B2** Planning and design documentation **B3** Sourcing digital audio assets **B4** Reviewing and refining designs	A design specification showing the planning, sourcing and processing of a range of sounds in readiness for an identified digital product. A selection of digital audio files which fulfil the design specification, accompanied by supporting development and testing documentation. A report evaluating the digital audio files against the design specification.
C Develop digital audio to meet client requirements	**C1** Digital audio processing methods **C2** Testing digital audio **C3** Reviewing digital audio **C4** Quality characteristics **C5** Skills, knowledge and behaviours	

Content

Learning aim A: Examine the principles that underpin digital audio

A1 Digital representation of audio

Characteristics, application and implications of using digital data to represent audio.

- Binary representation of sound, including:
  - binary numbers
  - pulse-code modulation (PCM).
- Sampling, analogue to digital conversion (ADC), using the Nyquist-Shannon sampling theorem. Features of sampling, including:
  - sample rate/frequency
  - frequency response
  - bit rates
  - digital clocking
  - synchronisation
  - quantization (including approximation, quantizing error)
  - dither
  - aliasing
  - oversampling.
- Error detection and correction.
- Digital to analogue conversion.

A2 Storing and using audio in digital form

Characteristics and implications of using and storing audio data in digital form.

- Audio file formats, including the characteristics of different audio file formats, selection and use of audio file formats, codecs.
- Compression, including:
  - compression types, e.g. lossy, lossless
  - compression methods used with digital audio.
- Impact of compression on digital audio.
- Musical instrument digital interface (MIDI).

Learning aim B: Design digital audio to meet client requirements

B1 Digital audio planning and design

Techniques and processes to consider when planning and designing digital audio for use in digital products.

- Digital processing and editing techniques.
- Sourcing digital audio assets.
- Compression formats and techniques.
- Quality characteristics, e.g. compatibility, user experience, usability, timing and length, file types, codecs.

B2 Planning and design documentation

- Requirements of the brief, including audience, purpose and client requirements.
- Organisation/company research.
- Legal and ethical considerations applicable to the equivalent legislation in England, Wales and Northern Ireland, e.g. copyright, royalties, digital rights management (DRM).
- Storyboards (where appropriate).
- Intended platform/media for delivery.
- Timeline, e.g. outlining which different assets are included and when different assets will be combined.

- Processing schedule, e.g. timeline of digital audio processing.
- Hardware, software and other resources required.
- Test plans to check accuracy, audio presentation, compatibility and other quality characteristics.
- Technical constraints, e.g. file types, software licensing.

B3 Sourcing digital audio assets

- Recording analogue audio, e.g. speech, music, sound effects.
- Creating unique digital audio, e.g. music, sound effects.
- Third party audio files.

B4 Reviewing and refining designs

Working with clients and others to improve the quality, effectiveness and appropriateness of designs.

- Gathering feedback from client(s) and potential users.
- Communicating with clients, e.g. email, verbal communication.
- Scheduling and documenting meetings.
- Agreeing and adjusting timescales.
- Refining ideas and solutions.
- Updating design specification documentation based on review and feedback.

Learning aim C: Develop digital audio to meet client requirements

C1 Digital audio processing methods

- Audio processing techniques, including:
  - simulating acoustic environments
  - delay-based processing
  - reverberation
  - pitch-based processing
  - room modelling
  - equalisation
  - dynamics.
- Storing and using digital audio, including:
  - file formats
  - compression
  - target device/platform
  - quality characteristics.
- Hardware and software requirements.
- Error detection and correction.

C2 Testing digital audio

- Testing digital audio for use in digital products, including compatibility, stability and acceptance.
- Obtaining feedback from others, e.g. effectiveness, presentation, audio performance and purpose.
- Making improvements to digital audio in response to testing and feedback from others.

C3 Reviewing digital audio

- Quality of digital audio.
- Fitness for audience and purpose.
- Suitability against the original requirements.
- Legal and ethical constraints.
- Technology constraints.
- Strengths and potential improvements.
- Optimising digital audio, e.g. resampling and different sampling rates, applying different tools or effects, using different compression methods, based on review and feedback.

C4 Quality characteristics

Quality characteristics of digital audio which can be measured against client requirements.

- Sound quality.
- Sound effects.
- Accuracy.
- Compatibility.
- Usability.
- Costs.

C5 Skills, knowledge and behaviours

- Planning and recording, including the setting of relevant targets with timescales, how and when feedback from others will be gathered.
- Reviewing and responding to outcomes, including the use of feedback from others, e.g. IT professionals and users who can provide feedback on the quality of the digital audio and its suitability against the original requirements.
- Demonstrating behaviour and its impact on outcomes, including professionalism, etiquette, being supportive of others, timely and appropriate leadership, accountability and individual responsibility.
- Evaluating outcomes to help inform high-quality, justified recommendations and decisions.
- Evaluating targets to obtain insights into own performance.
- Media and communication skills, including:
  - conveying intended meaning, e.g. written (email, design documentation, recording documentation, reports, visual aids for presentation use), verbal communication requirements (one-to-one and group, informal and formal situations)
  - use of tone and language for verbal and written communications to convey intended meaning and make a positive and constructive impact on audience, e.g. positive and engaging tone, technical/vocational language suitable for intended audience, avoidance of jargon
  - responding constructively to the contributions of others, e.g. supportive, managing contributions so all have the opportunity to contribute, responding to objections, managing expectation, resolving conflict.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Examine the principles that underpin digital audio</td><td rowspan="2">A.D1 Evaluate how the application of digital audio principles within digital audio signals and digital audio data affects the accuracy with which they reproduce the original audio or instrument.</td></tr>
<tr><td>A.P1 Explain the characteristics of digital audio and methods of processing sound in digital format.
A.P2 Explain the impact of representing and storing audio in digital format.</td><td>A.M1 Analyse how digital audio principles impact on the accuracy and usability of sound files, and techniques that can be used to enhance the accuracy and usability of the digital audio signal.</td></tr>
<tr><td colspan="2">Learning aim B: Design digital audio to meet client requirements</td><td rowspan="4">BC.D2 Evaluate the design and optimised digital audio files included in a digital product against client requirements.
BC.D3 Demonstrate individual responsibility, creativity, and effective self-management in the design, development and review of digital audio files.</td></tr>
<tr><td>B.P3 Produce designs for digital audio files for inclusion into a digital product which meets client requirements.
B.P4 Review the designs with others to identify and inform refinements.</td><td>B.M2 Justify decisions made, showing how the design will fulfil its purpose and meet client requirements.</td></tr>
<tr><td colspan="2">Learning aim C: Develop digital audio to meet client requirements</td></tr>
<tr><td>C.P5 Develop digital audio files to meet client requirements for inclusion into a digital product.
C.P6 Test digital audio files for correctness, audio presentation and compatibility.
C.P7 Review the extent to which the digital audio files meet the client requirements.</td><td>C.M3 Optimise digital audio files to meet client requirements for inclusion into a digital product.</td></tr>
</table>

Essential information for assignments

The recommended structure of assessment is shown in the unit summary along with suitable forms of evidence. *Section 6* gives information on setting assignments and there is further information on our website.

There is a maximum number of two summative assignments for this unit. The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aims: B and C (B.P3, B.P4, C.P5, C.P6, C.P7, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to hardware and software resources that will allow them to use the tools and techniques, as given in the unit content, to record and manipulate audio files.

Essential information for assessment decisions

Learning aim A

The evidence must include characteristics of digital audio techniques used for processing sound in a digital format. This must be supported by examples of how these are used. The evidence will include an analysis of how the different techniques could be used and the effect they would have on audio files and, where appropriate, the user.

For distinction standard, learners will provide a clear and balanced evaluation of how the characteristics of digital audio impact on how accurately analogue sound is represented when processed using digital data. The evidence must provide clear examples of how storing and processing data affects the way they could be used in a range of contexts, for example as a soundtrack for a video or a sound effect on a website. Learners must make comparisons between different techniques of processing and storing audio and the impact they would have on the audio files, target product and, where appropriate, the user. The report will demonstrate high-quality written/oral communication, through use of accurate and fluent technical vocabulary to support a well-structured and considered response that clearly connects chains of reasoning.

For merit standard, learners will show a clear understanding of how processing and storing digital audio impacts on the accuracy and usability of audio files. The report must provide a balanced discussion, supported by clear examples, of how at least five types of sampling (other than analogue to digital converter) impact on how accurately the digital data can represent the original sound, and techniques that can be used to detect errors and improve accuracy. The evidence will be technically accurate and demonstrate good-quality written or oral communication.

For pass standard, learners will explain the characteristics of digital audio. The explanations must be supported by examples of how audio data is stored (binary representation of sound) and processed in digital format. The evidence will demonstrate an understanding of the process of conversion from analogue to digital and the resource requirements of converting and storing audio. Learners must discuss how different features of sampling impact on audio data. The evidence must discuss how audio file formats and compression impact on how the audio data can be used. The evidence may have some inaccuracies and the review of the impact may be unbalanced.

Learning aims B and C

Learners must provide evidence that contains the raw (original) sounds, the audio files and appropriate planning and development evidence detailing the use of processing and testing techniques. Learners must provide evidence of evaluating the effectiveness and appropriateness of the digital audio files.

Learners must provide evidence of planning and developing a number of different digital audio files for at least two different uses. For example, the client may require sound effects, soundtracks and voiceovers to be produced for inclusion in an e-learning package or a computer game. Learners are not required to present the files in a larger digital product but must provide evidence that the produced files are appropriate and ready for use in the ways specified in the project brief.

At least two of the sounds they process for inclusion in the audio files will be recorded by learners, one of which must contain spoken voice and one must contain music that has been performed live or music that has been created by learners using digital techniques.

For distinction standard, learners will draw on, and show synthesis of, knowledge across the learning aims to evaluate how the decisions and processes applied throughout the planning, design, development and testing stages impacted on the effectiveness of the digital audio files. Learners will make suitable and reasoned justifications of decisions made in comparison to alternative solutions.

Learners must provide a thorough evaluation of the effectiveness of the digital audio files against design and client requirements. The evaluation will be supported by evidence from all stages of the development and review process to reach valid conclusions as to how the chosen processing techniques provided more accurate and usable digital audio in comparison to alternatives. Learners will provide well-considered, justifiable suggestions for future improvements to the digital audio files.

The evaluation will contain a systematic and accurate review of learners' own skills and performance and the impact that this had on the effectiveness of the digital audio files. Evaluation of behaviours will consider learners' use of 'soft skills' in relation to the vocational context of the project, such as managing and liaising with other members of the team or clients and time management. Learners will evaluate their own behaviours throughout the project and the impact they have on the outcomes. Learners will take individual responsibility for their own work, for example identifying potential issues and resolving these, reviewing their work and making improvements, keeping their work safe and secure and showing responsible use of quoted materials. Creativity will be shown, for example, through taking innovative approaches to problem-solving and through the originality of their solution. Learners will refer to tangible evidence to support their evaluation such as meeting notes, correspondence and time plans.

For merit standard, learners will apply their knowledge through selection and application of appropriate tools and techniques to plan, design, develop, test and optimise digital audio files that effectively meet client requirements. Learners will produce comprehensive designs, including alternative solutions. When developing their audio files, learners should produce an optimal solution in order to meet client requirements as closely as possible. Learners should also gather and analyse feedback on their audio files in order to make improvements.

The sourcing, development and testing stages must be well-documented with clear justification of decisions and selections made throughout. Learners will record the changes that are made and produce subsequent versions of the audio files as appropriate. Learners will make clear reference to the client's requirements, target product and platform, and consider legal and ethical issues as appropriate.

Learners must provide a clear, accurate and robust justification of how the chosen processing techniques will ensure the digital audio representation is accurate and usable and fully meets client requirements.

Learners will source a wide range of raw sounds in readiness for processing with appropriate, dedicated audio editing software.

Learners must optimise their audio files by making use of testing and feedback throughout development to improve and refine the audio files to fully meet client requirements, such as resampling sound at different sample rates, applying different tools and effects and using different compression methods.

Learners will provide a clear and balanced analysis of the success of their outcomes against the design and client requirements and the quality of the audio files. Learners will refer to how the audio files and their content suit the intended audience, purpose and platform of delivery. Learners must also provide an analysis of how any associated legal and ethical issues were considered and met. They will make accurate and reasoned suggestions as to how the digital audio files could be improved and will discuss alternative processing techniques that could be used if the task were to be repeated.

For pass standard, learners will apply their understanding through the planning, sourcing and processing of digital audio files to meet identified requirements. Learners will provide an explanation of the digital audio, and related computing, requirements of an identified client and identify the success/acceptance criteria that will ensure the client's requirements are met.

Learners will produce detailed designs for their audio files, including user requirements and technical documentation. The documentation will clearly outline how audio is required for at least two different uses. Learners must explain how digital audio processing methods could be used to produce the required audio files. Learners must consider the appropriateness of different possible techniques and formats and the impact these would have on user experience. Learners will source a range of raw sounds in readiness for processing with appropriate, dedicated audio editing software. Learners can identify and source more sounds than they will finally use and explain the reasons for choosing the sounds that were ultimately used. Learners must provide a clear record of the sources used and demonstrate an understanding of the implications of relevant legal and ethical issues in their selection and use of particular sounds. Learners must produce a number of sounds that meet the requirements of the client as outlined in their project brief. Learners should carry out and document a number of tests and reviews of their files (including use of test users and appropriate test plans, schedules and test data) to ensure that the solution works and meets the identified criteria. Learners must review their designs with others to identify improvements and refinements. They should provide evidence that different types of testing have been carried out.

Learners must show some awareness of the legal and ethical considerations related to sourcing and producing digital audio files.

Learners must provide documentation for the planning, design, development, production and quality assurance of their audio files, explaining the decisions they made during the project to ensure they met the project brief. Learners will produce a solution that meets the requirements of the client, however, some small issues of optimisation may persist.

Learners must provide a review of whether their work meets the client requirements, considering both positive and negative aspects of the outcomes, although their review may be unbalanced and/or superficial. Learners will use relevant feedback, such as client feedback, to make suggestions regarding possible alternative solutions that could be implemented.

Links to other units

This unit links to:

- Unit 10: Human-computer Interaction
- Unit 11: Digital Graphics and Animation
- Unit 13: Digital Video
- Unit 14: Computer Games Development
- Unit 15: Website Development
- Unit 16: Object-oriented Programming
- Unit 17: Mobile Apps Development
- Unit 24: Software Development
- Unit 25: Web Application Development.

Employer involvement

This unit would benefit from employer involvement in the form of:

- guest speakers
- technical workshops involving staff from local organisations/businesses
- contribution of design/ideas to unit assignment/scenario/case study/project materials, including own organisation/business materials as exemplars where appropriate
- feedback from staff from local organisations/businesses on plans/designs/items developed
- opportunities for observation of organisational/business application during work experience
- support from local organisation/business staff as mentors.

Unit 13: Digital Video

Level: **3**

Unit type: **Internal**

Guided learning hours: **60**

Unit in brief

Learners study the principles, processes and implications of using digital formats to record, store and edit digital videos to meet identified requirements.

Unit introduction

The addition of video to a digital product gives individuals and organisations flexibility in the way they deliver content and engage users. From embedded web content to stand alone videos, understanding how to plan and produce quality video is fundamental to ensuring your digital products have the intended impact. As a producer of digital video content, you will need to assess the requirements of a client and their users, as well as plan and create high-quality content to fulfil these requirements.

In this unit, you will learn about the computing principles that underpin digital video representation, transfer and storage, so that you can select and apply a range of suitable processes in order to develop digital video for a client. You will investigate, design, create, test and evaluate digital video to meet a range of identified requirements.

Through studying this unit, you will acquire knowledge and practical skills in how, and why, digital video can be used to meet a range of objectives. This will give you the skills and knowledge which will be of benefit in a range of apprenticeships and higher education courses, with the aim of progressing to employment in the creative computing industry, such as a media graphics specialist or a multimedia consultant.

Learning aims

In this unit you will:

A Examine the principles that underpin digital video

B Design digital video to meet client requirements

C Develop digital video to meet client requirements.

Summary of unit

Learning aim	Key content areas	Recommended assessment approach
A Examine the principles that underpin digital video	**A1** Digital representation of video **A2** Storing and using video in digital form	A report on the techniques used to record, store and represent video in digital format and the implications of using digital formats to store and reproduce video.
B Design digital video to meet client requirements	**B1** Digital video planning and design **B2** Planning and design documentation **B3** Sourcing digital assets **B4** Reviewing and refining designs	A design specification showing the planning, sourcing and processing of a range of digital content to produce digital videos for specific, identified purposes. Digital videos which fulfil the design specification, accompanied by supporting development and testing documentation. A report evaluating the digital videos against the design specification.
C Develop digital video to meet client requirements	**C1** Digital video production **C2** Testing digital video **C3** Reviewing digital video **C4** Quality characteristics **C5** Skills, knowledge and behaviours	

Content

Learning aim A: Examine the principles that underpin digital video

A1 Digital representation of video

Characteristics, application and implications of using digital data to represent video.

- Digital image representation:
  - colour modes
  - bit depth
  - 2D arrays.
- Properties of digital video, e.g. pixels, frame rates, bitrates.
- Aliasing.
- Quantization.
- Overload.
- Progressive scan and interlace.

A2 Storing and using video in digital form

Characteristics and implications of acquiring, storing and using data in digital format.

- Image acquisition, e.g. image sensors, digital and optical zoom, white balance.
- Video file formats, including the characteristics of different file formats, selection and use of video file formats, codecs.
- Compression techniques:
  - simple compression techniques, e.g. colour lookup table (CLUT), run-length encoding (RLE), truncation
  - interpolation
  - predictive techniques, e.g. adaptive differential pulse code modulation, differential pulse code modulation
  - transform coding
  - statistical coding.
- Purpose of digital video, e.g. advertise, educate, entertain, inform, persuade.
- Quality, including picture and sound.
- Usability, including resolution, scalability, buffering, download speeds, streaming and compatibility.
- Metadata.
- Subtitle data.

Learning aim B: Design digital video to meet client requirements

B1 Digital video planning and design

Techniques and processes to consider when planning and designing digital video.

- Digital processing and editing techniques.
- Compression formats and techniques.
- Quality characteristics, e.g. compatibility, user experience, usability, timing and length, file types, codecs.

B2 Planning and design documentation

- Requirements of the brief, including audience, purpose and client requirements.
- Organisation/company research.
- Legal and ethical considerations applicable to the equivalent legislation in England, Wales and Northern Ireland, e.g. copyright, accessibility.

- Product design:
  - mood boards
  - timeline and production schedules
  - timeline storyboards
  - scripts
  - location plans.
- Intended platform/media for delivery.
- Costs and budget.
- Health and safety assessments.
- Risk assessments.
- Hardware, software and other resources required.
- Test plans to check accuracy, video presentation, compatibility and other quality characteristics.
- Technical constraints, e.g. file types, software licensing.

B3 Sourcing digital assets

- Still images:
  - digital camera
  - graphic software
  - screen capture
  - third party images.
- Video:
  - digital video camera
  - screen capture
  - third party video.
- Animation.
- Audio:
  - types of audio, e.g. sound effects, soundtrack, voiceover
  - recording sound
  - creating unique digital audio
  - third party audio files.

B4 Reviewing and refining designs

Working with clients and others to improve the quality, effectiveness and appropriateness of designs.

- Gathering feedback from client(s) and potential users.
- Communicating with clients, e.g. email, verbal communication.
- Scheduling and documenting meetings.
- Agreeing and adjusting timescales.
- Refining ideas and solutions.
- Updating design specification documentation based on review and feedback.

Learning aim C: Develop digital video to meet client requirements

C1 Digital video production

Selection and use of digital video production processing tools and editing techniques.

- Digital video processing techniques:
  - simulating techniques
  - transitions
  - special effects (SFX)
  - visual effects (VFX)
  - titles
  - overlays
  - credits
  - audio tracks.
- Storing and using digital video:
  - file formats
  - compression
  - target device/platform
  - user requirements
  - quality characteristics.
- Storing and using other digital assets, e.g. audio, animation, graphics.
- Hardware and software requirements.
- Error detection and correction.

C2 Testing digital video

- Test digital video for compatibility, stability and acceptance.
- Obtain feedback from others, e.g. effectiveness, presentation, audio and visual performance and purpose.
- Make improvements to digital video in response to testing and feedback from others.

C3 Reviewing digital video

- Quality of digital video.
- Suitability for audience and purpose.
- Suitability against the original requirements.
- Legal and ethical constraints.
- Technology constraints.
- Strengths and potential improvements.
- Optimising digital video, e.g. rebalancing sound, exporting to different file types, using different compression methods based on review and feedback.

C4 Quality characteristics

Quality characteristics of digital graphics and animations which can be measured against client requirements.

- Image quality.
- Sound quality.
- Special and visual effects.
- Accuracy.
- Compatibility.
- Usability.
- Costs.

C5 Skills, knowledge and behaviours

- Planning and recording, including the setting of relevant targets with timescales, how and when feedback from others will be gathered.
- Reviewing and responding to outcomes, including the use of feedback from others, e.g. IT professionals and users who can provide feedback on the quality of the digital video and its suitability against the original requirements.
- Demonstrate behaviour and its impact on outcomes, including professionalism, etiquette, supportive of others, timely and appropriate leadership, accountability and individual responsibility.
- Evaluating outcomes to help inform high-quality, justified recommendations and decisions.
- Evaluating targets to obtain insights into own performance.
- Media and communication skills, including:
  - the ability to convey intended meaning, e.g. written (email, design documentation, recording documentation, reports and visual aids for presentation use), verbal communication requirements (one-to-one and group, informal and formal situations)
  - use of tone and language for verbal and written communications to convey intended meaning and make a positive and constructive impact on audience, e.g. positive and engaging tone, technical/vocational language suitable for intended audience and avoidance of jargon
  - responding constructively to the contributions of others, e.g. supportive, managing contributions so all have the opportunity to contribute, responding to objections, managing expectation, resolving conflict.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Examine the principles that underpin digital video</td><td rowspan="2">A.D1 Evaluate how the application of digital video principles affect video data and the impact this has on the accuracy and usability of video data.</td></tr>
<tr><td>A.P1 Explain the characteristics of digital video and methods of processing video in digital format.
A.P2 Explain the impact of representing and storing video in digital format.</td><td>A.M1 Analyse how digital video principles impact on the accuracy and usability of video files, and techniques that can be used to enhance the accuracy and usability of digital video.</td></tr>
<tr><td colspan="2">Learning aim B: Design digital video to meet client requirements</td><td rowspan="4">BC.D2 Evaluate the design and optimised video against client requirements.
BC.D3 Demonstrate individual responsibility, creativity, and effective self-management in the design, development and review of digital video.</td></tr>
<tr><td>B.P3 Produce designs for digital video which meet client requirements.
B.P4 Review the designs with others to identify and inform refinements.</td><td>B.M2 Justify decisions made, showing how the design will fulfil its purpose and meet client requirements.</td></tr>
<tr><td colspan="2">Learning aim C: Develop digital video to meet client requirements</td></tr>
<tr><td>C.P5 Produce digital video to meet client requirements.
C.P6 Test digital video for correctness, visual and audio presentation and compatibility.
C.P7 Review the extent to which the digital video meets the client's requirements.</td><td>C.M3 Optimise digital video to meet client requirements.</td></tr>
</table>

Essential information for assignments

The recommended structure of assessment is shown in the unit summary along with suitable forms of evidence. *Section 6* gives information on setting assignments and there is further information on our website.

There is a maximum number of two summative assignments for this unit. The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aims: B and C (B.P3, B.P4, C.P5, CP6, C.P7, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to:

- hardware and software resources that will allow them to use a selection of tools and techniques, as given in the unit content, to process and edit video
- audio and visual equipment capable of recording sound and video.

Essential information for assessment decisions

Learning aim A

The evidence must include characteristics of digital video techniques used for processing and editing video in a digital format. This must be supported by examples of how these are used. The evidence will include an analysis of how the different techniques could be used and the effect they would have on digital files and, where appropriate, the user.

For distinction standard, learners will provide a clear and balanced evaluation of how the characteristics of digital video data impact on how digital video can be processed and used. The evidence must provide clear examples of how storing and processing video in digital format affects the data that forms the digital video files and the impact this has on the way they could be used and/or processed further in a range of contexts. Learners must make comparisons between different, appropriate methods of processing and storing video files and provide justified suggestions as to which would be appropriate in different situations. The report will demonstrate high-quality written/oral communication through use of accurate and fluent technical vocabulary to support a well-structured and considered response that clearly connects chains of reasoning.

For merit standard, learners will show a clear understanding of how processing and storing digital video impacts on the quality and usability of the video files. The report must provide a balanced discussion, supported by clear examples, of how and why different acquisition and processing methods produce different results in terms of quality and usability of the video files. The evidence will be technically accurate and demonstrate good-quality written/oral communication.

For pass standard, learners will explain the characteristics of digital video and how image data is stored and represented in a computer system. The explanations must be supported by examples of how video data is processed in digital format and the impact of acquisition and processing methods on the output. The evidence must discuss how video file formats and compression impact on how the video data can be used. The evidence may have some inaccuracies and the review of the impact may be unbalanced.

Learning aims B and C

Learners must provide evidence of planning and developing a number of different digital videos for at least two different uses. For example, the client may require a video to advertise a product or service, or a video which provides a tutorial on how to use a product. At least one of the videos produced by learners must include video footage they have recorded themselves, and at least one video must contain content generated by screen capture software. The digital videos must be of sufficient length and complexity to show use of a range of appropriate uses of content and processing techniques.

For distinction standard, learners will draw on, and show synthesis of, knowledge across the learning aims to evaluate how the decisions and processes applied throughout the planning, design, development and testing stages, impacted on the effectiveness of the digital videos. Learners will make suitable and reasoned justifications of decisions made in comparison to alternative solutions.

Learners must provide a thorough evaluation of the effectiveness of the digital videos against design and client requirements. The evaluation will be supported by evidence from all stages of the development and review process, to reach valid conclusions as to how the chosen processes and techniques provided more appropriate video in comparison to alternatives. Learners will provide well-considered, justifiable suggestions for future improvements to the digital videos.

The evaluation will contain a systematic and accurate review of their own skills and performance and the impact that this had on the effectiveness of the digital video products. Evaluation of behaviours will consider learners' use of 'soft skills' in relation to the vocational context of the project, such as managing and liaising with other members of the team or clients and time management. Learners will evaluate their own behaviours throughout the project and the impact they have on the outcomes. Learners will take individual responsibility for their own work, for example identifying potential issues and resolving these, reviewing their work and making improvements, keeping their work safe and secure and showing responsible use of quoted materials. Creativity will be shown, for example, through taking innovative approaches to problem-solving and through the originality of their solution. Learners will refer to tangible evidence to support their evaluation such as meeting notes, correspondence and time plans.

For merit standard, learners will apply their knowledge through selection and application of appropriate tools and techniques to plan, design, develop, test and optimise digital videos that effectively meet client requirements. Learners will produce comprehensive designs, including alternative solutions. When developing their video files, learners should produce an optimal solution in order to meet client requirements as closely as possible. Learners should also gather and analyse feedback on their video files in order to make improvements.

The sourcing, development and testing stages must be well documented with clear justification of decisions and selections made throughout. Learners will record the changes that are made and produce subsequent versions of the video files as appropriate. Learners will make clear reference to the client's requirements, target product and platform, and consider legal and ethical issues as appropriate.

Learners must provide a clear, accurate and robust justification of how the chosen processing techniques will ensure the digital videos are appropriate for the use for which they were intended and fully meet client requirements.

Learners will source a wide range of digital assets in preparation for processing and editing with appropriate, dedicated editing software. The evidence will demonstrate accurate and appropriate use of visual effects, audio, for example, voiceovers, sound effects, soundtracks, and other components to fully meet the client's requirements.

Learners must optimise their videos by making use of testing and feedback throughout development to improve and refine the video to fully meet client requirements, such as exporting the video to different file type to improve compatibility or alter file size, applying different tools and effects to improve the appropriateness of the content or using different compression methods to achieve an appropriate balance of quality, file size and usability.

Learners will provide a clear and balanced analysis of the success of their outcomes, against the design and client requirements, and the quality of the digital video products. Learners will refer to how the videos and their content suit the intended audience, purpose and platform of delivery. Learners must also provide an analysis of how any associated legal and ethical issues were considered and met. They will make accurate and reasoned suggestions as to how the digital videos could be improved and will discuss alternative planning, sourcing and processing methods that could be used if the task were to be repeated.

For pass standard, learners will apply their understanding through the planning, sourcing and processing of digital content to produce video files to meet identified requirements. Learners will provide an explanation of the digital video, and related computing requirements of an identified client and identify the success/acceptance criteria that will ensure the client's requirements are met.

Learners will produce detailed designs for their video files, including user requirements and technical documentation. The documentation will clearly outline how video is required for at least two different uses. Learners will explain how digital video capture and processing methods could be used to produce the required video products. Learners must consider the appropriateness of different possible techniques and formats and the impact they would have on user experience.

Learners will source a range of digital assets in preparation for processing with appropriate editing software. Learners must provide a clear record of the sources used. Learners will carry out and document a number of tests and reviews of their files (including use of test users and appropriate test plans, schedules and test data) to ensure that the solution works and meets the identified criteria. Learners must review their designs with others to identify improvements and refinements. They should provide evidence that different types of testing has been carried out.

Learners must show some awareness of the legal and ethical considerations related to sourcing and producing digital video.

Learners must provide documentation for the planning, design, development, production and quality assurance of their video files, explaining the decisions they made during the project to ensure they met the project brief. Learners will produce a solution that meets the requirements of the client, however, some small issues of optimisation may persist.

Learners must provide a review of whether their work meets the client requirements, considering both positive and negative aspects of the outcomes, although their review may be unbalanced and/or superficial. Learners will use relevant feedback, such as client feedback, to make suggestions regarding possible alternative solutions that could be implemented.

Links to other units

This unit links to:

- Unit 10: Human-computer Interaction
- Unit 11: Digital Graphics and Animation
- Unit 12: Digital Audio
- Unit 14: Computer Games Development
- Unit 15: Website Development
- Unit 16: Object-oriented Programming
- Unit 17: Mobile Apps Development
- Unit 24: Software Development
- Unit 25: Web Application Development.

Employer involvement

This unit would benefit from employer involvement in the form of:

- guest speakers
- technical workshops involving staff from local organisations/businesses
- contribution of design/ideas to unit assignment/scenario/case study/project materials, including own organisation/business materials as exemplars where appropriate
- feedback from staff from local organisations/businesses on plans/designs/items developed
- opportunities for observation of organisational/business application during work experience
- support from local organisation/business staff as mentors.

Unit 14: Computer Games Development

Level: **3**

Unit type: **Internal**

Guided learning hours: **60**

Unit in brief

Learners investigate the computer games industry and its impact on technological and social trends. They will design and develop a computer game to meet requirements.

Unit introduction

The computer games industry has been growing year-on-year and has become a multi-billion pound industry. With the prevalence of computing devices, games consoles and mobile devices, this growth shows no sign of slowing. Many computer games are vast productions involving a range of people such as programmers, graphical artists, animators, level designers, actors and directors. As a games developer, you will analyse the needs of a client and understand the potential and limitations of different gaming solutions.

In this unit, you will investigate the technologies used in the computer gaming industry and the implications they have for users, developers and organisations. You will analyse how user needs and preferences impact on game design and how target technologies affect the design and development of a computer game. Finally, you will design, create and review a computer game to meet requirements and reflect on the skills and understanding applied during the design and development process.

You will apply analytical skills that would be used by any software developer to investigate the available technologies and current trends in order to design and develop appropriate software solutions. The skills you gain through this unit will benefit you as you progress to employment in the computer gaming industry, for example in computer games developer and software developer roles.

Learning aims

In this unit you will:

A Investigate technologies used in computer gaming

B Design a computer game to meet client requirements

C Develop a computer game to meet client requirements.

Summary of unit

Learning aim	Key content areas	Recommended assessment approach
A Investigate technologies used in computer gaming	**A1** Social trends in computer gaming **A2** Technologies used in computer gaming	A report investigating and evaluating social and technological trends in gaming and how they would influence the development of new computer games.
B Design a computer game to meet client requirements	**B1** Computer games design processes and techniques **B2** Design documentation **B3** Reviewing and refining designs	A design specification showing the design and development of a computer game to meet identified client requirements. Project brief, design documentation, development and testing logs, meeting notes and a report that evaluates the effectiveness and appropriateness of the computer game. The evidence should also suggest ways in which solutions could be improved and/or alternative solutions that could be used if the task were to be repeated.
C Develop a computer game to meet client requirements	**C1** Principles of computer games development **C2** Developing computer games **C3** Testing computer games **C4** Reviewing computer games **C5** Quality characteristics **C6** Skills, knowledge and behaviours	

Content

Learning aim A: Investigate technologies used in computer gaming

A1 Social trends in computer gaming

Social trends relevant to computer games, including:

- popular genres
- players, e.g. age range, gender, casual gamers, immersive gamers, themes
- game production, e.g. mainstream publisher, indie, free-to-play
- multiplayer
- artificial intelligence, e.g. search algorithms, mathematical optimisation, logic
- emerging technologies
- security of integrated services and multiplayer environments, e.g. Steam, Google Play™.

A2 Technologies used in computer gaming

Technologies are continually evolving; it is vital to remain up to date with what is current at the time.

- Benefits and limitations of different platform options for the development of computer games:
  - personal computers, e.g. Windows®, Mac®
  - consoles, e.g. PlayStation®, Xbox™, Nintendo®
  - mobile devices, e.g. smartphones, tablets, notebooks
  - web-based, e.g. Flash®, HTML5.
- Hardware options and their effect on the development of computer games, including:
  - central processing unit (CPU)
  - graphics processing unit (GPU)
  - memory, e.g. random-access memory (RAM), read-only memory (ROM)
  - output, e.g. display, sound
  - input, e.g. keyboard/mouse, touch, gamepad, joystick, kinetic, voice
  - storage, e.g. hard disk drive, cloud
  - connections, e.g. internet, local area network, mobile network
  - new technologies.
- Software options and their effect on the development of computer games, including:
  - operating system, e.g. Windows, Mac OS, Linux®
  - programming language, e.g. C++, Java®
  - device drivers, e.g. input/output devices
  - graphic options, e.g. DirectX®, OpenGL
  - audio options, e.g. music, ambiance, file format.
- Uses of game engines, their capabilities and how they aid computer game developers, including:
  - rendering engines
  - physics engines
  - collision detection
  - scripting
  - animation.

Learning aim B: Design a computer game to meet client requirements

B1 Computer games design processes and techniques

- Mathematical techniques and processes.
- Graphic processing and editing techniques.
- Platform and delivery.
- Visual styles.
- Assets.
- Game play features, to include:
  - interaction model, e.g. avatar, omnipresence
  - participation, e.g. single player, multiplayer
  - narrative, e.g. story, dialogue
  - game setting, e.g. physical, temporal, environmental, emotional, ethical
  - goals, e.g. what the player needs to achieve in the game
  - challenges, e.g. what the player must overcome
  - rewards, e.g. what the player will receive for completing goals or challenges
  - player actions, e.g. run, jump
  - rules, e.g. valid moves, how high the player can jump
  - feedback, e.g. how the player knows their progress
  - difficulty, e.g. degree of challenge
  - game mechanics, e.g. inventory, scoring, win condition
  - game structure, e.g. storyboard, flowchart, activity diagram
  - quality, e.g. compatibility, performance, gaming experience.

B2 Design documentation

- Requirements of the brief, including audience, purpose and client requirements.
- Legal and ethical considerations applicable to the equivalent legislation in England, Wales and Northern Ireland, e.g. copyright, royalties, digital rights management.
- Game design, to include:
  - type of gameplay
  - data dictionary
  - algorithm design, e.g. pseudocode
  - storyboards, flow charts, activity diagrams
  - visual styles, e.g. world (terrain, architecture, objects), characters, non-playing characters, feedback interface, perspectives (2D, 3D, first-person, third-person, scrolling, aerial and context-sensitive)
  - full motion video
  - assets, e.g. graphical, audio and video
  - gameplay features.
- Choice of programming languages, application program interface (APIs) and computer game development kits.
- Intended platform/media for delivery.
- Timeline, e.g. outlining which different assets are included and when different assets will be combined.
- Production schedule, e.g. timeline of development.
- Hardware, software and other resources required.
- Test plans to check playability, performance and other quality characteristics.
- Constraints, e.g. platform limitations.

B3 Reviewing and refining designs

- Working with clients and others to improve the quality, effectiveness and appropriateness of designs, including:
  - gathering feedback from client(s) and potential users
  - communicating with clients, e.g. email, verbal communication
  - scheduling and documenting meetings
  - agreeing and adjusting timescales
  - refining ideas and solutions.
- Updating design schematic documentation based on review and feedback.

Learning aim C: Develop a computer game to meet client requirements

C1 Principles of computer games development

- Design schematics.
- Computational processes applied to computer games development, e.g. use of rendering engines.
- Principles of mathematics applied to computer games development, e.g. vector, physics.
- Prototyping and game engine selection.
- Tools and techniques used to develop computer games.
- Quality characteristics used to test and assess suitability of computer games.
- Technical constraints.

C2 Developing computer games

- Visual style:
  - omnipresent, e.g. area of vision
  - avatar, e.g. line of sight.
- Input methods:
  - keyboard and mouse
  - gamepad
  - customisation of control, e.g. user configuration.
- Asset integration, to include:
  - graphical, e.g. raster, vector
  - animation and video, e.g. cut scene, story, arc
  - audio, e.g. syncing sound clips with visual displays
  - texture mapping, e.g. applying texture to a mesh
- Advanced features, to include:
  - artificial intelligence, e.g. search algorithms, learning algorithms
  - 3D rendering, e.g. 3D environment, first-person view
  - save game state, e.g. options to save, auto-save points
  - multiple players, e.g. multiple player controls, via network
  - player progression, e.g. achievements, leader boards.

C3 Testing computer games

- Test computer games, including playability, compatibility, stability and acceptance.
- Obtain feedback from others, e.g. effectiveness, presentation, performance, accessibility, portability, robustness, purpose.
- Make improvements and/or refinements to computer games in response to testing and feedback from others.

C4 Reviewing computer games

- Quality of the computer game.
- Suitability for audience and purpose.
- Suitability against the original requirements.
- Legal and ethical constraints.
- Technology constraints.
- Strengths and improvements.
- Platforms and compatibility.

C5 Quality characteristics

- Sources of quality characteristics which can be measured suitably against computer games, including playability, performance and presentation.

C6 Skills, knowledge and behaviours

- Planning and recording, including the setting of relevant targets with timescales, how and when feedback from others will be gathered.
- Reviewing and responding to outcomes, including the use of feedback from others, e.g. IT professionals and users who can provide feedback on the quality of the computer games and their suitability against the original requirements.
- Demonstrate behaviour and its impact on outcomes, including professionalism, etiquette, supportive of others, timely and appropriate leadership, accountability and individual responsibility.
- Evaluating outcomes to help inform high-quality, justified recommendations and decisions.
- Evaluating targets to obtain insights into own performance.
- Media and communication skills, including:
  - the ability to convey intended meaning, e.g. written (email, design documentation, recording documentation, reports, visual aids for presentation use), verbal communication requirements (one-to-one and group, informal and formal situations)
  - use of tone and language for verbal and written communications to convey intended meaning and make a positive and constructive impact on audience, e.g. positive and engaging tone, technical/vocational language suitable for intended audience, avoidance of jargon
  - responding constructively to the contributions of others, e.g. supportive, managing contributions so all have the opportunity to contribute, responding to objections, managing expectation, resolving conflict.

Assessment criteria

Pass	Merit	Distinction
Learning aim A: Investigate technologies used in computer gaming		**A.D1** Evaluate the impact of current and emerging technologies on the design and development of computer games to meet the requirements of the users and the computer games industry.
A.P1 Explain social and technological trends of computer games. **A.P2** Explain how current and emerging technologies impact computer games' design and development.	**A.M1** Discuss how current and emerging technologies impact on how games are designed and developed to meet the requirements of the users and the larger computer games industry.	
Learning aim B: Design a computer game to meet client requirements		**BC.D2** Evaluate the design and optimised computer game against client requirements. **BC.D3** Demonstrate individual responsibility, creativity and effective self-management in the design, development and review of a computer game.
B.P3 Produce designs for a computer game that meet client requirements. **B.P4** Review the designs with others to identify and inform refinements.	**B.M2** Justify decisions made, showing how the design will fulfil its purpose and client requirements.	
Learning aim C: Develop a computer game to meet client requirements		
C.P5 Produce a computer game to meet client requirements. **C.P6** Test a computer game for functionality, usability, stability and performance. **C.P7** Review the extent to which the computer game meets client requirements.	**C.M3** Optimise a computer game to meet client requirements.	

Essential information for assignments

The recommended structure of assessment is shown in the unit summary along with suitable forms of evidence. *Section 6* gives information on setting assignments and there is further information on our website.

There is a maximum number of two summative assignments for this unit. The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aims: B and C (B.P3, B.P4, C.P5, C.P6, C.P7, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to computer software resources that will allow them to use the tools and techniques (given in the unit content) to design and develop computer games, for example game engines such as Unity®, Unreal Development Kit™, or similar.

Essential information for assessment decisions

Learning aim A

Centres may wish to focus on particular areas such as specific consoles, devices, or genres of computer games. Learners must, however, be given the opportunity to explore alternative areas during their investigation and design.

The evidence must include discussion of social and technological trends in computer gaming and how these trends influence the design and development of computer games.

For distinction standard, learners will provide a clear and balanced evaluation of current and emerging technologies, and a comparison of how they impact on the development of a computer game to meet the requirements of the users and the game industry. Learners will provide clear examples of current and emerging technologies and the requirements of the users and the games industry. Learners must make comparisons between different technologies and how they impact on the games industry and the requirements and expectations of users. The report will demonstrate high-quality written/oral communication through the use of accurate and fluent, technical vocabulary to support a well-structured and considered response that clearly connects chains of reasoning.

For merit standard, learners will show a clear understanding of how available and emerging technologies affect the development of a computer game. The report must provide a balanced discussion as to how user needs and current and emerging technologies impact on the design and development of a computer game. The report will be technically accurate and demonstrate good quality written/oral communication.

For pass standard, learners will provide descriptions of how current and emerging technologies in gaming impact on the users and the games industry; the descriptions must be supported by examples of current and emerging technologies. Learners will explain the technologies available in gaming and how they affect the design and implementation of a game; learners must support their explanations with examples from existing computer games and how they make use of the technologies available during development. The evidence may have some inaccuracies and the review of the impact may be unbalanced.

Learning aims B and C

Learners must provide evidence of planning and developing a computer game. The computer game must be of sufficient complexity to show use of a range of appropriate software development tools and techniques.

For distinction standard, learners will draw on, and show synthesis of, knowledge across the learning aims in evaluating how the decisions and processes applied throughout the planning, development and testing stages impacted on the effectiveness of the computer game. Learners will make suitable and reasoned justifications of decisions made in comparison to alternative solutions.

Learners must provide a thorough evaluation of the effectiveness of the content produced against the design and client requirements. In order to reach valid conclusions as to how the chosen processes and techniques provided more appropriate content in comparison to alternatives, the evaluation will be supported by evidence from all stages of the planning, development and review processes. Learners will provide well-considered, justifiable suggestions for future improvements to the computer game.

The evaluation must contain a systematic and accurate review of their own skills and performance and the impact that this had on the effectiveness of the solutions. Evaluation of behaviours will consider learners' use of 'soft skills' in relation to the vocational context of a project, such as managing and liaising with other members of the team or clients and time management. Learners will evaluate their own behaviours throughout the project and the impact they have on the outcomes. Learners will take individual responsibility for their own work, for example identifying potential issues and resolving them, reviewing their work and making improvements, keeping their work safe and secure and showing responsible use of quoted materials. Creativity will be shown, for example, through taking innovative approaches to problem-solving and through the originality of their solution. Learners will refer to tangible evidence to support their evaluation such as meeting notes, correspondence and time plans.

For merit standard, learners will apply their knowledge through selection and application of appropriate methodologies to plan, design, develop, test and optimise a computer game that effectively meet client requirements. Learners will produce comprehensive designs, including alternative solutions. When developing their game, learners must produce an optimal solution in order to meet client requirements as closely as possible. Learners will also gather and analyse feedback on their game in order to make improvements.

The sourcing, development and testing stages must be well-documented with clear justification of decisions and selections made throughout. Learners will record the changes that are made and produce subsequent versions of the game as appropriate. Learners will make clear reference to the client requirements and target platform. They will consider legal and ethical issues as appropriate.

Learners must provide a clear, accurate and robust justification of how the design decisions will ensure the product is appropriate for the use for which it was intended and fully meets client requirements.

Learners will source a wide range of digital content in preparation for processing and editing with appropriate, dedicated editing software. The evidence will demonstrate accurate and appropriate use of visual and audio effects to fully meet the client requirements.

Learners must optimise their computer game by making use of testing and feedback throughout development to improve and refine the game to fully meet client requirements.

Learners will provide a clear and balanced analysis of the success of their outcomes against the design and client requirements, and the quality of the computer game. Learners will refer to how the computer game suits the intended audience, purpose and platform of delivery. Learners must also provide an analysis of how any associated legal and ethical issues were considered and met. They will make accurate and reasoned suggestions as to how the computer game could be improved and will discuss alternative planning, sourcing and processing methods that could be used if the task were to be repeated.

For pass standard, learners will apply understanding through the planning and development of virtualised solutions to meet client requirements. Learners will provide an explanation of the computer game requirements, and related computing requirements, of an identified client and identify the success/acceptance criteria that will ensure the client's requirements are met.

Learners will produce detailed designs for their computer game, including user requirements, visual designs and technical documentation. Learners must consider the appropriateness of different possible techniques and formats and the impact these would have on user experience. Learners must carry out and document a number of tests and reviews of the computer game, including use of test users and appropriate test plans, schedules and test data, to ensure that the solution works and meets the identified criteria. Learners must review their designs with others to identify improvements and refinements. They will provide evidence that different types of testing have been carried out. Learners' games will be functional, but there may be some performance issues and/or the implemented solution may not be as efficient or effective as it could be. Learners must show some awareness of the legal and ethical considerations related to producing computer games.

Learners must provide appropriate documentation for the planning, design, development, production and quality assurance of their computer game, explaining the decisions they made during the project to ensure they met the project brief. Learners will produce a solution that meets the requirements of the client, however, some small issues of optimisation may persist.

Learners must provide a review of whether their work meets the client requirements, considering both positive and negative aspects of the outcomes, although their review may be unbalanced and/or superficial. Learners will use relevant feedback, such as client feedback, to make suggestions for the possible alternative solutions that could be implemented.

Links to other units

This unit links to:

- Unit 10: Human-computer Interaction
- Unit 11: Digital Graphics and Animation
- Unit 12: Digital Audio
- Unit 13: Digital Video
- Unit 16: Object-oriented Programming
- Unit 18: Relational Database Development
- Unit 22: Systems Analysis and Design
- Unit 24: Software Development.

Employer involvement

This unit would benefit from employer involvement in the form of:

- guest speakers
- technical workshops involving staff from local organisations/businesses
- contribution of design/ideas to unit assignment/scenario/case study/project materials, including own organisation/business materials as exemplars where appropriate
- feedback from staff from local organisations/businesses on plans/designs/items developed
- opportunities for observation of organisational/business application during work experience
- support from local organisation/business staff as mentors.

Unit 15: Website Development

Level: **3**

Unit type: **Internal**

Guided learning hours: **60**

Unit in brief

Learners investigate website development principles. They will design and develop a website using scripting languages.

Unit introduction

Increasingly, organisations rely on websites to serve customers and, in some cases, to generate revenue. With millions of web pages being created daily, the need for websites to be engaging, innovative and desirable is important. As a website developer, you must use sophisticated techniques to capture user interest and to ensure that customers are served. The scripting involved in the development of websites has become crucial: website developers need to understand and acquire the necessary skills to find solutions to a variety of scenarios and problems.

In this unit, you will review existing websites – commenting on their overall design and effectiveness. You will use scripting languages such as Hypertext Markup Language (HTML), Cascading Style Sheets (CSS) and JavaScript® and a simple text editor, or rapid application development tools. Finally, you will reflect on the website design and functionality using a testing and review process.

Many software developers, database experts and systems managers need web client development skills as an integral part of their overall portfolio of expertise. This unit will prepare you for employment as a website developer or a website development apprenticeship. The unit will benefit you if you want to go on to higher education to develop your studies.

Learning aims

In this unit you will:

A Understand the principles of website development

B Design a website to meet client requirements

C Develop a website to meet client requirements.

Summary of unit

Learning aim	Key content areas	Recommended assessment approach
A Understand the principles of website development	**A1** Purpose and principles of website products **A2** Factors affecting website performance	A report describing the different types and purposes of websites. This will include an explanation of the factors that affect website performance and mathematical principles used in website development.
B Design a website to meet client requirements	**B1** Website design **B2** Common tools and techniques used to produce websites	Learners' devised design documentation arising from the identification of client requirements. A digital version of the website product, including an observation record sheet and supporting documentation, such as scripts and annotated screenshots, to justify design decisions. A report evaluating the design and the website against the client requirements.
C Develop a website to meet client requirements	**C1** Client-side scripting languages **C2** Website development **C3** Website review **C4** Website optimisation **C5** Skills, knowledge and behaviours	

Content

Learning aim A: Understand the principles of website development

A1 Purpose and principles of website products

- Purpose of websites, including the features of:
  - content-based (Web 2.0 technologies)
  - product and/or service-based
  - target audience, e.g. social networker, seekers, gamers, buyers, age profile, gender
  - requirements, e.g. user-friendly, consistent, navigational, customisable, flexible.
- Principles of website design, e.g. usability, white space, site layout, accessibility, spacing, navigation, typography, alignment, clarity, consistency/intuitiveness, accuracy, content, media, simplicity.
- Media and objects, e.g. position, colour, contrast, size, appropriateness.
- Creativity and innovation, e.g. unconventional layouts, white space, 'outside of the box' thinking, golden ratio.
- Search engine optimisation, e.g. indexing (meta tags), use of keywords, importance of updates, limiting crawling.

A2 Factors affecting website performance

- Where scripts run (on the web server – server-side scripts, or the local client machine – client-side scripts).
- Browser compliance, e.g. which elements are supported by different browsers.
- Server-side factors, e.g. bandwidth availability, number of hits, file types.
- Client-side factors, e.g. upload and download speeds, browser, cache memory, processor speed, interactivity.

Learning aim B: Design a website to meet client requirements

B1 Website design

Understanding the steps involved in developing a design for a client website.

- Problem definition statement requirements: intended audience, full summary of the problem to be solved, constraints, benefits, nature of interactivity, complexity of the website.
- Purpose requirements as defined in a client brief for their interactive website.
- Application of website design principles by professionally created websites.
- Initial design ideas/prototypes (illustrating design principles) and the requirements for an interactive website, including:
  - diagrammatic illustrations, e.g. storyboard, mood board, wireframe, site maps
  - realistic representations
  - search engine optimisation
  - alternative design ideas/prototypes, including compatibility with mobile/tablet devices.
- Client-side scripting design tools and techniques, e.g. pseudocode, flow charts (including use of British Computer Society (BCS) standard flow chart symbols) used to develop original code.
- Effective use of ready-made and/or original assets, e.g. a digital animation, digital graphic, digital audio and video, or any other combined assets.
- Obtaining and using feedback from others to help refine alternative design ideas/prototypes and make decisions.
- Testing plan requirements and its completion with test data to test functionality.
- Identifying technical and design constraints and working around them.
- Legal and ethical considerations applicable to the equivalent legislation in England, Wales and Northern Ireland:
  - Copyright, designs and patents legislation and its requirements in terms of protecting software products and digital media, such as images, music and films.
  - Data protection legislation and the requirements it places on organisations to keep data about living individuals secure.

B2 Common tools and techniques used to produce websites

Use of tools and techniques and their suitability for different client requirements.

- HTML, HTML5 and subsequent updates.
- Tables.
- Forms, text field, text area, buttons, radio buttons, check boxes.
- Navigation, menus, hyperlinks (internal and external), anchors.
- Interactive components, e.g. hot spots, pop-ups, buttons, menus, rollover images.
- Colour schemes, styles and templates.
- CSS, e.g. background colour, background images, text formatting, borders, padding, heading styles, element position.
- Embedded multimedia/digital asset content, e.g. digital animation, digital graphics, digital audio, digital video.
- Accessibility features, e.g. alternative tags, zoom features, text-to-speech.
- The World Wide Web Consortium (W3C®) standards for accessibility and HTML compliance.
- Platform compatibility, e.g. browser, operating system, mobile devices.
- Exporting and compressing of digital assets into suitable file types.

Learning aim C: Develop a website to meet client requirements

C1 Client-side scripting languages

- Embedding of original client-side scripts into web pages to provide more interactivity and improve the usability of the website.
- Types of web scripting languages, e.g. JavaScript®, VBScript®.
- Uses of scripting languages, e.g. alerts, confirming choices, browser detection, creating rollovers, checking/validating input, handling forms.
- Constructs, e.g. syntax, loops, decision-making, functions, parameter passing, handling events, methods.

C2 Website development

Creation of interactive websites, including:

- use of CSS, e.g. HTML tags, CSS frameworks, box model, access CSS from HTML, doc types
- use of original client-side scripting
- compatibility with mobile and tablet devices
- effective use of tools and techniques
- the uploading of files to a web server or host computer/device.

C3 Website review

Reviewing interactive websites:

- quality in comparison with other similar websites
- suitability for intended purpose and audience
- suitability against the client's requirements, including optimisation
- legal and ethical constraints
- strengths and improvements.

C4 Website optimisation

Optimising an interactive website, including:

- performance and user testing
- obtaining and evaluating feedback from others
- checking interactivity
- checking compatibility
- refinements and making improvements to meet client needs to optimise the website.

C5 Skills, knowledge and behaviours

- Planning and recording, including the setting of relevant targets with timescales, how and when feedback from others will be gathered.
- Reviewing and responding to outcomes, including the use of feedback from others, e.g. IT professionals and users who can provide feedback on the quality of the website and their suitability against the original requirements.
- Demonstrate own behaviours and their impact on outcomes, including professionalism, etiquette, supporting others, timely and appropriate leadership, accountability and individual responsibility.
- Evaluating outcomes to help inform high-quality, justified recommendations and decisions.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Understand the principles of website development</td><td rowspan="2">A.D1 Evaluate how the principles of website design are used to produce creative, high-performance websites which that client requirements</td></tr>
<tr><td>A.P1 Compare the principles of website design used in two websites, including their suitability for the intended audience and intended purpose.</td><td>A.M1 Analyse how the principles of website design are used to produce creative, high-performance websites that meet client requirements.</td></tr>
<tr><td colspan="2">Learning aim B: Design a website to meet client requirements</td><td rowspan="4">BC.D2 Evaluate the design and optimised website against client requirements.
BC.D3 Demonstrate individual responsibility, creativity and effective self-management in the design, development and review of a website.</td></tr>
<tr><td>B.P2 Produce designs for a website that meets client requirements.
B.P3 Review the website design proposals with others to identify and inform improvements.</td><td>B.M2 Justify the design decisions, explaining how they will meet the user's needs and be fit for purpose.</td></tr>
<tr><td colspan="2">Learning aim C: Develop a website to meet client requirements</td></tr>
<tr><td>C.P4 Produce a website for an intended audience and purpose.
C.P5 Test the website for functionality, compatibility and usability.
C.P6 Review the extent to which the website meets client requirements.</td><td>C.M3 Optimise a website to meet client requirements.</td></tr>
</table>

Essential information for assignments

The recommended structure of assessment is shown in the unit summary along with suitable forms of evidence. *Section 6* gives information on setting assignments and there is further information on our website.

There is a maximum number of two summative assignments for this unit. The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.M1, A.D1)

Learning aims: B and C (B.P2, B.P3, C.P4, C.P5, C.P6, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to software resources that will allow them to use tools and techniques (given in the unit content) to design and develop websites. For example, text editors (such as Notepad®++), rapid authoring software (such as Dreamweaver®, Kompozer), File Transfer Protocol (FTP) service (such as FileZilla®) to upload websites to a web server.

Essential information for assessment decisions

Learning aim A

For distinction standard, learners will give a detailed and balanced evaluative report that explains how the two sites meet user requirements. This must be explored further by identifying the requirements of the websites, for example it has a secure login, and why these are important for the user. Learners will discuss what overall impact the site will have on the organisation, including positive and negative outcomes. The report will demonstrate high-quality written/oral communication through use of accurate and fluent technical vocabulary to support a well-structured and considered response that clearly connects chains of reasoning.

For merit standard, learners will show a clear understanding of how the two sites employ different principles of website design to develop websites that are creative and high-performing. Learners will give a detailed analysis of how user needs and principles of website design impact on the design and development of a website. The report must provide a balanced discussion, supported by reasoned examples. It will be technically accurate and demonstrate good-quality written/oral communication.

For pass standard, learners will give a detailed comparison of two websites, for example Asda and Tesco – two similar commerce sites, with an explanation of who the site is aimed at and its purpose. Learners will explain the use of design principles in each website to compare their application. The evidence may have some inaccuracies and the comparison may be unbalanced.

Learning aims B and C

For distinction standard, learners will draw on, and show synthesis of, knowledge across the learning aims to evaluate how the decisions and methodologies applied throughout the design, development, maintenance, optimisation and testing stages of their website impacted on the overall outcomes. They will consider whether the website meets client requirements, including achieving its stated purpose and appealing to the target audience. Learners will justify their designs and provide a discussion on why alternative designs were not used.

Learners will give a detailed and balanced evaluation of how effectively their completed website meets the client requirements, including appealing to the target audience and meeting its stated purpose, in comparison to alternative solutions. Their evaluation will be supported by evidence from all stages of the project to reach conclusions and suggest developments. The evaluation must contain a systematic and accurate review of their own skills, performance and behaviours and the impact that this had on the development of the final website. Learners will take individual responsibility for their own work, for example identifying potential issues and resolving them, reviewing their work and making improvements, keeping their work safe and secure and showing responsible use of quoted materials. Creativity will be shown, for example, by taking innovative approaches to problem-solving and through the originality of their solution.

For merit standard, learners will apply their knowledge through selection and application of appropriate methodologies to design, develop, maintain and test an effective, optimised website to meet client requirements. Learners will produce comprehensive designs, including alternative solutions. When developing their website, learners will produce an optimal solution to meet client requirements as closely as possible. Learners will also gather and analyse feedback on their website in order to make improvements. Learners will record the changes that are made and produce subsequent versions of the website as appropriate.

Learners will give a clear analysis of the success of their solution, giving accurate and reasoned suggestions as to how the solution could be improved, they will discuss alternative solutions that could be implemented if the task were to be repeated. They will consider how decisions they made during the project affected the outcomes, and justify why these decisions were made. They will give an evaluation of how their skills and behaviours affected the outcomes of the website.

For pass standard, learners will apply understanding through the planning and development of the website to meet client requirements. Learners will produce detailed designs for their website including user requirements, visual designs and technical documentation. Learners will carry out and document a number of tests and reviews of the website (including use of test users and appropriate test plans, schedules and test data) to ensure that the solution works and meets the identified criteria. They will give evidence that different types of testing have been carried out and that important problems and errors identified have been responded to. Learners' websites will be functional and meet the identified requirements, but there may be some performance issues and/or the implemented solution may not be as efficient or effective as it could be.

Learners will review how the decisions they made during planning and development affected the website. Learners will explain the extent to which the website meets the initial project brief. They will consider both positive and negative aspects of the website, although their review may be unbalanced and/or superficial. They will make reference to the possible alternative solutions that could be implemented.

Links to other units

This unit links to:

- Unit 10: Human-computer Interaction
- Unit 11: Digital Graphics and Animation
- Unit 12: Digital Audio
- Unit 13: Digital Video
- Unit 17: Mobile Apps Development
- Unit 22: Systems Analysis and Design
- Unit 25: Web Application Development.

Employer involvement

This unit would benefit from employer involvement in the form of:

- guest speakers
- technical workshops involving staff from local organisations/businesses
- contribution of design/ideas to unit assignment/scenario/case study/project materials, including own organisation/business materials as exemplars where appropriate
- feedback from staff from local organisations/businesses on plans/designs/items developed
- opportunities for observation of organisational/business application during work experience
- support from local organisation/business staff as mentors.

Unit 16: Object-oriented Programming

Level: **3**

Unit type: **Internal**

Guided learning hours: **60**

Unit in brief

Learners explore the object-oriented paradigm in the context of programming. They will design and develop programmed solutions to identified problems.

Unit introduction

Object-oriented programming is an industry-proven method for developing reliable modular programs and it is popular in software engineering. Consistent use of object-oriented techniques can lead to shorter development life cycles, increased productivity and can lower the cost of producing and maintaining systems. Programming with objects simplifies the task of creating and maintaining complex applications. As a professional working in a software development role, you will need an understanding of, and some proficiency in, object-oriented programming.

In this unit, you will study the principles of object-oriented programming, and explore the tools and techniques used in the design and development of object-oriented software. You will use a structured approach to the design and development of applications, ensuring the solution is well-documented and tested thoroughly against the original user requirement.

All software is made using programmed code, which is compiled into a usable package for an end user. Programming is a core skill in any software development job role and offers progression to a computer science degree. This unit will aid progression to a software development role or provide a basis for further study in programming and software development.

Learning aims

In this unit you will:

A Understand the principles of object-oriented programming

B Design object-oriented solutions to identified problems

C Develop object-oriented solutions to identified problems.

Summary of unit

Learning aim	Key content areas	Recommended assessment approach
A Understand the principles of object-oriented programming	**A1** Paradigm of object-oriented programming **A2** Factors affecting performance, safety and security **A3** Computational thinking in object-oriented programming	A report explaining the principles of object-oriented programming and their importance, covering languages, libraries and principle features of object-oriented programming.
B Design object-oriented solutions to identified problems	**B1** Designing object-oriented programs **B2** Computational thinking skills applied to object-oriented programming design	A collection of object-oriented programs demonstrating principles of object-oriented programming, and use of mathematical functions and libraries.
C Develop object-oriented solutions to identified problems	**C1** Developing object-oriented programs **C2** Constructs and techniques **C3** Graphical user interface **C4** Test and review object-oriented programs **C5** Quality characteristics **C6** Skills, knowledge and behaviours	

Content

Learning aim A: Understand the principles of object-oriented programming

A1 Paradigm of object-oriented programming

- Distinguishing characteristics of object-oriented programming languages against other types of programming languages.
- The benefits of object-oriented programming, e.g. reusability, reliability, flexibility, multiplatform.
- Features of object-oriented programs, including:
  - objects, e.g. instance identity, state, behaviour
  - classes, e.g. constructors, destructors, abstract
  - methods, e.g. procedures, functions, arguments.
- Features of object-oriented programming and their importance, including:
  - encapsulation, e.g. objects, public, private, protected
  - data abstraction, e.g. data hiding
  - inheritance, e.g. subclasses, method overriding, extends, effect of public versus private on inheritance
  - polymorphism, e.g. multiple implementation of methods
  - relationships, e.g. association, aggregation, composition
  - interfaces, e.g. implicit, explicit
  - overloading and overriding, e.g. method, operator
  - predefined libraries, e.g. math, functions (random, pi, calculus)
  - modularity, e.g. reusability, portability, plugability.

A2 Factors affecting performance, safety and security

Elements that can affect performance, safety and security, such as:

- platform, e.g. desktop, web, distributed
- garbage collection, e.g. destroying unused objects
- interpreters, e.g. Java virtual machine, interpreted languages.

A3 Computational thinking in object-oriented programming

The mathematical and logical processes that underpin the design of object-oriented programs:

- algorithms, e.g. calculation, structured solution
- application of predefined functions, e.g. math libraries
- graphical user interface (GUI) resolutions and element position, e.g. x- and y-coordinates
- creation of 2D shapes, e.g. circle, rectangle
- use of programming logic and conditional statements
- use of Boolean algebra in conditional statements.

Learning aim B: Design object-oriented solutions to identified problems

B1 Designing object-oriented programs

- Problem definition statement to include intended users, full summary of the problems to be solved, constraints, benefits, nature of interactivity, complexity of problems.
- Purpose and any other requirements as defined in a client brief for different software solutions.
- Initial design ideas/prototypes (illustrating design principles) for software programs, including:
  - description of the main program tasks, input and output formats
  - diagrammatic illustrations, e.g. screen layouts, user interfaces, navigation
  - algorithms, processing stages (flow charts, pseudocode and events)
  - data structures
  - data storage constraints and requirements

  - control structures
  - data validation
  - error handling and reporting, e.g. try/catch
  - Unified Modelling Language® (UML), e.g. use case, class, sequence, activity diagrams.
- A list of predefined programs and/or code snippets.
- A list of ready-made and/or original assets, e.g. a digital animation, digital graphic, digital audio and video, or any other combined assets.
- Feedback from others to help refine alternative design ideas/prototypes and make decisions.
- A test plan with test data (typical, extreme and erroneous).
- Technical and design constraints, e.g. connectivity, memory storage, programming language.

B2 Computational thinking skills applied to object-oriented programming design

Elements of computational thinking used in the design of an object-oriented program, including:

- logical thinking – using readily available information to solve problems
- creative thinking – proposing ideas for original, different solutions to familiar design problems
- algorithmic thinking – using a predefined set of instructions to solve problems.

Learning aim C: Develop object-oriented solutions to identified problems

C1 Developing object-oriented programs

Selecting and applying appropriate object-oriented programming principles and features to develop programs.

- Ensure a suitable integrated development environment to produce code.
- Suitable programming languages, e.g. C++, Java®, Python™, Ruby®.
- Library routines, standard code and user generated subroutines.
- Packages, e.g. groups of classes.
- Classes, e.g. constructors, public, private.
- Objects, e.g. creation, destruction, methods, instances.
- Class relationships, e.g. composition, aggregation, ‘has a’.
- Inheritance, e.g. extends, ‘is a’.
- Interfaces, e.g. implements, uses.
- Annotated code to demonstrate understanding and to allow effective repair/debugging of the program and maintainability.
- Compiled or interpreted programs to run on designated platform or environment.

C2 Constructs and techniques

Constructs and techniques.

- Constants and variables, e.g. local and global variables, public and private variables.
- Data types, e.g. char, string, integer, real, Boolean.
- Statements, to include assignment, input and output, sequence, iteration (while do, repeat until, for…next), selection (if…then…else. Case select).
- Self-documenting code, e.g. self-documenting identifiers and comments.
- Arithmetic operators: [+, –, *, /, %].
- Logical operators: [!=,<, <=, >, >=, AND, OR, XOR, true, false].
- Subroutines/functions/procedures/methods.
- Basic string-handling commands to examine individual characters and substrings.
- Basic file-handling operations, e.g. open, read, write, close.
- Arrays, splitting and joining.
- 2D and 3D arrays.
- Recursion.
- File handling, e.g. text, xml, database, including reading and writing.

C3 Graphical user interfaces

- Integrated development environment (IDE) tools for GUI creation, e.g. toolbox, palette.
- Programming convention, e.g. naming, commenting, indenting, toggle case for variable and method naming.
- User events, e.g. button click, enter values.
- Debugging, e.g. debug mode, watch, step through.
- Deployment, e.g. linking, create executable.
- GUI resolutions and element position, e.g. x and y coordinates.
- Creation of 2D shapes, e.g. circle, rectangle.

C4 Test and review object-oriented programs

- Functional testing against the test plan with the test data (typical, extreme and erroneous).
- Review quality of the program in terms of reliability, usability, efficiency/performance, maintainability and portability.
- Gather feedback from users on the quality (reliability, usability, efficiency/performance, maintainability, portability) of the solution.

C5 Quality characteristics

Quality characteristics of object-oriented programming which can be measured against client requirements, including:

- accuracy
- functionality
- usability.

C6 Skills, knowledge and behaviours

- Planning and recording, including the setting of relevant targets with timescales, how and when feedback from others will be gathered.
- Reviewing and responding to outcomes, including the use of feedback from others, e.g. IT professionals and users who can provide feedback on the quality of the object-oriented programs and their suitability against the original requirements.
- Demonstrate own behaviours and their impact on outcomes, including professionalism, etiquette, supportive of others, timely and appropriate leadership, accountability and individual responsibility.
- Evaluating outcomes to help inform high-quality, justified recommendations and decisions.
- Evaluating targets to obtain insights into own performance.
- Media and communication skills, including:
  - the ability to convey intended meaning, e.g. written (email, design documentation, recording documentation, reports, visual aids for presentation use); verbal communication requirements (one to one and group, informal and formal situations)
  - use of tone and language for verbal and written communications to convey intended meaning and make a positive and constructive impact on audience, e.g. positive and engaging tone, technical/ vocational language suitable for intended audience, avoidance of jargon
  - responding constructively to the contributions of others, e.g. supportive, managing contributions so all have the opportunity to contribute, responding to objections, managing expectation, resolving conflict.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Understand the principles of object-oriented programming</td><td rowspan="2">A.D1 Evaluate the effectiveness of object-oriented programming with regard to its principles.</td></tr>
<tr><td>A.P1 Explain the importance of principles of object-oriented programming and factors affecting the performance, safety and security of object-oriented programs.
A.P2 Explain how mathematics is used when creating object-oriented programs.</td><td>A.M1 Analyse the importance of the principles of object-oriented programming and the use of mathematics in object-oriented programming.</td></tr>
<tr><td colspan="2">Learning aim B: Design object-oriented solutions to identified problems</td><td rowspan="4">BC.D2 Evaluate the impact of the methodologies used to plan, develop and refine object-oriented program solutions.
BC.D3 Demonstrate individual responsibility, creativity and effective self-management in the design, development and review of object-oriented programs.</td></tr>
<tr><td>B.P3 Produce designs for object-oriented programs to solve different problems and which provide an appropriate solution for the client.
B.P4 Review the plans for object-oriented programs with others to identify and inform refinements to produce a design.</td><td>B.M2 Justify the design decisions, explaining how they will meet the client's needs and be fit for purpose.</td></tr>
<tr><td colspan="2">Learning aim C: Develop object-oriented solutions to identified problems</td></tr>
<tr><td>C.P5 Produce object-oriented programs and graphical user interface solutions that meet program designs.
C.P6 Test object-oriented programs for functionality, usability, stability and performance.
C.P7 Review the extent to which the programs meet client requirements.</td><td>C.M3 Produce optimised object-oriented programs and graphical user interface solutions that meet client requirements.</td></tr>
</table>

Essential information for assignments

The recommended structure of assessment is shown in the unit summary along with suitable forms of evidence. *Section 6* gives information on setting assignments and there is further information on our website.

There is a maximum number of two summative assignments for this unit. The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aims: B and C (B.P3, B.P4, C.P5, C.P6, C.P7, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to software resources that will enable them to use the tools and techniques (given in the unit content) for design and development, e.g. an integrated development environment such as Visual Studio®, Dev C++, Eclipse®, IDLE, NetBeans™ or similar. Many free resources are available, depending on the object-oriented language selected.

Essential information for assessment decisions

Learning aim A

For distinction standard, learners will give detailed explanations of the principles of object-oriented programming and the application of mathematical concepts in programming. In doing so, they must cover all of the principles listed in the content. Learners must analyse principles and concepts to discuss their importance in the production of effective programmed solutions. Learners must evaluate object-oriented programming in general, considering the principles they have explained. They must explain why object-oriented programming is used and what advantages it offers to the programmer and the end user. Learners must articulate their arguments fluently and views concisely, providing an evaluation that makes reasoned, valid judgements. The evidence will demonstrate high-quality written/oral communication through the use of accurate and fluent business and technical vocabulary to support a well-structured and considered response that clearly connects chains of reasoning.

For merit standard, learners will present a reasoned and well-explained analysis of the importance of object-oriented programming principles and the application of mathematical concepts in programming. In doing so, they must cover all of the principles listed in the content. Learners must analyse principles and concepts to discuss their importance in the production of effective programmed solutions. The evidence must provide a balanced discussion, be technically accurate and demonstrate good-quality written or oral communication.

For pass standard, learners will provide explanations of the importance of principles of object-oriented programming. Learners must also explain the application of mathematical concepts in programming. In doing so, learners must cover the majority of the principles and concepts listed in the content.

Learning aims B and C

Centres must provide learners with an appropriate set of problems. Learners will design and develop solutions to at least two problems. The problems may be varied, but must include a requirement for a graphical user interface, inheritance, polymorphism, method overloading, method overriding. These can be addressed in separate programs or evidenced in any combination, so long as all are present and there are no less than two programs designed and created.

For distinction standard, learners will draw on, and show synthesis of, knowledge across the learning aims in evaluating how the decisions and processes applied throughout the planning, development and testing stages impacted on the effectiveness of the object-oriented programming. Learners will make suitable and reasoned justifications of decisions made in comparison to alternative solutions.

Learners will provide comprehensive designs for each solution, make refinements to their designs and provide detailed explanation of the use of mathematics in their designs. Learners' designs must be fit for purpose and adhere to the original requirements. Learners must implement their designs to develop their solutions, creating object-oriented programs and a graphical user interface, ensuring that formal testing of their completed programs is applied and that any errors are logged and repaired accordingly. Learners must gather feedback on the effectiveness of their programs and make refinements to improve functionality. Learners must then optimise their programs in order to provide best possible performance and to ensure a high level of security.

Learners must provide a thorough evaluation of the effectiveness of the content produced against the design and client requirements. The evaluation will be supported by evidence from all stages of the planning, development and review processes in order to reach valid conclusions. Learners will provide well-considered, justifiable suggestions for future improvements to the object-oriented programming.

The evaluation must contain a systematic and accurate review of their skills and performance and the impact this had on the effectiveness of the solutions. Evaluation of behaviours will consider learners' use of 'soft skills' in relation to the vocational context of the project, such as managing and liaising with other members of the team or clients, and in time management. Learners will evaluate their own behaviours throughout the project and the impact they had on the outcomes. Learners will take individual responsibility for their own work, for example identifying potential issues and resolving them, reviewing their work and making improvements, keeping their work safe and secure and showing responsible use of quoted materials. Creativity will be shown, for example, through taking innovative approaches to problem-solving and through the originality of their solution. Learners will refer to tangible evidence to support their evaluation, such as meeting notes, correspondence and time plans.

For merit standard, learners will apply their knowledge through the selection and application of appropriate tools and techniques to plan, design, develop, test and optimise object-oriented programming that effectively meets client requirements. Learners will produce detailed designs for each solution and evidence refinements made to their designs with explanations of the use of mathematics in their designs. Learners must implement their designs to develop their solutions, creating object-oriented programs and a graphical user interface, ensuring that formal testing of their completed programs is applied and that any errors are logged and repaired accordingly. Learners must gather feedback on the effectiveness of their programs and make refinements to improve functionality.

The development and testing stages must be well-documented with clear justification of decisions and selections made throughout. Learners will make clear references to the client's requirements and consider any legal and ethical issues, as appropriate.

Learners must produce programming that is fully optimised for use as intended and that fully meets the client requirements.

For pass standard, learners will apply understanding through the planning and development of object-oriented programs to meet client requirements. Learners will provide detailed designs for each solution. Learners must then implement their designs to develop their solutions, creating object-oriented programs and a graphical user interface. Learners must complete formal testing of their completed programs, ensuring that any errors are logged and repaired accordingly.

The implemented solutions must work, but there may be some performance issues and/or the implemented solutions may not be as efficient or effective as they could be.

Learners must review how the decisions they made during planning and development affected their solutions, explaining to what extent they met the initial project briefs. They will consider both positive and negative aspects of their solutions, although their review may be unbalanced and/or superficial. Learners will use relevant feedback, such as client feedback, to make suggestions regarding possible alternative solutions that could be implemented.

Links to other units

This unit links to:

- Unit 10: Human-computer Interaction
- Unit 11: Digital Graphics and Animation
- Unit 12: Digital Audio
- Unit 13: Digital Video
- Unit 14: Computer Games Development
- Unit 17: Mobile Apps Development
- Unit 18: Relational Database Development.
- Unit 22: Systems Analysis and Design
- Unit 24: Software Development
- Unit 25: Web Application Development.

Employer involvement

This unit would benefit from employer involvement in the form of:

- guest speakers
- technical workshops involving staff from local organisations/businesses
- contribution of design/ideas to unit assignment/scenario/case study/project materials, including own organisation/business materials as exemplars where appropriate
- feedback from staff from local organisations/businesses on plans/designs/items developed
- opportunities for observation of organisational/business application during work experience
- support from local organisation/business staff as mentors.

Unit 17: Mobile Apps Development

Level: **3**

Unit type: **Internal**

Guided learning hours: **60**

Unit in brief

Learners investigate mobile apps and design and develop an application intended for use on mobile devices.

Unit introduction

Millions of people carry a mobile device that rivals the capability of many desktop computers. These devices offer a broad range of functionality by bringing together many different technologies. To develop high-quality mobile apps, you must have an understanding of how they are designed to run specifically on mobile devices and how you can exploit the technologies currently available to ensure an effective final product.

In this unit, you will investigate mobile apps, how they are used, why they are created, the differences between devices and the implications of creating and using software on mobile devices. You will study the design considerations inherent in mobile apps and general software design. You will design, develop, test and review a mobile app to fulfil a specific set of client requirements.

With over a million apps on both Apple App Store® and Google Play Store™, and the growing popularity of Microsoft Windows® mobile devices, the mobile app development industry is highly competitive and continually expanding. Many organisations use mobile apps to support their operations in one way or another. Mobile app development is an important skill for software developers who wish to retain their competitive edge. This unit will help you to progress to an app development role and gives you a basis for further study of the design and development of mobile apps and services.

Learning aims

In this unit you will:

A Investigate mobile apps and mobile devices

B Design a mobile app that utilises device functions

C Develop a mobile app that utilises device functions.

Summary of unit

Learning aim	Key content areas	Recommended assessment approach
A Investigate mobile apps and mobile devices	**A1** Types of mobile apps **A2** Context of mobile apps **A3** Mobile device integration **A4** Mobile app programming	A report evaluating bespoke mobile apps running on different mobile devices. An analysis of mobile device functions and the context in which mobile apps are used.
B Design a mobile app that utilises device functions	**B1** Requirements for an app **B2** Designing a mobile app	Analysis, design and development of a mobile app. An analysis of context. Product design documents. A log of the development process, annotated code, screenshots of running app or demonstration of app running on a mobile device. Testing documentation, including a test log, log of errors and any resolutions made.
C Develop a mobile app that utilises device functions	**C1** Content preparation for mobile apps **C2** Developing a mobile app **C3** Testing a mobile app **C4** Lessons learned from developing a mobile app **C5** Reviewing own skills, knowledge and behaviours	

Content

Learning aim A: Investigate mobile apps and mobile devices

A1 Types of mobile apps

Understand the characteristics and implications of different types of mobile applications, including:

- native apps – those that are programmed for, and installed on, a specific mobile platform
- web apps – remote apps not required to be installed on the device, e.g. mobile web pages
- hybrid apps – cross-platform compatible scripting that can be installed on a device.

A2 Context of mobile apps

Understand how the features, purpose and context of mobile apps impact on their design, development and use, including:

- locale, e.g. maps
- utility, e.g. file manager
- productivity, e.g. office
- immersive full screen, e.g. games
- entertainment, e.g. music players
- widgets, e.g. news ticker, quick device settings.

A3 Mobile device integration

Understand the characteristics and implications of integrating mobile app services on different mobile devices.

- Using device functions, e.g. accelerometer, Global Positioning System (GPS).
- User interface, e.g. small screen, touch screen.
- Operating system, e.g. Android™, iOS.
- Device permissions, e.g. read phone status, network access, read contacts.

A4 Mobile app programming

Understand development options and environments for developing apps.

- Programming languages, e.g. Java®, Objective-C®.
- Programming environments, e.g. Android Studio, Xcode®.

Learning aim B: Design a mobile app that utilises device functions

B1 Analyse requirements for an app

The mobile computing requirements of an identified situation:

- device capabilities required, e.g. accelerometer, GPS
- input required, e.g. touch screen, voice, timed event
- output required, e.g. video, audio, vibration
- the user's needs, e.g. location-based services, accessibility considerations.

B2 Designing a mobile app

Producing appropriate design documentation for a mobile app to meet identified requirements.

- User requirements.
- A proposed solution:
  - description of program tasks
  - target platform(s)
  - screen layouts and navigation
  - algorithms, e.g. pseudocode, activity diagrams
  - control structures
  - data validation
  - integration of device capabilities, i.e. how, when and where device capabilities will be utilised.

- Alternative solutions.
- Details of resources and assets to be used:
  - predefined code
  - video, graphical, audio.
- Test and review schedule.
- Constraints, e.g. time, phone permissions, phone capabilities, limitation of platform.
- Legal and ethical considerations applicable to the equivalent legislation in England, Wales and Northern Ireland, e.g. privacy, security, use of content created by others.

Learning aim C: Develop a mobile app that utilises device functions

C1 Content preparation for mobile apps

- Selection and application of appropriate processing and editing techniques to prepare resources for each specific device and purpose.
- Optimisation, e.g. file size, image size, selecting/removing sections of prewritten code.
- Alternative formats for screen orientation e.g. landscape, portrait.
- File formats, i.e. compatibility.
- Compression.
- Encryption.

C2 Developing a mobile app

Producing a mobile app to meet identified requirements through the use of appropriate programming language(s), tools and/or development environments, e.g. Android Studio, Xcode.

- Programming constructs:
  - constants
  - operators, arithmetic, logical
  - reserved words, e.g. public, final
  - input and output commands
  - local variables
  - global variables
  - assignment
  - sequence
  - selection
  - iteration.
- Functions and procedures.
- Data types, e.g. char, integer, real, Boolean.
- Objects and classes.
- Event handling, e.g. forms, screen components, actions.
- Utilise device capabilities, e.g. language APIs, Android Sensor, iOS Core Motion Framework.
- Interrogate device status, e.g. location, battery life.
- Orientation of device, e.g. autodetection, force orientation mode.
- Code annotation.
- Create executable for target device.
- Quality control:
  - efficiency and performance, e.g. system resources used, accessing storage media
  - maintainability, i.e. the ease of modification and improving the app
  - portability, i.e. range of device compatibility
  - usability, i.e. ease of use, how easily the user can interact with the app.

C3 Testing a mobile app

Select and use appropriate testing methodologies to ensure the mobile app meets the identified requirements.

- Test plans and test data.
- How and what to test:
  - functionality, e.g. all utilities work as intended
  - acceptance, e.g. fitness for purpose
  - performance, e.g. stress loading
  - usability, e.g. users can complete tasks easily
  - compatibility, e.g. different model/brand of phone.
- Selecting appropriate test users.
- User feedback, i.e. response from end users regarding the app.
- Analysis of user feedback:
  - collation of results
  - identification of trends, e.g. '60% of users suggested…'.
- Improving and refining the app:
  - making use of the outcomes of testing and review
  - change logs
  - versioning
  - optimising the app, e.g. exporting assets to different file formats, improving the efficiency of code, developing the user interface based on review and feedback.

C4 Lessons learned from developing a mobile app

Evaluate the effectiveness of the app that has been developed with reference to:

- the extent to which the solution met the identified requirements
- issues arising during testing and refinement
- how the final app could be improved to better meet the needs of the user and fulfil the identified client requirements
- alternative solutions that could be implemented if the task were to be repeated.

C5 Reviewing own skills, knowledge and behaviours

- Planning and recording opportunities for skills, knowledge and behaviours development, including the setting of relevant targets with timescales, and how and when feedback from others will be gathered.
- Reviewing and responding to the outcomes of own skills knowledge and behaviours development, including the use of feedback from others.
- Own behaviours and their impact on outcomes, including professionalism, etiquette, being supportive of others, timely and appropriate leadership, accountability.
- Evaluating targets set for skills, knowledge and behaviour development to obtain insights into own performance.

Assessment criteria

Pass	Merit	Distinction
Learning aim A: Investigate mobile apps and mobile devices		
A.P1 Explain how the purpose of a mobile app and the needs, preferences and characteristics of the user affect its design and the provided features. **A.P2** Explain the impact of current technologies on the design and implementation of mobile apps.	**A.M1** Analyse how the implementation and design of mobile apps is affected by the intended user, current technologies and the purpose of the app.	**A.D1** Evaluate how the effectiveness of mobile app implementation and design are affected by the intended user, current technologies and the purpose of the app.
Learning aim B: Design a mobile app that utilises device functions		
B.P3 Produce designs for a mobile app to meet identified requirements. **B.P4** Review the mobile app designs with others to identify and inform refinements.	**B.M2** Justify how decisions made during the design process ensure the design for the app will meet identified requirements.	**BC.D2** Evaluate the design and optimised mobile app against client requirements. **BC.D3** Demonstrate individual responsibility, creativity and effective self-management in the design, development and review of a mobile app.
Learning aim C: Develop a mobile app that utilises device functions		
C.P5 Produce a mobile app that meets the design criteria. **C.P6** Test a mobile app for functionality, usability, stability and performance. **C.P7** Review the extent to which the mobile app meets the identified requirements.	**C.M3** Optimise a mobile app that meets the design criteria.	

Essential information for assignments

The recommended structure of assessment is shown in the unit summary along with suitable forms of evidence. *Section 6* gives information on setting assignments and there is further information on our website.

There is a maximum number of two summative assignments for this unit. The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aims: B and C (B.P3, B.P4, C.P5, C.P6, C.P7, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to:

- an integrated development environment with support for mobile development such as Android Studio, Eclipse®, Xcode or similar
- mobile devices such as Android phones or tablets, Apple phones or tablets, or similar.

Essential information for assessment decisions

Learning aim A

Learners must have access to more than one mobile device configuration to allow for a full investigation and evaluation of the chosen apps, for example different versions of mobile device operating systems, mobile phones or tablets.

Learners will investigate at least two different apps that have implementations on at least two different mobile platforms, for example iOS and Android. The chosen examples must provide learners with enough scope to examine a range of current technologies and design features, and the ways in which they are implemented on different systems.

For distinction standard, learners will provide a clear and balanced evaluation of how the capabilities and constraints of different devices and platforms impact on the success of mobile phone apps implementation. Learners will provide clear examples of how they used the principles of mobile design, the requirements of the user and current technology, and how successful and/or appropriate these were to the identified situation. Learners must make comparisons between different apps and different implementations of the same app, making justified suggestions for improvements. The evidence will demonstrate high-quality written/oral communication through use of accurate and fluent technical vocabulary to support a well-structured and considered response that clearly connects chains of reasoning.

For merit standard, learners will show a clear understanding of how the context in which the app is designed to operate impacts on its design, development and use. The analysis must provide a balanced discussion as to how user needs, the tasks that are to be performed and the current technologies (including target platform and device capabilities) impact on features available in the apps and the way in which features are implemented. The report will be technically accurate and demonstrate good-quality written/oral communication.

For pass standard, learners will explain how a mobile app's design and features are affected by the task(s) that it must perform and the needs and preferences of the user. The descriptions will be supported by relevant examples of how these needs and preferences are met in at least two different mobile phone apps. Learners will explain how the technologies currently available on mobile platforms affect the ways in which an app is designed and implemented. The learner will support their explanations with examples from the identified apps. Learners will explain how apps that have implementations on two or more devices make use of technologies currently available on the target platform and how the implementations differ from each other in terms of design, use and application. The evidence may have some inaccuracies and the explanations may be unbalanced.

Learning aims B and C

Learners must have access to more than one mobile device configuration to allow for design for multiple devices and implementation of a developed app onto a mobile device. For example, different versions of mobile device operating systems, mobile phones or tablets.

Learners must develop a mobile app that is of sufficient complexity to demonstrate appropriate use of a range of technologies/functions offered by modern mobile devices.

For distinction standard, learners will draw on and show synthesis of knowledge across the learning aims to evaluate how the decisions and methodologies applied throughout the design, development, maintenance, optimisation and testing of the mobile app impacted on its effectiveness. Learners will justify their designs and provide a discussion on why alternative designs were not used.

Learners will provide a detailed evaluation of their completed app's effectiveness in comparison to alternative solutions. Their evaluation must be supported by evidence from all stages of the project to reach conclusions and suggest future developments. It will contain a systematic and accurate review of their own skills, performance and behaviours, and the impact that this had on the effectiveness of the final app.

Learners will take individual responsibility for their own work, for example identifying potential issues and resolving them, reviewing their work and making improvements, keeping their work safe and secure and showing responsible use of quoted materials. They will show creativity, for example by taking innovative approaches to problem solving and through the originality of their solution.

For merit standard, learners will apply their knowledge through the selection and application of appropriate methodologies to design, develop, maintain and test an effective, optimised mobile app to meet identified requirements. Learners will produce comprehensive designs to cover multiple devices, alternative solutions and use of device functions. Learners must make use of feedback from others to help improve and refine the designs to create a solution. They will justify decisions made when developing the design. When developing their app, learners will produce optimal code in order to implement the required device functions in the most efficient way.

Learners will gather and analyse feedback on their app in order to make improvements. They will record the changes that are made and produce subsequent versions of the app as appropriate.

Learners must optimise their apps by making use of testing and feedback throughout development to improve and refine the final solution, for example resampling and exporting assets to different file types to reduce demands on system resources, making use of additional phone features, enhancing the user interface.

Learners must provide a clear and balanced analysis of the success of their solution, giving accurate and reasoned suggestions as to how it could be improved. They will discuss alternative solutions that may be implemented if the task were to be repeated. They must consider how decisions they made during the project affected the outcomes and justify why they made these decisions.

For pass standard, learners will apply understanding through the planning and development of a mobile app to meet identified requirements. Learners will produce detailed designs for their mobile app, including user requirements, visual designs and technical documentation. Learners must show evidence that they have sought feedback on their suggested solutions and made use of this feedback to create a final design.

Learners must carry out and document a number of tests and reviews of the mobile app, including use of test users and appropriate test plans, schedules and test data, to ensure that the solution works and meets the identified criteria. They will provide evidence that different types of testing have been carried out and that important problems and errors identified have been addressed.

Learners must install the app on a target device and it must work, but there may be some performance issues and/or the implemented solution may not be as efficient or effective as it could be.

Learners will review how the decisions they made during planning and development affected the final app, explaining to what extent it meets the initial project brief. They must consider both positive and negative aspects of the app, although their review may be unbalanced and/or superficial. Learners will make reference to the possible alternative solutions that could be implemented.

Links to other units

This unit links to:

- Unit 10: Human-computer Interaction
- Unit 11: Digital Graphics and Animation
- Unit 12: Digital Audio
- Unit 13: Digital Video
- Unit 14: Computer Games Development
- Unit 16: Object-oriented Programming
- Unit 18: Relational Database Development
- Unit 22: Systems Analysis and Design
- Unit 24: Software Development
- Unit 26: Programmable Devices and Controllers.

Employer involvement

This unit would benefit from employer involvement in the form of:

- guest speakers
- technical workshops involving staff from local organisations/businesses
- contribution of design/ideas to unit assignment/scenario/case study/project materials, including own organisation/business materials as exemplars where appropriate
- feedback from staff from local organisations/businesses on plans/designs/items developed
- opportunities for observation of organisational/business application during work experience
- support from local organisation/business staff as mentors.

Unit 18: Relational Database Development

Level: **3**

Unit type: **Internal**

Guided learning hours: **60**

Unit in brief

Learners will examine how databases have developed to become an essential repository of information, and apply their skills to design and develop data storage solutions to meet an identified need.

Unit introduction

Databases underpin many processes in numerous aspects of modern society. From stock control systems for large multi-outlet online retailers to the smallest niche internet forums, databases are a repository of information that make up the world wide web as we know it. As a database developer, you will need to understand and gain practical skills in using technologies that will enable you to design and develop databases that can be used by many different connecting systems.

In this unit, you will examine the structure of data, its origins and how an efficient data design follows through into an effective, useful database. You will investigate database management systems (DBMS) and apply practical skills in designing and developing a database within a given DBMS.

This unit will provide you with the knowledge, confidence and skills needed for eventual progression to a role as a data storage solutions professional, such as a database developer, administrator, management information analyst or website developer.

Learning aims

In this unit you will:

A Examine the purpose and structure of data storage in relational database management systems

B Design a relational database solution to meet client requirements

C Develop a relational database solution to meet client requirements.

Summary of unit

Learning aim	Key content areas	Recommended assessment approach
A Examine the purpose and structure of data storage in relational database management systems	**A1** Relational database management systems **A2** Manipulating data structures and data in relational databases **A3** Normalisation	A presentation or report explaining data storage and structures, the process of normalisation and the advantages of using relational database systems.
B Design a relational database solution to meet client requirements	**B1** Relational database design techniques and processes **B2** Design documentation **B3** Reviewing and refining designs	A practical activity involving the design and development of a relational database to fulfil identified client requirements. Evidence will include a project brief, design documentation, development and testing logs, meeting notes and a report that evaluates the effectiveness and appropriateness of the relational database and suggests ways in which solutions could be improved and/or alternative solutions that could be used if the task were to be repeated.
C Develop a relational database solution to meet client requirements	**C1** Producing a database solution **C2** Testing the database solution **C3** Reviewing the database solution **C4** Optimising the database solution **C5** Reviewing own skills, knowledge and behaviours	

Content

Learning aim A: Examine the purpose and structure of data storage in relational database management systems

A1 Relational database management systems

- Types of relational database management systems (RDBMS) and their operating system support, e.g. MySQL, Oracle®.
- RDBMS based on relational models.
- Relational data structures, including:
  - relation
  - attribute
  - domain
  - tuple
  - degree
  - cardinality
  - relational database.
- Relational algebra sets:
  - symbols
  - union
  - intersect
  - join and select.
- Database relations, e.g. entity relationship, generic, semantic.
- Relational keys, including:
  - super key
  - candidate key
  - primary key
  - foreign key.
- Integrity constraints, including:
  - entity integrity
  - referential integrity.
- Entity relationships, including:
  - one-to-one
  - one-to-many
  - many-to-many.

A2 Manipulating data structures and data in relational databases

Defining, modifying and removing data structures and data, including:

- updating, inserting, modifying and deletion
- retrieval of data for queries and reports
- administration of users
- security, integrity and recovery.

A3 Normalisation

The role of normalisation in developing efficient data structures, including:

- anomalies (update, insertion, deletion)
- primary keys, foreign keys, composite keys
- indexing
- referential integrity
- data dictionary
- cascading update, deletion techniques
- joins, unions and intersects

- stages of normalisation, including:
  - un-normalised form (UNF)
  - first normal form (1NF)
  - second normal form (2NF)
  - third normal form (3NF)
  - Boyce-Codd normal form (BCNF).

Learning aim B: Design a relational database solution to meet client requirements

B1 Relational database design techniques and processes

Techniques and processes to consider when designing relational databases, including:

- database design, such as:
  - conceptual, logical and physical modelling
  - entity relationship modelling
- mathematical relations, e.g. relational algebra
- DBMS selection, e.g. MySQL
- application design, e.g. user interface, software applications
- database implementation techniques, e.g. prototyping, data conversion and testing
- quality, effectiveness and appropriateness of the solution:
  - correctness of data
  - relationships between data
  - data integrity
  - normalisation.

B2 Design documentation

Design specification, to include:

- requirements of the brief (audience, purpose and client requirements)
- legal and ethical considerations applicable to the equivalent legislation in England, Wales and Northern Ireland:
  - Data Protection legislation
  - Sarbanes-Oxley Act 2002
  - European Union (EU) Directive on Data Protection
  - Intellectual Property legislation
- data structure designs, including:
  - data dictionaries, e.g. tables, field names, data types and validation
  - data flow diagrams
  - entity relationship diagrams
  - normalisation
- application (user interface) design, including:
  - data entry/input (verification, validation, calculated fields, masks, directed input)
  - reports (queries, presentation of data, layouts)
  - task automation (imports, updates, deletions)
  - queries using multiple criteria, form values and wild cards
  - action queries
  - calculated queries
- hardware, software and other resources required
- test plans to check correctness of data, functionality, accessibility and usability
- implementation, maintenance, and support plans (including training schedule to users)
- timescales
- technical constraints, e.g. data stores, capacity, performance of hardware/software.

B3 Reviewing and refining designs

Working with clients and others to improve the quality, effectiveness and appropriateness of solution designs, including:

- gathering feedback from client(s) and potential users
- communicating with clients, e.g. email, verbal communication
- scheduling and documenting meetings
- agreeing and adjusting timescales
- refining ideas and solutions
- updating design specification documentation.

Learning aim C: Develop a relational database solution to meet client requirements

C1 Producing a database solution

Use of an appropriate database management system and Structured Query Language (SQL) to produce a database solution to meet client's requirements, including:

- creating, setting up and maintaining data tables
- creating links/relationships between data tables
- applying data validation rules
- generating outputs, e.g. user-generated queries, automated queries, reports
- application and user interface, e.g. navigation, data entry forms, subforms
- automated functions
- populating the database
- SQL statements to extract, manipulate and modify data
- applying security measures to control access to data, e.g. user access levels, policies.

C2 Testing the database solution

- Different types of testing:
  - referential integrity
  - functionality
  - security
  - stability.
- Selection and use of appropriate test data, e.g. erroneous data, extreme data.
- Selecting suitable test users.
- Gathering feedback from users.
- Producing appropriate test documentation.
- Making use of testing outcomes to improve and/or refine the database solution.

C3 Reviewing the database solution

Criteria for use when reviewing the database solution against:

- quality of the database
- fitness for purpose
- suitability against the original requirements
- legal and ethical constraints
- technology constraints
- strengths and improvements
- platforms and compatibility.

C4 Optimising the database solution

- Data types.
- Data sizes, e.g. size on disk.
- Many tables, e.g. overheads for many tables.
- Query optimising, e.g. select specific columns.

C5 Reviewing own skills, knowledge and behaviours

- Planning and recording opportunities for the development of skills, knowledge and behaviours, including the setting of relevant targets with timescales, and how and when feedback from others will be gathered.
- Reviewing and responding to the outcomes of own skills, knowledge and behaviours development, including the use of feedback from others.
- Own behaviours, and their impact on outcomes, including professionalism, etiquette, being supportive of others, timely and appropriate leadership, accountability.
- Evaluating targets set for development of skills, knowledge and behaviour to obtain insights into own performance.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Examine the purpose and structure of data storage in relational database management systems</td><td rowspan="2">A.D1 Evaluate the principles of relational database models, the importance of normalisation and how they can provide reliable and efficient data structures.</td></tr>
<tr><td>A.P1 Explain the principles of relational database models and how they are used to provide reliable data structures.
A.P2 Explain the process of normalisation within a relational database.</td><td>A.M1 Analyse the principles of relational database models, the importance of normalisation and how they can provide reliable and efficient data structures.</td></tr>
<tr><td colspan="2">Learning aim B: Design a relational database solution to meet client requirements</td><td rowspan="3">BC.D2 Evaluate the design and optimised database solution against client requirements.
BC.D3 Demonstrate individual responsibility, creativity, and effective self-management in the design, development and review of a database solution.</td></tr>
<tr><td>B.P3 Produce a design for a relational database solution that meets client requirements.
B.P4 Review the design with others to identify and inform refinements.</td><td>B.M2 Justify design decisions made, showing how the design will meet client requirements.</td></tr>
<tr><td colspan="2">Learning aim C: Develop a relational database solution to meet client requirements</td></tr>
<tr><td>C.P5 Produce a database solution to meet client requirements.
C.P6 Test a relational database for functionality and performance.
C.P7 Review the extent to which the database solution meets client requirements.</td><td>C.M3 Optimise a database solution to meet client requirements.</td></tr>
</table>

Essential information for assignments

The recommended structure of assessment is shown in the unit summary along with suitable forms of evidence. *Section 6* gives information on setting assignments and there is further information on our website.

There is a maximum number of two summative assignments for this unit. The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aims: B and C (B.P3, B.P4, C.P5, C.P6, C.P7, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to:

- software resources that will allow them to use tools and techniques (as given in the unit content) to design and develop a relational database
- a suitable RDBMS, e.g. Access™, MySQL, Oracle.

Essential information for assessment decisions

Learning aim A

For distinction standard, learners will provide a clear and balanced evaluation of relational database principles and a comparison of the advantages each stage of normalisation offers to the effectiveness of the data model. Learners will also provide clear examples of normalisation within relational data models. Learners will articulate their arguments and views concisely and professionally, and evaluate concepts, ideas and actions in order to reach reasoned and valid conclusions. The report will demonstrate high-quality written/oral communication through the use of accurate and fluent technical vocabulary to support a well-structured and considered response that clearly connects chains of reasoning.

For merit standard, learners will undertake an in-depth analysis of relational database principles and normalisation, and be able to articulate this using appropriate examples. There will be detailed explanation of normalisation and a clear discussion on how the process improves the efficiency of a relational database. Learners will use appropriate diagrams and examples to enable the concept to be relayed effectively. The report will be technically accurate and will demonstrate good-quality written/oral communication.

For pass standard, learners will explain the structure of data and how suitable database management systems, with which they are familiar, allow data to be manipulated and presented. Learners will show an understanding of normalisation and the process involved; they will also support their explanations with relevant examples, although the number of examples may be limited. The evidence may contain some inaccuracies.

Learning aims B and C

Learners will use SQL in the creation, manipulation and interrogation of their relational data models.

For distinction standard, learners will draw on, and show synthesis of, knowledge across the learning aims to evaluate how the decisions and methodologies applied throughout the designing, development, maintenance, optimisation and testing of their database solution impacted on its effectiveness in meeting client requirements. Learners will produce detailed designs directly related to the user's needs. Learners will fully understand the complexities of the proposed system and propose a robust and wholly professional database solution. The design and subsequent product must be fully functional and optimal in terms of the usability and efficiency of data and process. There will be evidence that learners have adopted an iterative approach to their work and undergone a process of continuous improvement during design and development, gaining and using feedback from both peers and the client. The structure of the data will be optimised in order to reduce storage and processing overheads while remaining flexible.

Learners show appreciation of client needs and will clearly and robustly justify exactly how they have met these needs and how their finished product matches what the client requested in their initial analysis. Learners will be able to confidently demonstrate their system on both a user and technical level, showing how it meets client needs and how they have anticipated possible future demands and expansions.

Learners will take individual responsibility for their own work, for example identifying potential issues and resolving these, reviewing their work and making improvements, keeping their work safe and secure and demonstrating responsible use of quoted materials. Creativity will be demonstrated, for example, through taking innovative approaches to problem-solving and through the originality of their solution.

For merit standard, learners will clearly analyse the users' requirements and provide a justification of the design decisions they have made. Learners will have gathered and considered feedback from others during the design stage in order to identify possible improvements. They should also use the testing and reviewing they have completed at pass level to inform the optimisation of the database. The optimisations they carry out could be related to the efficiency or performance of the database, or improving its usability, for example by adjusting queries to provide clearer results that better meet the client requirements.

For pass standard, learners will perform a user needs analysis and design a solution that is appropriate, producing detailed documentation in order to build a working solution. Learners will have considered the data structure and undertaken normalisation in an attempt to optimise the solution. A suitably complex solution consisting of a minimum of five tables created using SQL is required. Learners will produce a solution that meets the identified requirements. However, some small issues may persist. Evidence of successful testing using normal, extreme and erroneous data will be evidenced, as well as a system that provides the expected outputs. Learners will have gathered and considered feedback from others during the design stage in order to identify possible improvements.

Learners will also reflect on how their system is appropriate for the client and whether it has met the initial specification provided. Learners will consider both positive and negative aspects of the final outcomes in relation to the identified client requirements, although the review may be unbalanced and/or superficial. They will make suggestions for possible improvements to their product.

Links to other units

This unit links to:

- Unit 14: Computer Games Development
- Unit 16: Object-oriented Programming
- Unit 17: Mobile Apps Development
- Unit 22: Systems Analysis and Design
- Unit 23: Systems Methodology
- Unit 24: Software Development
- Unit 25: Web Application Development
- Unit 31: Large-scale Data Systems
- Unit 32: Business Process Modelling Tools.

Employer involvement

This unit would benefit from employer involvement in the form of:

- guest speakers
- technical workshops involving staff from local organisations/businesses
- contribution of design/ideas to unit assignment/scenario/case study/project materials, including own organisation/business materials as exemplars where appropriate
- feedback from staff from local organisations/businesses on plans/designs/items developed
- opportunities for observation of organisational/business application during work experience
- support from local organisation/business staff as mentors.

Unit 19: Computer Networking

Level: **3**

Unit type: **Internal**

Guided learning hours: **60**

Unit in brief

Learners examine modern computer networks design. They plan, install and manage a computer network system.

Unit introduction

Computer networks are increasingly changing the way we communicate, work, access resources, stay informed, collaborate and learn. Organisations rely heavily on computer networks to conduct their internal as well as external operations. From the smallest home computer network to the biggest computer network of them all (the internet), networks affect our social, commercial, political and personal interactions.

In this unit, you will learn about the major types and models of computer networks such as local area network (LAN), wide area network (WAN), peer-to-peer and client server. You will identify the computer network hardware and software components required to design and implement networks. You will learn network communication protocols and examine communication technologies used to connect computers to wired and wireless networks. You will learn to use network design strategies to develop, implement and manage a scalable, available, efficient and secure computer network to meet identified requirements.

Due to the huge impact of computer networking on our modern way of life, there is an increasing need for high-level computer networking knowledge and skills in this dynamic field. The successful completion of this unit will give you valuable skills to either progress to further or higher education studies, or pursue one of the many network support careers in the design, development and management of computer networking systems infrastructure.

Learning aims

In this unit you will:

A Investigate how computer networks use networking communications protocols to provide effective and secure access to networking services and resources

B Investigate computer network design to meet client requirements

C Develop a computer network to meet client requirements.

Summary of unit

Learning aim	Key content areas	Recommended assessment approach
A Investigate how computer networks use networking communications protocols to provide effective and secure access to networking services and resources	**A1** Network types and models **A2** Network components **A3** Network communication standards and protocols **A4** Networking infrastructure services and resources	A report explaining the types and characteristics of computer networks, the need to use networking standard protocols, and the networking hardware and software components to provide secure access to the networking services and resources.
B Investigate computer network design to meet client requirements	**B1** Network design strategies and architectures **B2** Network development planning **B3** Network services and resources access	Learner-devised design documentation, including network diagrams and addressing scheme table arising from the identification of client requirements. Notes covering network design strategies and network development planning. Photographs and screenshots of network development, configuration testing, troubleshooting and optimisation, supported by assessor's observation or witness statement. Overall report evaluating and reviewing the design and implementation stages. Diary notes, witness testimony, audio/video recorded discussion demonstrating skills, knowledge and behaviours.
C Develop a computer network to meet client requirements	**C1** Network implementation and configuration **C2** Network testing and troubleshooting **C3** Network performance monitoring **C4** Evaluation and review of network design **C5** Skills, knowledge and behaviours	

Content

Learning aim A: Investigate how computer networks use networking communications protocols to provide effective and secure access to networking services and resources

A1 Network types and models

- Network types and characteristics:
  - LAN, wireless local area network (WLAN), WAN, storage area network (SAN)
  - intranet, extranet, internet, cloud
  - wired and wireless integration.
- Network topologies:
  - physical topologies, e.g. star, extended star, hierarchical
  - logical topologies, e.g. Ethernet standards for wired and wireless (802 family).
- Network models:
  - Peer-to-peer
  - client/server
  - thin client.
- Modern networking trends and challenges, e.g. virtualisation, cloud computing, bring your own devices (BYOD), software-defined networking (SDN), storage-defined networks.

A2 Network components

- Hardware components, including:
  - End user devices, including mobile
  - connectivity devices, e.g. switches, routers, access points
  - connection media, e.g. cable, wireless, fibre.
- Software components, including:
  - networking systems software
  - network monitoring, management and troubleshooting tools, e.g. performance monitor. Events and logs viewer, packet sniffers
  - network applications, e.g. database, document management.

A3 Network communication standards and protocols

- Network communications standards and protocols, including:
  - OSI layers and protocols
  - TCP/IP stack, ports, sockets, packets, frames, bits, encapsulation
  - IEE 802 standards for wired and wireless Ethernet protocols.

A4 Networking infrastructure services and resources

- Network infrastructure services, including:
  - domain name service (DNS)
  - directory services (DS)
  - authentication services
  - Dynamic Host Configuration Protocol (DHCP) and network addressing services
  - routing and remote access services.
- Network services and resources
  - file and print services
  - web, mail and communications services.

Learning aim B: Investigate computer network design to meet client requirements

B1 Network design strategies and architectures

- Organisational and business goals, and technical requirements analysis.
- Network size, small office/home office (SOHO), small and medium-sized business (SMB), large enterprise.
- Design aims, strategies and requirement for LAN and WAN, e.g. scalability, availability, redundancy, performance, security, manageability adaptability, affordability and maintainability.
- Design constraints and trade-offs, e.g. budget, time, environment.
- Network physical design schemes, including:
  - flat design, hierarchical design, Enterprise Campus and Branch
  - network diagrams and physical layout
  - LAN/WAN equipment requirements, e.g. equipment features, LAN and WAN device selection.
- Logical network design, including:
  - IP addressing
  - IPV4 versus IPV6, private versus public IP
  - naming schemes
  - virtual LAN (VLAN) design issues.

B2 Network development planning

- Network components and services selection:
  - hardware components selection, e.g. server types and hardware requirement and selection, storage requirement, storage area networks (SANs), switching and routing requirement, e.g. layer 2, layer 3 and layer 4 switches, wireless AP requirements, routers and WAN devices
  - software components selection, e.g. operating systems (client/server), applications, network monitoring and management software
  - infrastructure services selection and requirement, e.g. DS, DNS, DHCP, web, mail, FTP.
- Network installation planning:
  - devices configuration planning, e.g. switches, routers, access point, prototyping and simulation
  - infrastructure services installation and test planning e.g. DNS, DHCP, NAT.
- LAN and WAN connectivity test plans.

B3 Network services and resources access

- Authentication planning, e.g. password policies, audit policies.
- Users and groups naming, structure and access rights.
- Planning access permissions to resources, e.g. directories, files, printers.

Learning aim C: Develop a computer network to meet client requirements

C1 Network implementation and configuration

- Configuration and testing of network hardware components:
  - prototype development, simulation testing
  - network devices connection and configuration, e.g. switches, routers, wireless devices and access point.
- Configuration of network software and infrastructure services:
  - create, configure and connect virtual or physical servers and clients
  - install and configure network services.
- Network resources configuration and access:
  - create users, groups, shared resources, access policies.

C2 Network testing and troubleshooting

- Network connectivity tests.
- Network infrastructure services implementation test.
- Network resources access tests.
- Troubleshooting results and documentation.

C3 Network performance monitoring

- Establishment of a network performance baseline.
- Monitoring network performance, e.g. bandwidth, storage, processing.
- Event views logs usage review.

C4 Evaluation and review of network design

- Network design evaluation against requirements and initial needs.
- Evaluation of network development and implementation.
- Evaluation and review of testing and troubleshooting results.
- Future enhancement area and plans.
- Network optimisation, e.g. improving performance, security, manageability and ease of access.

C5 Skills, knowledge and behaviours

- Planning, and recording, including the setting of relevant targets with timescales, and how and when feedback from others will be gathered.
- Reviewing and responding to outcomes, including the use of feedback from others.
- Demonstrate own behaviours and their impact on outcomes, including professionalism, etiquette, being supportive of others, timely and appropriate leadership, accountability.
- Evaluating outcomes to help inform high-quality, justified recommendations and decisions.
- Documenting processes and outcomes, e.g. diary notes, planning documents, witness testimonies, and discussion notes or recordings.
- Communication skills, including:
  - the ability to convey intended meaning, e.g. written (email, design documentation, recording documentation, reports, visual aids for presentation use), verbal communication requirements (one-to-one and group, informal and formal situations)
  - use of tone and language for verbal and written communications to convey intended meaning and make a positive and constructive impact on audience, e.g. positive and engaging tone, technical/vocational language suitable for intended audience, avoiding jargon.
- Responding constructively to the contributions of others, e.g. being supportive, managing contributions so all have the opportunity to contribute, responding to objections, managing expectation, resolving conflict.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Investigate how computer networks use networking communications protocols to provide effective and secure access to networking services and resources</td><td rowspan="2">A.D1 Evaluate different network models and their suitability to meet different client requirements.</td></tr>
<tr><td>A.P1 Explain the need for different computer network types and models.
A.P2 Explain the characteristics and functions of network components.</td><td>A.M1 Analyse the functions of different network components required to construct different network types.</td></tr>
<tr><td colspan="2">Learning aim B: Investigate computer network design to meet client requirements</td><td rowspan="4">BC.D2 Evaluate the network design and the implemented optimised network against client requirements.
BC.D3 Demonstrate individual responsibility and effective self-management in the planning and implementation of the network.</td></tr>
<tr><td>B.P3 Explain the need for network design and planning strategies.
B.P4 Design a network to meet client requirements.</td><td>B.M2 Justify the design decisions made, showing how the design will fulfil its purpose and meet client requirements.</td></tr>
<tr><td colspan="2">Learning aim C: Develop a computer network to meet client requirements</td></tr>
<tr><td>C.P5 Develop and configure a network to meet client requirements.
C.P6 Test a network to ensure it meets client requirements.
C.P7 Review the extent to which the network meets client requirements.</td><td>C.M3 Optimise a network to meet client requirements.</td></tr>
</table>

Essential information for assignments

The recommended structure of assessment is shown in the unit summary along with suitable forms of evidence. *Section 6* gives information on setting assignments and there is further information on our website.

There is a maximum number of two summative assignments for this unit. The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aims: B and C (B.P3, B.P4, C.P5, C.P6, C.P7, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to:

- a physical or virtualised networking environment that provides the necessary hardware and software required to build and test computer networks safely
- computer systems, switches, routers, wireless access points, cabling, and operating systems for clients and servers
- online resources for research and development.

Essential information for assessment decisions

Learning aim A

The evidence should cover network hardware and software, including protocols and how they are used to construct a variety of networks types and models.

For distinction standard, learners will provide a clear and balanced evaluation of the different network models, including peer-to-peer, client/server and thin client. They must consider a wide range of aspects, including ease of use, ease of set-up, performance and suitability for different types of applications. The evidence will provide reasoned examples of the suitability of the different models to different networking applications, and clearly explain each model's benefits and drawbacks. The evidence will demonstrate high-quality written or oral communication through use of accurate and fluent technical vocabulary to support a well-structured and considered response that clearly connects chains of reasoning.

For merit standard, learners will provide a thorough analysis of the key functions of networking hardware and software components, including those used in LAN, WAN and wireless networks. Learners will demonstrate accurate understanding of the importance of the use of protocols and standards to connect various types of computer networks as outlined in the content. They will provide appropriate examples and illustrations to demonstrate their understanding of the complex issue of how data gets transferred within and between computer networks. The evidence will be technically accurate and demonstrate good-quality written or oral communication.

For pass standard, learners will provide detailed explanations of why different types and models of computer networks are needed and how that impacts on the choice of the network type and model used. They will explain how networks are continually evolving and taking different shapes and forms, from LAN, WAN, intranet, extranet and internet to cloud computing. Learners must also explain the general characteristics and functions of the network hardware and software components used to build and connect computer networks as covered in the unit content. The evidence may have some inaccuracies and make limited use of examples as illustrations.

Learning aims B and C

Learners are expected to provide evidence that they have planned a network to meet specific client requirements and are then required to install and configure a computer network. They will collect the evidence required, showing that the network is functional according to given specification. The provided specification must be sufficiently complex to give the learner scope to demonstrate the appropriate range of skills. For example, it must include more than one network type, e.g. wired and wireless, and include user requirements such as shared files, folders and printers, email and intranet access.

Learners must also provide evidence that they have tested the network functionality. They also need to consider the degree to which the client requirements are met.

For distinction standard, learners will draw on, and show synthesis of, knowledge across the learning aims to evaluate both their design for the network and the implementation of it, with particular focus on how effectively the network met the client requirements. Learners will provide reasoned justification of their design.

Their evaluation must be supported by evidence from all stages of the project to reach conclusions and suggest future developments.

Learners will articulate their arguments and views concisely and professionally, and evaluate concepts, ideas and actions to reach reasoned and valid conclusions when justifying planning, configuration and implementation decisions in the development of a computer network. They will demonstrate individual responsibility and effective self-management when planning and implementing the network. Learners should provide evidence of their methods of working, which can be in the form of log books, annotated screen and diary notes, planning documents, witness testimonies and discussion notes or recordings.

For merit standard, learners will provide a reasoned justification for the decisions they have made in the network design, referring to both technical considerations and the need to meet the client requirements. Learners will apply their knowledge through selection and application of appropriate methodologies to design, develop, implement and optimise the network to meet client requirements. Learners must optimise the network, improving its performance, functionality or ease of use. The optimisation may be based on the testing done, which may reveal performance issues, security loopholes, usability issues or other aspects of the network that could be improved.

For pass standard, learners will explain the need to follow design strategies to produce an appropriate network design, taking into consideration organisation needs and design goals, such as scalability, availability and security. Learners must also explain the network development planning, including network component selection criteria, and logical and physical design schemes and diagrams used to plan and prepare for the development and deployment of the network. They will provide evidence of implementing the plan and provide a completed test plan to show thatthe network has been fully tested.

Learners must provide a review of their work, considering both positive and negative aspects of the outcomes, and how well it matches the client requirements, although their review may be unbalanced and/or superficial.

Links to other units

This unit links to:

- Unit 20: Managing and Supporting Systems
- Unit 21: Virtualisation
- Unit 29: Network Operating Systems
- Unit 30: Communication Technologies.

Employer involvement

This unit would benefit from employer involvement in the form of:

- guest speakers
- technical workshops involving staff from local organisations/businesses
- contribution of design/ideas to unit assignment/scenario/case study/project materials, including own organisation/business materials as exemplars where appropriate
- feedback from staff from local organisations/businesses on plans/designs/items developed
- opportunities for observation of organisational/business application during work experience
- support from local organisation/business staff as mentors.

Unit 20: Managing and Supporting Systems

Level: **3**

Unit type: **Internal**

Guided learning hours: **60**

Unit in brief

Learners study how computer networks are managed and the support measures that can be used to assist a range of users. Learners also set up and manage a computer system.

Unit introduction

Effective management and support of computers and networked systems are vital to individuals and organisations. Users who lack technical expertise in IT need help in order to make best use of the technology available to them and deal with technical problems. Knowing how to assist users at all levels of an organisation, and how to keep a system operating when people get things wrong, is a skill highly valued by employers.

In this unit, you will investigate the role of a systems manager who may look after a range of desktop systems, servers or a network, along with the tools and technologies used to carry out this role. You will carry out practical tasks, including setting up, configuring and optimising a system to meet a defined requirement. You will also create user policies and training materials for the system and set up a fault recording system. To complete the assessment task within this unit, you will need to draw on your learning from across your programme.

Networked systems are commonplace in organisations and are a pervasive element of everyday life. Many homes have a small network and networked mobile devices are very popular. This unit enables you to understand the tasks necessary for different network system scenarios and how good management can help you to protect and optimise systems. This unit prepares you for a role as an IT support technician or system manager – roles in which you will need to develop specialist skills to be able to manage and support these systems.

Learning aims

In this unit you will:

A Investigate common IT system management and support tools

B Design the management and support infrastructure for a networked IT system to meet an organisation's requirements

C Carry out management and support activities on a networked IT system.

Summary of unit

Learning aim	Key content areas	Recommended assessment approach
A Investigate common IT system management and support tools	**A1** Live system management **A2** System maintenance and disaster recovery **A3** System and network management tools **A4** Managing user support requests	Written report or blog. Audio or video recorded discussion on the activities and tools used to manage and support an organisation's IT system.
B Design the management and support infrastructure for a networked IT system to meet an organisation's requirements	**B1** Plan management and support procedures **B2** Plan user desktop interface **B3** System planning	A plan for managing and supporting an IT system to meet a client's requirements, accompanied by supporting development and testing documentation. Diary of activities carried out, supported by screenshots and photos. Observation reports. Audio or video recording of user feedback. A report evaluating the systems management and support procedures against the client's requirements.
C Carry out management and support activities on a networked IT system	**C1** Support activities **C2** System management and implementation activities **C3** System optimisation **C4** Skills, knowledge and behaviours	

Content

Learning aim A: Investigate common IT system management and support tools

A1 Live system management

The day-to-day activities involved in managing a live system, including:

- configuring systems to support users and applications and secure the system
- providing technical support to users
- managing users, e.g. creating accounts, allocating passwords and setting access levels
- monitoring of usage and identification of misuse
- fault-finding, use of fault recording database, updating solutions to faults
- setting up and running backup and restore procedures
- security procedures:
  - antivirus scans
  - firewall configuration
  - access control
  - configuring security policies
  - managing security patches and updates
  - management of software
  - centralised software rollout and updates
  - license management
- drive management:
  - imaging
  - drive mapping
- network management, protocol and IP (internet protocol) address management.

A2 System maintenance and disaster recovery

Planning and preparation activities:

- contingency planning to deal with major problems, e.g. a major virus infection or security breach, server hardware failure, network (local area network (LAN) and wide area network WAN)) failure, power outages, disasters, e.g. flood, fire
- strategic long-term planning of hardware and software developments, e.g. operating system upgrades, server hardware updating or expansion
- formulating and updating a network code of practice
- supervision and management of network staff
- advising senior management
- legal and ethical considerations applicable to the equivalent legislation in England, Wales and Northern Ireland, e.g. copyright, data protection.

A3 System and network management tools

- The variety of systems to be managed:
  - servers and virtual PCs
  - cloud storage
  - mobile devices
  - laptops
  - desktops
  - bring your own device (BYOD).
- Tools that a system manger can use to support the day-to-day running of the system:
  - performance monitoring and management tools
  - provision of user desktop computing by various means, including server virtualisation with thin client computing and web-based applications

- tools used to create and remotely deploy desktop disk images
- asset management, including software licenses
- remote desktop access and control.

A4 Managing user support requests

The systems used to manage user support requests:

- support request reporting systems, e.g. telephone helpdesk and web-based reporting tools
- user support request database, allocation of requests to support technicians, escalation of unresolved issues
- solution knowledge base and its use to support technicians
- analysis of support request data to identify issues, e.g. training needs, problem software and hardware, scheduling of resources (time of day/week when most problems occur), staffing issues.

Learning aim B: Design the management and support infrastructure for a networked IT system to meet an organisation's requirements

B1 Plan management and support procedures

Working with clients to develop procedures for the management and support of a computer system, including:

- creation of a network code of practice
- developing support request reporting and escalation procedures
- installation and setup of support request database
- agreeing a service level agreement
- developing contingency plans
- user support documentation, e.g. FAQs (frequently asked questions)
- creation of security policies, access control and traffic management expectations.

B2 Plan user desktop interface

Working with clients to develop a standard user desktop environment for installation on user PCs, including:

- selection of operating system, applications, versions and settings to create desktop disk image, testing of the desktop image
- define user groups
- define user rights and security policies.

B3 System planning

Planning typical system requirements, taking into account client requirements and growth of the system, including:

- define disk space requirements, quotas, drive mappings
- network design, IP addressing, subnetting
- backup procedures.

Learning aim C: Carry out management and support activities on a networked IT system

C1 Support activities

Support activities for a networked IT system, including:

- helpdesk and technical support:
  - fault logging and management
  - communicating with users
  - routine support and repair tasks
- analysis of support data to identify problem areas and trends

- account management:
  - user account creation
  - passwords resets
  - setting and adjusting access rights
  - storage areas and limits.

C2 System management and implementation activities

System management and implementation activities for a networked IT system, including:

- system configuration, adjusting settings on server and client machines
- usage monitoring:
  - bandwidth
  - bottlenecks
  - storage
  - use of peripherals
- software management:
  - patches
  - upgrades
  - security updates
  - new application rollout
  - software removal
- device configuration:
  - firewalls
  - routers
  - wireless access points
  - joining a mobile device to a network
- disk configuration, creating network shared drives, creating user system disk images, setting permissions on folders
- backup and restore.

C3 System optimisation

- Security optimisation:
  - firewalls and access control rules
  - latest patches and known vulnerabilities
  - device hardening as required
  - management of system permissions, auditing the access rights of users.
- Traffic optimisation – checking performance, under load, throughput and speed, identifying the contention (bottleneck) points and how these might be managed.

C4 Skills, knowledge and behaviours

- Planning and recording, including the setting of relevant targets with timescales, how and when feedback from others will be gathered.
- Reviewing and responding to outcomes including the use of feedback from others, e.g. users of the supported system.
- Demonstrate own behaviours and their impact on outcomes, including professionalism, etiquette, supportive of others, timely and appropriate leadership, accountability.
- Evaluating outcomes to help inform high-quality, justified recommendations and decisions.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Investigate common IT system management and support tools</td><td rowspan="2">A.D1 Evaluate the different activities and tools used to manage and support an IT system, reflecting on their impact on the security, usability and performance of the system.</td></tr>
<tr><td>A.P1 Explain the activities involved in IT system management and support.
A.P2 Explain the tools and systems that can be used to assist with IT system management and support activities.</td><td>A.M1 Justify the use of activities and tools to manage and support an IT system.</td></tr>
<tr><td colspan="2">Learning aim B: Design the management and support infrastructure for a networked IT system to meet an organisation's requirements</td><td rowspan="4">BC.D2 Evaluate the system management and support procedures against an organisation's requirements.
BC.D3 Demonstrate individual responsibility and effective self-management in the planning and implementation of a fully protected IT system.</td></tr>
<tr><td>B.P3 Produce a plan for managing and supporting an IT system to meet an organisation's requirements.
B.P4 Assess how feedback has improved the plan for managing and supporting an IT system.</td><td>B.M2 Justify the planning decisions made, showing how these will provide effective user support.</td></tr>
<tr><td colspan="2">Learning aim C: Carry out management and support activities on a networked IT system</td></tr>
<tr><td>C.P5 Implement a managed and supported IT system that meets an organisation's requirements, using feedback from others.
C.P6 Test a managed and supported IT system that meets an organisation's requirements.
C.P7 Support a managed IT system in line with an organisation's requirements.</td><td>C.M3 Optimise a managed and supported IT system that meets an organisation's requirements.</td></tr>
</table>

Essential information for assignments

The recommended structure of assessment is shown in the unit summary along with suitable forms of evidence. *Section 6* gives information on setting assignments and there is further information on our website.

There is a maximum number of two summative assignments for this unit. The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aims: B and C (B.P3, B.P4, C.P5, C.P6, C.P7, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to:

- computer hardware and software that they can use to build their network systems
- a computer that can be used as a server
- several client computers and networking hardware such as a switch, router and a wireless access point
- computers (real or virtual).

Essential information for assessment decisions

Learning aim A

For distinction standard, learners will demonstrate comprehensive and detailed technical understanding of the different systems management tools and activities that are used. Learners will provide justified reasons why each tool or technique is important and relate its use to issues of security, usability and performance, giving examples wherever possible. The evidence will demonstrate high-quality written/oral communication through use of accurate and fluent technical vocabulary to support a well-structured and considered response that clearly connects chains of reasoning.

For merit standard, learners will show an in-depth understanding of the tools and activities used to manage and support a system. Learners will give clear, robust justification to show how the selected activity is used in managing or supporting a system and its importance for management or support purposes. Learners will justify how and why the selected tools are used to support certain activities. The evidence will be technically accurate and demonstrate good-quality written communication.

For pass standard, learners will explain both the typical system management activities and the tools that are used to support these activities. Learners will provide materials which use relevant vocational language and fully cover the content. Learners' evidence may have some inaccuracies and their explanations may be unbalanced or incomplete and supported by limited use of examples.

Learning aims B and C

For distinction standard, learners will draw on, and show synthesis of, knowledge across the learning aims to evaluate how the decisions and processes applied throughout the planning, design, development and testing stages impacted on the effectiveness of the managed and supported IT system. Learners will make suitable and reasoned justifications of decisions made in comparison to alternatives.

Learners must provide a thorough evaluation of the effectiveness of the support and management of the system against the plan and client requirements, supported by evidence from all stages of the development and review process. Learners will reach valid conclusions as to how the chosen support and management techniques provided a more effective and better supported system in comparison to alternatives. Learners will provide well-considered, justifiable suggestions for future improvements to the management and support of the system.

Evaluation of behaviours will consider learners' use of 'soft skills' in relation to the vocational context of project, such as managing and liaising with other members of the team or clients, and in time management. Learners will evaluate their own behaviours throughout the project and the impact these had on the outcomes. Learners will refer to tangible evidence to support their evaluation such as meeting notes, correspondence and time plans.

Learners will take individual responsibility for their own work, for example identifying potential issues and resolving these, reviewing their work and making improvements, keeping their work safe and secure, showing responsible use of quoted materials.

For merit standard, learners will apply their knowledge through selection and application of appropriate tools and techniques to plan, design, develop, test and optimise the managed and supported IT system that effectively meets client requirements. The planning, development and testing stages must be well-documented with clear, accurate justification of learners' planning decisions and selections, showing how these decisions and selections meet the client's requirements for effective user support.

Learners must optimise the managed and supported system by making use of testing and feedback to improve and refine the performance, usability and security of the system, for example by adjusting file permissions, disk and device configurations or adapting user support arrangements.

For pass standard, learners will apply their understanding through the planning and set-up of a system that meets identified requirements. Learners will need to follow a case study that provides sufficient complexity to provide the required evidence. This requires that the system supports a number of users and the users have shared and private data folders with different levels of access. Learners must provide evidence, including photographs and/or screenshots of the set-up and configuration process. Testing of the functionality of the system must be carried out using a completed test plan as evidence. It will be beneficial to stress test the system, for example by copying large files over the network as this will provide helpful data for optimising the system. Learners must set up a fault reporting system for the users to report any issues or problems that arise. The fault reporting system must also be tested to ensure it works properly. Learners will collect feedback from others (system users and/or clients) on both the plan to support the system and on the implemented system. The feedback will inform improvements made during the planning stage and learners will assess the usefulness of this feedback in improving the plan. You can expect learners to produce a solution that meets the requirements of the client; however, some small issues of optimisation may persist.

Links to other units

The assessment for this unit should draw on knowledge, understanding and skills developed from:

- Unit 1: Principles of Computer Science
- Unit 3: Planning and Management of Computing Projects
- Unit 5: Building Computer Systems
- Unit 6: IT Systems Security
- Unit 21: Virtualisation
- Unit 26: Programmable Devices and Controllers
- Unit 28: Computer Forensics
- Unit 29: Network Operating Systems
- Unit 30: Communication Technologies.

Employer involvement

This unit would benefit from employer involvement in the form of:

- guest speakers
- technical workshops involving staff from local organisations/businesses
- contribution of design/ideas to unit assignment/scenario/case study/project materials, including own organisation/business materials as exemplars where appropriate
- feedback from staff from local organisations/businesses on plans/designs/items developed
- opportunities for observation of organisational/business application during work experience
- support from local organisation/business staff as mentors.

Unit 21: Virtualisation

Level: **3**

Unit type: **Internal**

Guided learning hours: **60**

Unit in brief

Learners study how and why virtualisation can be used by individuals and organisations, and set up virtualised solutions to meet identified needs.

Unit introduction

The use of virtualisation gives individuals and organisations a flexible approach to how computer infrastructure is used. From individual developers to large multinational organisations, virtualisation offers IT professionals the scope to use resources in new, efficient and creative ways. As a future IT professional, it is essential that you are able to assess the needs of users and organisations, as well as analyse the extent to which IT systems and computing solutions fulfil these needs.

In this unit, you will explore the scope of virtualised solutions, how different types of virtualisation can be used to meet user/business needs and the impact that implementing virtualised solutions has on individuals and organisations. You will analyse the computing needs of organisations and how virtualisation can help an organisation meet its aims. Finally, you will design and create virtualised solutions to meet a range of identified requirements.

This unit will provide you with the analytical skills and knowledge base that you will need to enter an IT apprenticeship as a network support engineer, or for progression to a degree course with the goal of becoming a systems analyst or programmer/developer.

Learning aims

In this unit you will:

A Examine the concepts, uses and implications of virtualisation

B Implement a virtualised solution to meet identified requirements

C Demonstrate appropriate testing and maintenance procedures.

Summary of unit

Learning aim	Key content areas	Recommended assessment approach
A Examine the concepts, uses and implications of virtualisation	**A1** Types of virtualisation **A2** Computing requirements of an organisation **A3** Impact of virtualisation	A report detailing an investigation carried out on how virtualised solutions could be implemented within an identified organisation in order to fulfil the organisation's business and computing requirements.
B Implement a virtualised solution to meet identified requirements	**B1** Planning virtualised solutions **B2** Reviewing and refining plans **B3** Developing virtualised solutions	A project brief detailing client requirements, design specifications for the proposed solution, development and testing logs, meeting notes and a report that evaluates the effectiveness and appropriateness of the implemented solution.
C Demonstrate appropriate testing and maintenance procedures	**C1** Testing and maintaining virtualised solutions **C2** Reviewing and refining virtualised solutions **C3** Lessons learned from developing virtualised solutions **C4** Presentation skills **C5** Reviewing own skills, knowledge and behaviours	

Content

Learning aim A: Examine the concepts, uses and implications of virtualisation

A1 Types of virtualisation

The characteristics, application requirements and implications of different types of virtualisation.

- Hardware virtualisation:
  - 'full virtualisation', 'partial virtualisation' and 'paravirtualisation'
  - emulation
  - hardware-assisted virtualisation
  - snapshots and teleportation.
- Local desktop virtualisation (using a client-based virtualisation application).
- Remote desktop virtualisation, e.g. 'fat', 'thin' and 'zero' client, use of remote desktop services, application of a virtual desktop infrastructure (VDI).
- Memory virtualisation.

A2 Computing requirements of an organisation

The aims and requirements of businesses and organisations, and how IT is used to support these.

- The services an organisation provides and how they may be virtualised.
- Aims and goals of organisations in the context of virtualisation and how these may be met.
- Customers – needs, expectations, how product/service is delivered.
- Staff – needs, working styles and patterns.
- Location – staff, customers, business premises, market/service delivery point.
- Legal and ethical considerations, e.g. licensing, data security, privacy.
- Requirements that cannot be met using virtualisation.

A3 Impact of virtualisation

- The implications of virtualised computing solutions for individual users:
  - uses and applications of virtualisation
  - flexibility
  - cost
  - efficiency
  - challenges, e.g. technical support staff skills, staff training, implementation procedures.
- The implications of virtualised computing solutions for organisations:
  - user experience, e.g. ease of use, performance, availability, accessibility
  - staffing issues, e.g. skills, training, individual needs, working patterns
  - cost, e.g. virtualisation resources, infrastructure staffing, training
  - implementation, e.g. choosing a solution(s), timescales, testing, migration to new system
  - legal and ethical considerations under current or equivalent legislation in England, Wales and Northern Ireland, e.g. licensing, data security, privacy.

Learning aim B: Implement a virtualised solution to meet identified requirements

B1 Planning virtualised solutions

Planning documentation for virtualised solutions, to include:

- purpose
- client requirements
- user needs
- technical requirements
- hardware, software and other resources required.

B2 Reviewing and refining plans

Working with clients and others to improve the quality, effectiveness and appropriateness of plans, including:

- gathering feedback from client(s) and potential users
- communicating with clients, e.g. email, verbal communication
- scheduling and documenting meetings
- agreeing and adjusting timescales
- refining ideas and solutions
- updating design specification documentation.

B3 Developing virtualised solutions

Implement virtualised solutions to meet identified requirements.

- Preparing the host computer, e.g. virtualisation software installation, upgrading of components.
- Preparing a virtualised solution, e.g. guest operating system image, allocation of host computer resources.
- Adding, removing and updating software on the virtualised solution.
- Detailed documentation of the development process.

Learning aim C: Demonstrate appropriate testing and maintenance procedures

C1 Testing and maintaining virtualised solutions

- Selecting and using a range of appropriate testing methodologies to ensure virtualised solutions meet identified requirements:
  - different types of testing, e.g. system testing, user testing
  - selecting suitable test users
  - gathering feedback from users
  - producing appropriate test documentation
  - making use of testing outcomes.
- Ongoing maintenance activities:
  - software updates
  - security updates, virus scanning
  - user management
  - performance monitoring and configuration adjustments.

C2 Reviewing and refining virtualised solutions

Monitoring ongoing performance of virtualised solutions, making updates and changes as required.

- Security issues and updates.
- Software updates.
- Compatibility issues.
- Changing user requirements.
- Hardware developments.

C3 Lessons learned from developing virtualised solutions

Evaluating the effectiveness of the solutions that have been developed with reference to:

- how far the solution met the identified requirements
- efficiency of the solution
- ease of use
- issues arising during testing and maintenance
- stability
- the potential update schedule
- how the implemented solution could be improved to better meet the needs of the user and fulfil the identified needs
- alternative solutions that could be implemented if the task were to be repeated.

C4 Presentation skills

Communication requirements:

- media conventions and requirements to convey intended meaning, e.g. written communication requirements (email, design documentation, recording documentation, reports, visual aids for presentation use, etc.), verbal communication requirements (one-to-one and group, formal and informal situations)
- use of tone and language for verbal and written communications to convey intended meaning and make a positive and constructive impact on audience, e.g. positive and engaging tone, technical/vocational language suitable for intended audience, avoidance of jargon
- responding constructively to the contributions of others, e.g. being supportive, managing contributions so that all have the opportunity to contribute, responding to objections, managing expectations, resolving conflict.

C5 Reviewing own skills, knowledge and behaviours

- Planning and recording opportunities for development of skills, knowledge and behaviours, including the setting of relevant targets with timescales, and how and when feedback from others will be gathered.
- Reviewing and responding to the outcomes of own skills, knowledge and behaviours development, including the use of feedback from others.
- Own behaviours, and their impact on outcomes, including professionalism, etiquette, being supportive of others, timely and appropriate leadership, accountability and individual responsibility.
- Evaluating targets set for development of skills, knowledge and behaviour to obtain insights into own performance.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Examine the concepts, uses and implications of virtualisation</td><td rowspan="2">A.D1 Evaluate the impact that the implementation of virtualised solutions can have on an organisation.</td></tr>
<tr><td>A.P1 Explain the characteristics of different types of virtualisation.
A.P2 Explain how virtualised solutions can be used to meet the computing requirements of an organisation and their potential impact.</td><td>A.M1 Analyse the impact that the implementation of virtualised solutions can have on an organisation.</td></tr>
<tr><td colspan="2">Learning aim B: Implement a virtualised solution to meet identified requirements</td><td rowspan="3">BC.D2 Evaluate the plan and optimised virtualised solution against client requirements.
BC.D3 Demonstrate individual responsibility, creativity, and effective self-management in the design, development and review of virtualised solutions.</td></tr>
<tr><td>B.P3 Produce plans for a virtualised solution to meet client requirements.
B.P4 Develop a virtualised solution to meet client requirements.</td><td>B.M2 Justify planning and implementation decisions, showing how they will provide an effective solution that meets client requirements.</td></tr>
<tr><td colspan="2">Learning aim C: Demonstrate appropriate testing and maintenance procedures</td></tr>
<tr><td>C.P5 Test a virtualised solution, confirming that it meets client requirements.
C.P6 Review the extent to which a virtualised solution meets client requirements.</td><td>C.M3 Optimise a virtualised solution to meet client requirements.</td><td></td></tr>
</table>

Essential information for assignments

The recommended structure of assessment is shown in the unit summary along with suitable forms of evidence. *Section 6* gives information on setting assignments and there is further information on our website.

There is a maximum number of two summative assignments for this unit. The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aims: B and C (B.P3, B.P4, C.P5, C.P6, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to:

- hardware and software resources that will allow them to use the tools and techniques (given in the unit content) to design and develop virtualised solutions
- a range of commercial cost-based and free virtualisation resources.

This unit does not require any particular technology. Centres will be able to effectively deliver this entire unit using free-licensed operating systems and virtualisation, or they can opt for paid-for solutions.

Essential information for assessment decisions

Learning aim A

Learners will provide evidence that demonstrates an understanding of virtualisation through analysis of an organisation's computing requirements.

For distinction standard, learners will produce a clear and balanced evaluation, supported by fluent and accurate technical language, of how the virtualised solutions will impact on the case study organisation. Learners will provide an accurate and robust analysis of how different virtualised solutions would impact on all areas of the business and its stakeholders, providing reasoned and balanced justification as to why one suggested solution may be preferable to another and/or where tasks may be better suited to non-virtualised solutions. The report will demonstrate high-quality written/oral communication through the use of accurate and fluent technical vocabulary to support a well-structured and considered response that clearly connects chains of reasoning.

For merit standard, learners will show a clear understanding of how the characteristics of a variety of types of virtualisation can impact on the organisation. Learners will also provide a clear, accurate and robust analysis of the issues. The report will be technically accurate and demonstrate the use of good-quality communication.

For pass standard, learners will provide explanations of the characteristics of hardware virtualisation, local desktop virtualisation and remote desktop virtualisation. The explanations will be supported by examples of how these systems can be implemented to replace and/or support current systems. Learners will demonstrate an understanding of the resource requirements of the identified uses and how these might impact – both positively and negatively – on the requirements of the organisation and its stakeholders. The report may have some inaccuracies and the review of the impact may be unbalanced.

Learning aims B and C

Learners will provide evidence that identifies and develops virtualised solutions to meet stated client requirements.

Centres will ensure that the client requirements are sufficiently detailed and complex to allow learners to demonstrate the required skills. For example, the scenario might require the development of a virtualised desktop that provides a range of end user facilities (such as applications, shared resources).

For distinction standard, learners will draw on, and show synthesis of, knowledge across the learning aims to evaluate how the decisions and methodologies applied throughout the designing, development, optimisation, testing and maintenance of the implemented virtualised solution impacted on their effectiveness. Learners will make suitable and reasoned justification of decisions made in comparison to alternative solutions.

Learners will provide a thorough evaluation of the effectiveness of the implemented solution (including comparison to alternative solutions), which will be supported by evidence from all stages of the development in order to reach valid conclusions and suggest future actions and

improvements. The evaluation will contain a systematic and accurate review of their skills and performance, and the impact that this had on the effectiveness of the solutions. Evaluation of behaviours will consider learners' use of 'soft skills' in relation to the vocational context of the project, such as managing and liaising with other members of the team or clients, and in time management.

Learners will evaluate their own behaviours throughout the project and the impact these had on the outcomes. Learners will take individual responsibility for their own work, e.g. identifying potential issues and resolving these, reviewing their work and making improvements, keeping their work safe and secure and demonstrating responsible use of quoted materials. Creativity will be demonstrated, for example, through taking innovative approaches to problem-solving and through the originality of their solution. Where possible, learners will refer to tangible evidence to support their evaluation, such as meeting notes, correspondence and time plans.

For merit standard, learners will apply their knowledge through the selection and application of appropriate methodologies to design, develop, maintain and test an effective, optimised virtualised solution to meet client needs.

Learners will consider how decisions they made during the planning and implementation of the project affected the outcomes and justify why these decisions were made. Using the results of testing and review completed at pass level, learners will optimise the virtualised solution they have created so that it better meets the client requirements. The optimisation could include adjustment of the security or performance of the system, changes to improve the user interface or other aspects of the system.

For pass standard, learners will apply their understanding through the planning and development of virtualised solutions to meet client requirements. Plans will include an explanation of the requirements of the solution and technical specifications for the suggested solutions. Learners will provide evidence that different types of testing have been carried out and that problems and errors identified have been responded to. Learners should also perform ongoing maintenance to the solution, applying changes and updates as required. The implemented solution must work but there may be some performance issues and/or the implemented solution may not be as efficient or effective as it could be.

Learners will review how the decisions they made during planning and development affected the implemented solution, explaining to what extent they met the initial project briefs. They will consider both positive and negative aspects of the solution, although their review may be unbalanced and/or superficial.

Links to other units

This unit links to:

- Unit 19: Computer Networking
- Unit 20: Managing and Supporting Systems
- Unit 29: Network Operating Systems
- Unit 30: Communication Technologies.

Employer involvement

This unit would benefit from employer involvement in the form of:

- guest speakers
- technical workshops involving staff from local organisations/businesses
- contribution of design/ideas to unit assignment/scenario/case study/project materials, including own organisation/business materials as exemplars where appropriate
- feedback from staff from local organisations/businesses on plans/designs/items developed
- opportunities for observation of organisational/business application during work experience
- support from local organisation/business staff as mentors.

Unit 22: Systems Analysis and Design

Level: **3**

Unit type: **Internal**

Guided learning hours: **60**

Unit in brief

Learners will study the principles of systems analysis and develop the skills to analyse and design a solution to meet an organisation's needs.

Unit introduction

Most organisations and businesses rely on computer systems to support their activities. These systems are often unique to the organisation where they are implemented. Systems analysis is a process that identifies the computing needs of an organisation, designs solutions and plans changes and updates. Systems analysts need to be able to solve problems and have a thorough knowledge of computer software and hardware.

In this unit, you will learn how to use systems analysis methods to examine an organisation and analyse its current systems. In many cases, the organisation will already have a computer system and will have decided to revise their current system because of a change in their activities or investment in new technology. You will learn how to plan for the implementation of a new or revised system that is specific to the client's requirements. The design that you develop may be used to develop a new IT system or develop an existing one.

A computing professional will need a detailed knowledge of how organisations work. By completing this unit you will gain an understanding of how to investigate how an organisation works. The analytical skills developed in this unit will be of great benefit in many different computing career paths, including progression to a programmer or systems analyst role. For those progressing to higher education, systems analysis is a subject included in many computer science degrees.

Learning aims

In this unit you will:

A Examine the principles of systems analysis and design

B Investigate the computing requirements of an identified organisation

C Develop a design for a computing system to meet an organisation's needs.

Summary of unit

Learning aim	Key content areas	Recommended assessment approach
A Examine the principles of systems analysis and design	**A1** Development models **A2** Systems analysis tools and techniques	A report that explores software development models, systems analysis tools and techniques and their suitability for modelling business processes.
B Investigate the computing requirements of an identified organisation	**B1** Computing and business needs of an identified organisation **B2** Investigation techniques that use standard analytical methods **B3** Threats to system success **B4** Requirements specification	A requirements specification document covering the business needs and overall requirements of the new system. A completed design for the proposed system, including input and output definitions, data and process modelling and testing methodology. A report evaluating the requirements specification and design against the organisation's requirements.
C Develop a design for a computing system to meet an organisation's needs	**C1** Input and output requirements **C2** Data and processes within a system **C3** Testing and maintenance methodologies **C4** Skills, knowledge and behaviours	

Content

Learning aim A: Examine the principles of systems analysis and design

A1 Development models

Standard software development models used in the computing industry:

- waterfall model:
  - requirements specification
  - design
  - implementation
  - testing
  - debugging
  - installation and maintenance
- systems life cycle:
  - definition
  - investigation and analysis
  - design
  - implementation
  - testing
  - documentation
  - evaluation
  - maintenance
- alternative models:
  - rapid application development (RAD)
  - agile methodologies, e.g. Scrum, dynamic systems development method (DSDM), adaptive software development (ASD)
  - prototyping.

A2 Systems analysis tools and techniques

Standard ways of analysing and describing computer systems:

- data flow diagrams (DFDs), context diagrams
- computer-aided software engineering (CASE) and other appropriate software tools
- structured systems analysis and design method (SSADM)
- Unified Modelling Language® (UML®):
  - structure (static) diagrams, e.g. class diagram, component diagram
  - behaviour (dynamic) diagrams, e.g. activity diagram, use case diagram, interaction diagrams
- suitability of methods for different programming paradigms, e.g. object-oriented, event-driven, procedural
- business process reengineering (BPR).

Learning aim B: Investigate the computing requirements of an identified organisation

B1 Computing and business needs of an identified organisation

The aims and requirements of an organisation, and how IT is used to support these:

- the services an organisation provides
- aims and goals of an organisation
- customers – needs, expectations, how product/service is delivered
- staff – needs, working styles and patterns
- location – staff, customers, premises, market/service delivery point.

B2 Investigation techniques that use standard analytical methods

Research and analysis that provides a detailed and accurate description of the current system(s):

- information gathering, e.g. questionnaires, interviews, observations
- document analysis
- protocols for carrying out investigation, e.g. confidentiality, company policy, security.

B3 Threats to system success

Factors affecting the success and failure of a current system:

- risks, e.g. completing tasks, budget, missed deadline(s), stakeholder support, staff involvement
- constraints, e.g. costs, scope, time
- provision of appropriate resources, e.g. people, time, budgets, maintenance system
- change management, user involvement in the development process.

B4 Requirements specification

Documentation that describes a new or updated system, to include:

- the scope and boundaries of the proposed system
- inputs and outputs in the new system
- processes required in the proposed system
- timings, e.g. proposed timescales, milestones
- risks and constraints
- recommendations for future action.

Learning aim C: Develop a design for a computing system to meet an organisation's needs

C1 Input and output requirements

Appropriate and detailed design documentation for the input and output of the proposed system, including:

- visuals, e.g. screen layouts, storyboards, alternative layout for different platforms and devices
- data entry forms, including layout and structure, proposed fields, data entry methods
- report forms
- hardware and software requirements.

C2 Data and processes within a system

Detailed design documentation showing the data requirements of and use within a proposed system, including:

- modelling data, e.g. entity relationship diagrams, data flow diagrams
- data dictionaries, e.g. data stores, entities, data structures, validation
- process modelling using a variety of tools, e.g. flow charts, decision tables, activity diagrams.

C3 Testing and maintenance methodologies

Appropriate documentation to identify and plan for testing and maintenance of the proposed system:

- testing methods, e.g. volume testing, scalability, multiplatform
- developing test plans
- identifying test data, e.g. normal, extreme, abnormal
- choosing test users
- proposed test schedule
- proposed maintenance and update schedule.

C4 Skills, knowledge and behaviours

- Planning and recording, including the setting of relevant targets with timescales, how and when feedback from others will be gathered.
- Reviewing and responding to outcomes, including the use of feedback from others, e.g. IT professionals and users who can provide feedback on the quality of the computing system and its suitability against the original requirements.
- Demonstrate own behaviours and their impact on outcomes, including professionalism, etiquette, supportive of others, timely and appropriate leadership, accountability.
- Evaluating outcomes to help inform high-quality, justified recommendations and decisions.
- Communication skills, including:
  - the ability to convey intended meaning, e.g. written (email, design documentation, recording documentation, reports, visual aids for presentation use, etc.), verbal communication requirements (one-to-one and group, informal and formal situations)
  - use of tone and language for verbal and written communications to convey intended meaning and make a positive and constructive impact on audience, e.g. positive and engaging tone, technical/vocational language suitable for intended audience, avoidance of jargon
  - responding constructively to the contributions of others, e.g. supportive, managing contributions so all have the opportunity to contribute, responding to objections, managing expectation, resolving conflict.

Assessment criteria

Pass	Merit	Distinction
Learning aim A: Examine the principles of systems analysis and design		
A.P1 Explain the principles of software development models. **A.P2** Explain the features of different systems analysis tools and techniques for modelling business processes.	**A.M1** Assess the suitability of different systems analysis tools and techniques for modelling business processes.	**A.D1** Evaluate the suitability of different system analysis tools and techniques for modelling business processes.
Learning aim B: Investigate the computing requirements of an identified organisation		
B.P3 Produce a requirements specification to meet the business and computing requirements of an identified organisation.	**B.M2** Justify the decisions made in a requirements specification to meet the business and computing requirements of an identified organisation.	**BC.D2** Evaluate the requirements specification and design against the organisation's requirements. **BC.D3** Demonstrate individual responsibility, creativity and effective self-management in producing a design for a computing system.
Learning aim C: Develop a design for a computing system to meet an organisation's needs		
C.P4 Produce a design for a computing system that will meet the business and computing requirements of an identified organisation. **C.P5** Explain how feedback has been used to refine the design for a computing system that will meet the business and computing requirements of an identified organisation.	**C.M3** Justify system design decisions made, showing how the proposed computing system will meet the business and computing requirements of an identified organisation.	

Essential information for assignments

The recommended structure of assessment is shown in the unit summary along with suitable forms of evidence. *Section 6* gives information on setting assignments and there is further information on our website.

There is a maximum number of two summative assignments for this unit. The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aims: B and C (B.P3, C.P4, C.P5, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

Learners should have access to standard software packages. Software that provides standard flow-charting symbols would be useful, though not essential.

Essential information for assessment decisions

Learning aim A

For distinction standard, learners will provide a clear and balanced evaluation of the different tools and techniques in relation to modelling business processes. The evaluation will be linked to real life examples. Learners must consider the suitability of the tools to model different types of business processes and how appropriate they are for the different programming paradigms such as object-oriented, event-driven, and procedural programming. Learners will provide reasoned, justified conclusions in this regard.

Learners must articulate their arguments fluently and views concisely. The evidence will demonstrate high-quality written/oral communication through the use of accurate and fluent business and technical vocabulary to support a well-structured and considered response that clearly connects chains of reasoning.

For merit standard, learners will provide a clear, balanced assessment of the suitability of the tools and techniques for at least two different systems analysis models. For example, learners might compare the use of the standard systems life cycle with Agile methodologies in one of the creative industries (such as games development) where systems and processes are different from more traditional industries. Learners must show that they understand how the use of different tools and techniques might result in a different development process. The evidence must be technically accurate and demonstrate good-quality written or oral communication.

For pass standard, learners will explain the principles and features of the different software development models and system analysis tools, as listed in the unit content. They need to explain the different stages of the development models, providing examples of what each stage involves. For each systems analysis tool or technique, they must explain its main features. The evidence may have some inaccuracies and may include limited use of examples to illustrate the explanations.

Learning aims B and C

Learners will develop a design for a proposed computing system, either real or imaginary. In order to complete the design, learners will need to be given an appropriate amount of detail about the proposed system and the business requirements.

For distinction standard, learners will provide a thorough evaluation of the effectiveness of the requirements specification and design against the client requirements, supported by evidence from all stages of the development. Learners will draw on and show synthesis of knowledge across the learning aims to evaluate how the decisions and processes applied throughout the investigation and development of the requirements specification and the design impacted on the effectiveness of the system design.

Learners will review the process to reach valid conclusions as to how the chosen systems analysis techniques provided a more accurate and usable design in comparison to alternatives. Learners must refer to tangible evidence to support their evaluation such as meeting notes, correspondence and time plans. Learners will provide well-considered, justifiable suggestions for future improvements to the design. Their evidence will be detailed and well-presented and clearly show how their design meets the client requirements.

Evaluation of behaviours will consider learners' use of 'soft skills' in relation to the vocational context of the project, such as managing and liaising with other members of the team or clients, and in time management. Learners will evaluate their own behaviours throughout the project and the impact these had on the outcomes. Learners will take individual responsibility for their own

work, for example identifying potential issues and resolving these, reviewing their work and making improvements, keeping their work safe and secure and showing responsible use of quoted materials. Creativity will be shown, for example, through taking innovative approaches to problem-solving and through the originality of their solution.

For merit standard, learners will justify decisions made in the requirements specification and the design. The justification will relate to overall decisions such as which systems analysis methodology to use as well as more detailed design decisions such as how they divided up the processing steps and how they chose particular data tables and the relationships between them. They must clearly relate their decisions back to the scenario organisation's requirements, showing how these decisions helped ensure the appropriateness of the requirements specification and the design.

For pass standard, learners will produce both a requirements specification and a design for the new or updated system that meets identified client requirements. The requirements specification must relate to the scenario they have been given. Use of a real system could make the investigation and evidence collection process more accessible to learners. The requirements specification produced by learners must cover the topics listed in the unit content. They must produce a design based on the same scenario, developing the outlines provided in the requirements specification for the inputs, outputs and processes. They will select a single systems analysis methodology and use this to create the design for the system. They must obtain feedback on their design, preferably from someone with business experience who can provide helpful advice on the suitability of system. Learners must use this feedback to improve their design and explain how useful the feedback was in assisting them to refine the design.

Links to other units

This unit links to:

- Unit 10: Human-computer Interaction
- Unit 14: Computer Games Development
- Unit 15: Website Development
- Unit 16: Object-oriented Programming
- Unit 17: Mobile Apps Development
- Unit 18: Relational Database Development
- Unit 23: Systems Methodology
- Unit 24: Software Development
- Unit 25: Web Application Development
- Unit 32: Business Process Modelling Tools.

Employer involvement

This unit would benefit from employer involvement in the form of:

- guest speakers
- technical workshops involving staff from local organisations/businesses
- contribution of design/ideas to unit assignment/scenario/case study/project materials, including own organisation/business materials as exemplars where appropriate
- feedback from staff from local organisations/businesses on plans/designs/items developed
- opportunities for observation of organisational/business application during work experience
- support from local organisation/business staff as mentors.

Unit 23: Systems Methodology

Level: **3**

Unit type: **Internal**

Guided learning hours: **60**

Unit in brief

Learners investigate systems methodology and its uses in systems development and problem solving. They will use systems methodology, tools and techniques to solve a problem.

Unit introduction

Systems methodology is a framework used in software development to structure the development stages. Systems methodology helps you to formulate and structure thinking about a problem scenario by providing an action-oriented process of inquiry and taking action to improve it.

In this unit, you will be introduced to the systems methodology approaches used by engineers to solve complex problems. You will undertake research into the principles of systems methodology along with the tools and techniques used to solve a complex problem. You will select and apply systems methodologies to solve a formulated problem, reflecting on your systems methodology skills and performance.

This unit will prepare you with the knowledge, confidence and skills needed for a range of apprenticeships or higher education courses, including computing and computer science, or to enter the workplace as a computing professional such as a systems analyst or systems engineer.

Learning aims

In this unit you will:

A Investigate the principles of systems methodology and systems techniques used to solve computing problems

B Apply systems methodology tools and techniques to identify and solve a computing problem

C Review a solution to a computing problem.

Summary of unit

Learning aim	Key content areas	Recommended assessment approach
A Investigate the principles of systems methodology and systems techniques used to solve computing problems	**A1** The software development life cycle **A2** Systems methodology principles **A3** Systems methodology techniques	A report focusing on the differences between various systems methodologies and techniques that could be used to solve computing problems, depending on the nature of the computing problem.
B Apply systems methodology tools and techniques to identify and solve a computing problem	**B1** Problem investigation **B2** Selecting appropriate systems methodology **B3** Applying systems methodology techniques **B4** Applying systems methodology tools	A practical activity using systems methodology techniques and tools to solve the problem statement. The evidence will include a report outlining the problem statement and a possible solution, drawings and planning documentation. An evaluation of the use of systems methodology to solve a computing problem and a conclusion of improvements that could be made to the solution. The report will show accurate understanding of the fundamental processes of systems methodology.
C Review a solution to a computing problem	**C1** Reviewing the development process and outcomes **C2** Skills, knowledge and behaviours	

Content

Learning aim A: Investigate the principles of systems methodology and systems techniques used to solve computing problems

A1 The software development life cycle

The stages of the software development life cycle (SDLC) and the alternative approaches available, including:

- waterfall method
- spiral development
- prototyping
- incremental development.

A2 Systems methodology principles

The nature and features of different system methodologies:

- traditional structured methodologies, including:
  - Yourdon Systems Method (YSM)
  - structured systems analysis and design (SSADM)
  - Jackson's System Structured Development (JSD)
- agile methodologies, including:
  - rapid applications development (RAD)
  - Scrum methodology
  - dynamic systems development (DSDM)
  - extreme programming (XP).

A3 Systems methodology techniques

- Object-oriented techniques: unified modelling language (UML®), analysis models such as cases, analysis class diagram.
- Structured techniques: entity relationship diagram (ERD), logical data structure, process such as data flow diagram (DFD), time such as entity life history, models.
- Computer-aided software engineering (CASE) tools, e.g. system requirements specification documentation, data dictionary, screen design for data input, decision table checking.

Learning aim B: Apply systems methodology tools and techniques to identify and solve a computing problem

B1 Problem investigation

Investigating a scenario to define a problem statement.

- Project proposal:
  - project description
  - problem opportunity
  - SWOT (strengths, weaknesses, opportunities, threats) analysis.
- Components of problem definition.
- Goals.
- Environment.

B2 Selecting appropriate systems methodology

Criteria which affect the choice of methodology, including:

- stakeholders, e.g. developers, clients, users and their experience of software development and the problem domain
- type of system being developed, e.g. safety or security critical, goals and priorities of the system
- the development context, e.g. programming environment, constraints such as technical, time and financial costs.

B3 Applying systems methodology techniques

Appropriate techniques for modelling a solution to a problem, including:

- conceptual models
- cross-checking models
- context models
- data flow diagrams (DFD)
- structured diagrams
- action diagrams
- decision tables
- matrices
- structured English.

B4 Applying systems methodology tools

Appropriate tools for modelling a solution to a problem, including:

- drawing tools
- CASE tools
- system repositories
- data dictionary
- database management system
- project management tools.

Learning aim C: Review a solution to a computing problem

C1 Reviewing the development process and outcomes

- Sources of information, including problem statement, application of systems methodology, application of systems methodology techniques and tools, feedback from others.
- Review and evaluation criteria, including:
  - testing and measurement activities undertaken
  - record keeping for systems methodology in relation to design, testing and modifications
  - requirements and the extent to which these have been met
  - feedback from others/client and outcomes of action taken
  - constraints, e.g. time, copyright, technology constraints
  - strengths and weaknesses of systems methodology tools and techniques
  - development decisions and priority setting
  - management of own time and progress
  - production skills, e.g. ideas generation, design.

C2 Skills, knowledge and behaviours

- Planning and recording, including the setting of relevant targets with timescales, how and when feedback from others will be gathered.
- Reviewing and responding to outcomes, including the use of feedback from others, e.g. IT professionals and users who can provide feedback on the quality of the solution developed.
- Demonstrate own behaviours and their impact on outcomes, including professionalism, etiquette, supportive of others, timely and appropriate leadership, accountability and individual responsibility.
- Evaluating outcomes to help inform high-quality justified recommendations and decisions.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Investigate the principles of systems methodology and systems techniques used to solve computing problems</td><td rowspan="2">A.M1 Evaluate the use of the applied software development life cycle model and systems methodology in the problem-solving process.</td></tr>
<tr><td>A.P1 Explain the stages of the software development lifecycle.
A.P2 Explain the principles of systems methodologies used in the problem-solving process.</td><td>A.M1 Compare the use of the applied software development life cycle model and systems methodology in the problem-solving process against alternative options.</td></tr>
<tr><td colspan="2">Learning aim B: Apply systems methodology tools and techniques to identify and solve a computing pr oblem</td><td rowspan="4">BC.D2 Evaluate the process of applying a systems methodology to a computing problem in order to develop a proposed solution.
BC.D3 Demonstrate individual responsibility and effective self-management in the application and review of systems methodologies to identify and develop a solution to a problem.</td></tr>
<tr><td>B.P3 Define a problem statement for an identified scenario.
B.P4 Develop a solution to a computing problem, using appropriate systems methodologies.</td><td>B.M2 Justify the choice of systems methodology tools and techniques used to provide a solution to a computing problem.</td></tr>
<tr><td colspan="2">Learning aim C: Review a solution to a computing problem</td></tr>
<tr><td>C.P5 Review the solution to a computing problem, considering feedback from others and identifying possible improvements.</td><td>C.M3 Assess potential improvements to the solution in relation to the problem statement.</td></tr>
</table>

Essential information for assignments

The recommended structure of assessment is shown in the unit summary along with suitable forms of evidence. *Section 6* gives information on setting assignments and there is further information on our website.

There is a maximum number of two summative assignments for this unit. The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aims: B and C (B.P3, B.P4, CP.5, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners must have access to software resources that will enable them to use the tools and techniques (given in the unit content) to design a solution to a computing problem, such as diagramming software, e.g. Microsoft Visio®.

Essential information for assessment decisions

Learning aim A

For distinction standard, learners will provide a clear and balanced evaluation of the effectiveness of the software development life cycle models and systems methodologies that were used to solve an identified problem, with clear links to the importance of the models and methodologies in the process of solving the problem. Learners' evidence will show that they understand how different software development life cycles and methodologies are suited to different types of development. Learners must articulate their arguments fluently and views concisely, providing an evaluation which makes reasoned, valid judgements. The evidence will demonstrate high-quality written/oral communication through the use of accurate and fluent technical vocabulary to support a well-structured and considered response that clearly connects chains of reasoning.

For merit standard, learners will compare the ways in which software development life cycle models and methodologies were used to solve the problem against alternative ways of problem-solving. Learners will present a reasoned and well explained comparison of the life cycle models and systems methodologies. The evidence must provide a balanced discussion covering both traditional structured and agile methodologies, supported by clear examples. The evidence must be technically accurate and demonstrate good quality written or oral communication.

For pass standard, learners will provide an explanation of the stages of the software development life cycle and the principles of system methodologies given in the unit content used to solve an identified problem. The evidence may have some inaccuracies and may include limited examples to illustrate the explanations.

Learning aims B and C

For distinction standard, learners will draw on, and show synthesis of, knowledge across the learning aims to evaluate the application of systems methodology to identify and resolve a computing problem, referring to appropriate feedback received. The evaluation will determine the strengths and weaknesses of the systems methodology and the development process undertaken throughout. Clear, justifiable references will be made to planning and recording throughout, along with relevant constraints.

Evaluation of behaviours will consider the learners' use of 'soft skills' in relation to the vocational context of the project, such as managing and liaising with other members of the team or clients and in time management. Learners will evaluate their own behaviours throughout the project and the impact these had on the outcomes. Learners will refer to tangible evidence to support their evaluation such as meeting notes, correspondence and time plans.

For merit standard, learners will give a clear, accurate and well-reasoned justification of the choice of systems methodology tools and techniques used to solve the computing problem. Learners could refer to both their own ideas and the feedback they obtained. They must explain why they chose the system methodology tools and techniques and how the tools and techniques helped to provide a solution to the computing problem. Learners will also provide a balanced assessment of the appropriateness of potential improvements to the solution against the requirements of the problem statement.

For pass standard, learners will provide evidence that they have used appropriate methods, tools and techniques such as agile methods, modelling and diagramming techniques, drawing tools and CASE tools to define a problem statement and develop a solution. The problem statement will be supported by documentation showing understanding of the different aspects of the problem investigation process given in the content. Learners will also provide a realistic review of the solution to the computing problem, referring to the systems methodology tools and techniques used during problem solving, along with consideration of the feedback received and the problem definition.

Links to other units

This unit links to:

- Unit 22: Systems Analysis and Design
- Unit 32: Business Process Modelling Tools.

Employer involvement

This unit would benefit from employer involvement in the form of:

- guest speakers
- technical workshops involving staff from local organisations/businesses
- contribution of design/ideas to unit assignment/scenario/case study/project materials, including own organisation/business materials as exemplars where appropriate
- feedback from staff from local organisations/businesses on plans/designs/items developed
- opportunities for observation of organisational/business application during work experience
- support from local organisation/business staff as mentors.

Unit 24: Software Development

Level: **3**

Unit type: **Internal**

Guided learning hours: **60**

Unit in brief

Learners study the underpinning concepts and implications of programming languages to design, develop and test computer programs.

Unit introduction

We live in an age in which both organisations and individuals increasingly depend on the functions and services offered by computing devices and computer-controlled devices. Understanding the concepts of high-quality application design and development is key to ensuring that products are effective. As a computing programmer or software engineer, you will need to understand the characteristics of different programming languages in order to select and apply appropriate methodologies to meet a client's needs.

In this unit, you will learn about the principles of design and developing computer programs, and the programming techniques and constructs used by current languages. You will design, develop, test, refine and review computer programs for a given purpose. To complete the assessment task within this unit, you will need to draw on your learning from across your programme.

By developing your analytical, problem-solving and programming skills, this unit will help you to progress to higher education or employment as a software developer or software engineer.

Learning aims

In this unit you will:

A Examine the principles of computer programming

B Design a software solution to meet identified requirements

C Develop a software solution to meet identified requirements.

Summary of unit

Learning aim	Key content areas	Recommended assessment approach
A Examine the principles of computer programming	**A1** Uses of software applications **A2** Features and characteristics of programming languages **A3** Constructs and techniques and their implementation in different languages **A4** Principles of logic applied to program design **A5** Quality of computer programs	A report evaluating how the principles of software design and computer programming are applied to create effective, high-quality applications.
B Design a software solution to meet identified requirements	**B1** Software development life cycle **B2** Software solutions design	A project brief identifying the scope of the problem and user/client requirements. Design documentation for the suggested solution. User feedback and design refinement documentation. Development and support documentation, including development and testing logs, meeting notes and a report that evaluates the outcomes and development of the project.
C Develop a software solution to meet identified requirements	**C1** Software solutions development **C2** Testing software solutions **C3** Improvement, refinement and optimisation of software applications **C4** Review of software solutions **C5** Skills, knowledge and behaviours	

Content

Learning aim A: Examine the principles of computer programming

A1 Uses of software applications

The uses and implications of software applications in solving problems and fulfilling needs, including:

- gaming and entertainment
- productivity
- information storage and management
- repetitive tasks or dangerous tasks
- social media
- search engines.

A2 Features and characteristics of programming languages

- The uses and applications of different types of programming languages, developed to assist in the solution of particular problems:
  - high-level and low-level languages
  - procedural
  - object-oriented
  - event-driven
  - logical
  - machine
  - markup.
- Factors to compare and contrast in programming languages, including:
  - hardware and software needed for running and developing a program
  - special devices required
  - performance
  - preferred application areas
  - development time
  - ease of development.

A3 Constructs and techniques and their implementation in different languages

- Programming languages constructs and techniques, including:
  - command words
  - constants and variables, local and global variables
  - data types – character, string, integer, real, Boolean
  - statements – assignment, input and output, sequence, iteration, selection
  - logical operations.
- Other constructs, e.g.:
  - subroutines, functions and procedures
  - string handling, including examining single characters and substrings
  - arrays – 2D and 3D, splitting and joining
  - file handling – open, read, write, close, database
  - data structures
  - event handling.
- Documentation of code.

A4 Principles of logic applied to program design

Principles, including:

- iteration – repetition of a computational procedure applied to the result of a previous application
- mathematical logic – inference, consistency, completeness, verification by truth tables
- propositional dynamic logic to demonstrate the function of algorithms
- use of sets, e.g. properties and interrelationships of sets of data, search/filter sets of data.

A5 Quality of computer programs

How the design and implementation of a computer program affect quality, including:

- efficiency/performance, e.g. the system resources a program consumes, central processing unit (CPU) cycles, processor time, memory space, accessing storage media
- maintainability, e.g. ease with which a program can be modified by its present or future developer in order to carry out corrective, perfective or adaptive maintenance
- portability, e.g. range of computer hardware, operating systems and platforms on which the source code can be run/compiled/interpreted
- reliability, e.g. accuracy and the consistency of its outputs
- robustness, e.g. quality of coding and testing to that ensure that extreme and erroneous data can be processed without causing the program to crash
- usability, e.g. ease with which an end user can use the program.

Learning aim B: Design a software solution to meet identified requirements

B1 Software development life cycle

Application of the software development life cycle stages, including:

- assessment of the requirements for a given problem
- design specification, e.g. scope, inputs/outputs, user interface, timescales
- develop code
- implementation
- test, e.g. white box and black box testing, refinement, optimisation
- maintenance, e.g. corrective, adaptive and increased functionality.

B2 Software solutions design

- Problem definition statements, to include: intended users, full summary of the problem to be solved, constraints, benefits, nature of interactivity, complexity of problem.
- Purpose and any other requirements as defined in a client brief.
- Features of software:
  - description of main program tasks, input and output formats
  - diagrammatic illustrations, to include screen layouts, user interfaces, navigation
  - algorithms, processing stages to include flowcharts, pseudocode and events
  - data structures
  - data storage
  - control structures
  - data validation
  - error handling and reporting.
- Choice of language.
- List of predefined programs and/or code snippets.
- List of ready-made and/or original assets such as a digital animation, digital graphic, digital audio and video.
- Feedback from others to help refine alternative design ideas/prototypes and make decisions.
- Test plan with test data to include typical, extreme and erroneous data.
- Technical and design constraints, e.g. connectivity, memory storage, programming languages.

Learning aim C: Develop a software solution to meet identified requirements

C1 Software solutions development

The process of software development, including:

- the development environment to produce code
- the development and refinement of software programs using a suitable programming language
- library routines, standard code and user-generated subroutines used to add to the efficiency of a program.

C2 Testing software solutions

- Testing of the programs, including:
- test plan
- test data - typical, extreme and erroneous data
- selection and use of appropriate types of testing to test part or all of a program, e.g. functional testing, stability, compatibility.

C3 Improvement, refinement and optimisation of software applications

Methods of improving, refining and optimising:

- annotated code to allow effective repair/debugging of the program and maintainability
- program compilation for a designated platform or environment
- review – quality of a program in terms of reliability, usability, efficiency/performance, maintainability, portability
- eliciting feedback from users
- making use of the outcomes of testing and feedback
- documenting changes to the design and solution.

C4 Review of software solutions

Evaluation of software solutions, including:

- suitability for audience and purpose
- ease of use
- quality of the software solution, e.g. reliability, usability, efficiency/performance, maintainability, portability
- constraints of the programming language
- general constraints, e.g. time, programmer knowledge, rules of languages vary with implementation
- strengths and weaknesses of the software solutions
- improvements that can be made
- optimising software solutions, e.g. improving robustness, improving efficiency of the code, adding additional functionality.

C5 Skills, knowledge and behaviours

- Planning and recording, including the setting of relevant targets with timescales, how and when feedback from others will be gathered.
- Reviewing and responding to outcomes, including the use of feedback from others, e.g. IT professionals and users who can provide feedback on the program and its suitability when assessed against the original requirements.
- Demonstrating own behaviours and their impact on outcomes, including professionalism, etiquette, supportive of others, timely and appropriate leadership, accountability and individual responsibility.
- Evaluating outcomes to help inform high-quality justified recommendations and decisions.
- Evaluating targets to obtain insights into own performance.

- Media and communication skills, including:
  - the ability to convey intended meaning, e.g. written (email, design documentation, recording documentation, reports, visual aids for presentation use, etc.), verbal communication requirements (one-to-one and group, informal and formal situations)
  - use of tone and language for verbal and written communications to convey intended meaning and make a positive and constructive impact on audience, e.g. positive and engaging tone, technical/vocational language suitable for intended audience, avoidance of jargon
  - responding constructively to the contributions of others, e.g. supportive, managing contributions so all have the opportunity to contribute, responding to objections, managing expectations, resolving conflict.

Assessment criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">Learning aim A: Examine the principles of computer programming</td><td rowspan="3">A.D1 Evaluate how software design and programming can impact on the quality of the application produced.</td></tr>
<tr><td>A.P1 Explain how principles of computer programming are applied in different languages to produce software applications.
A.P2 Explain how the principles of software design are used to produce applications to meet the needs of users.</td><td>A.M1 Analyse how software design and programming can impact on the quality of the application produced.</td></tr>
<tr><td colspan="2">Learning aim B: Design a software solution to meet identified requirements</td></tr>
<tr><td>B.P3 Produce a design for a computer program meeting client requirements.
B.P4 Review the design with others to identify and inform improvements to the proposed solution.</td><td>B.M2 Justify design decisions, showing how the design will result in an effective solution.</td><td rowspan="3">BC.D2 Evaluate the final design and optimised software application against client requirements.
BC.D3 Demonstrate individual responsibility, creativity and effective self-management in the design, development and review of the software solution.</td></tr>
<tr><td colspan="2">Learning aim C: Develop a software solution to meet identified requirements</td></tr>
<tr><td>C.P5 Produce a computer program to meet client requirements.
C.P6 Review the extent to which the final computer program meets client requirements.</td><td>C.M3 Optimise a computer program to meet client requirements.</td></tr>
</table>

Essential information for assignments

The recommended structure of assessment is shown in the unit summary along with suitable forms of evidence. *Section 6* gives information on setting assignments and there is further information on our website.

There is a maximum number of two summative assignments for this unit. The relationship of the learning aims and criteria is:

Learning aim: A (A.P1, A.P2, A.M1, A.D1)

Learning aims: B and C (B.P3, B.P4, C.P5, C.P6, B.M2, C.M3, BC.D2, BC.D3)

Further information for teachers and assessors

Resource requirements

For this unit, learners should have access to:

- a range of programming languages
- integrated development environment (IDE) and diagramming tools that will allow them to use a range of tools and techniques (given in the unit content) to design and develop computer programs

Learners will need access to examples of programs and code bases written in a range of languages for a number of different purposes. (While accessing the code base of many proprietary applications is restricted, there are often many open-source alternatives that can be used.)

Essential information for assessment decisions

Learning aim A

Evidence for this assignment will be in the form of a written response which investigates the principles and purpose of different programming languages. The report will make use of specific examples of code implementation (and the chosen paradigm) to explore how the example code has been implemented to meet specific needs.

The code base used by learners in their investigation must be of sufficient complexity to allow analysis of the implementation of a range of programming constructs, including standard and language-specific techniques, logical structures and mathematical principles.

For distinction standard, learners will provide a clear and balanced evaluation of the use of different programming languages (in identified programs) to solve different, specific problems. Learners will provide a detailed analysis of the programming principles used in the identified programmes. They will evaluate the success of their implementation in terms of the quality of code produced, and in a wider context where applicable. Quality should be considered in terms of the degree to which user requirements are met, the robustness of the code, its maintainability, efficiency, portability and ease of use.

Learners will provide an evaluation of the identified programming languages. They will consider the principles they have analysed and explain why specific programming languages are used and what advantages they may offer to the programmer and the end user.

Learners must articulate their arguments and views fluently and concisely, providing an evaluation which makes reasoned and valid judgements. The evidence will demonstrate high-quality written/oral communication through the use of accurate and fluent technical vocabulary to support a well-structured and considered response that clearly connects chains of reasoning.

For merit standard, learners will show a clear understanding of how different programming languages are implemented to solve problems. They will provide a balanced and reasoned analysis of the strengths and weaknesses of the identified code in solving the problems and the quality of the implementations. They will analyse the strengths and weaknesses of the identified languages and how they affect the requirements of the user and the development of a program to meet defined needs. The evidence will be technically accurate and demonstrate good quality written or oral communication.

For pass standard, learners will explain the range of programming languages available, as given in the unit content. Learners will explain how each differs in terms of constructs, techniques, use and requirements. Learners must choose one example program that has been created to solve a particular problem/meet a specific need, and provide descriptions of how programming constructs and the principles of software design have been applied to develop a solution to meets the required needs of users. Learners must explain how various different software design methods can be used to produce effective applications. This can be achieved by using supporting examples. The evidence may have some inaccuracies and may include limited use of examples to illustrate the explanations.

Learning aims B and C

Learners must develop a program to solve a specific problem. The problem must be of significant complexity to allow learners to demonstrate the ability to apply a range of appropriate problem-solving and programming skills.

For distinction standard, learners will draw on, and show synthesis of, knowledge across the learning aims to produce a detailed evaluation of the planning, development and refinement of the solutions in line with the client requirements. Learners must explain the methodologies applied throughout the process and justify their use in ensuring the requirements of the client are met.

Learners must provide a thorough evaluation of the effectiveness of the final program, including a systematic evaluation of the techniques, principles and constructs applied in their program. Learners will provide well-considered, justifiable suggestions for future improvements to the program.

Evaluation of behaviours will consider learners' use of 'soft skills' in relation to the vocational context of the project, such as managing and liaising with other members of the team or clients and time management. Learners will evaluate their own behaviours throughout the project and the impact they have on the outcomes. Learners must refer to tangible evidence to support their evaluation such as meeting notes, correspondence and time plans.

Learners will take individual responsibility for their own work, such as identifying potential issues and resolving these, reviewing their work and making improvements, keeping their work safe and secure and showing responsible use of quoted materials. Creativity will be shown, for example through taking innovative approaches to problem-solving and through the originality of their solution.

For merit standard, learners will apply their knowledge through the selection and application of appropriate methodologies to plan, develop and test an effective, optimised computer program. Learners will use feedback from others to identify how their design could be improved and produce a final solution design.

Learners must provide a clear, accurate and well-reasoned justification for the decisions made throughout the development of the program, linking decisions to their effectiveness in meeting user requirements. By doing this, learners will optimise the effectiveness and efficiency of their solution towards the user requirements. They will take into account feedback from others and explain how they decided to accept or reject recommendations.

Learners must optimise their computer program by making use of testing and feedback throughout development to improve and refine their code to fully meet client requirements, for example improving data validation procedures, the efficiency of the code or the usability of the program.

For pass standard, learners will apply their understanding of the software development life cycle to design and develop a computer program to meet identified requirements. Learners must apply an understanding of the client requirements and provide planning documentation that demonstrate the possible solutions to the identified problems. Learners must seek feedback on their design and use this feedback to improve the quality of their design solution for the problem.

Learners must produce evidence that the finished program has been tested using a number of different appropriate testing methods to ensure they are functional. Learners must produce solutions that meet the requirements of the client; however some small issues may persist.

Learners will provide a review of whether their work meets the client requirements, considering both positive and negative aspects of the outcomes, although their review may be unbalanced and/or superficial. Learners will use relevant feedback such as client feedback to make suggestions regarding possible alternative solutions that could be implemented.

Links to other units

This assessment for this unit should draw on knowledge, understanding and skills developed from:

- Unit 1: Principles of Computer Science
- Unit 3: Planning and Management of Computing Projects
- Unit 5: Building Computer Systems
- Unit 6: IT Systems Security
- Unit 10: Human-computer Interaction
- Unit 18: Relational Database Development
- Unit 22: Systems Analysis and Design
- Unit 31: Large-scale Data Systems
- Unit 32: Business Process Modelling Tools.

Employer involvement

This unit would benefit from employer involvement in the form of:

- guest speakers
- technical workshops involving staff from local organisations/businesses
- contribution of design/ideas to unit assignment/scenario/case study/project materials, including own organisation/business materials as exemplars where appropriate
- feedback from staff from local organisations/businesses on plans/designs/items developed
- opportunities for observation of organisational/business application during work experience
- support from local organisation/business staff as mentors.

4 Planning your programme

How do I choose the right BTEC National qualification for my learners?

BTEC Nationals come in a range of sizes, each with a specific purpose. You will need to assess learners very carefully to ensure that they start on the right size of qualification to fit into their 16–19 study programme, and that they take the right pathways or optional units that allow them to progress to the next stage.

If a learner is clear that they want to progress to the workplace they should be directed towards an occupationally-specific qualification, such as a BTEC National Diploma, from the outset. Some learners may want to take a number of complementary qualifications or keep their progression options open. These learners may be suited to take a BTEC National Certificate or Extended Certificate. Learners who then decide to continue with a fuller vocational programme can transfer to a BTEC National Diploma or Extended Diploma, for example for their second year.

Some learners may want to take a number of complementary qualifications or keep their progression options open. These learners may be suited to taking a BTEC National Certificate or Extended Certificate. Learners who then decide to continue with a fuller vocational programme can transfer to a BTEC National Diploma or Extended Diploma, for example for their second year.

Some learners are sure of the sector they want to work in and are aiming for progression into that sector via higher education. These learners should be directed to the two-year BTEC National Extended Diploma as the most suitable qualification.

As a centre, you may want to teach learners who are taking different qualifications together. You may also wish to transfer learners between programmes to meet changes in their progression needs. You should check the qualification structures and unit combinations carefully as there is no exact match among the different sizes. You may find that learners need to complete more than the minimum number of units when transferring.

When learners are recruited, you need to give them accurate information on the title and focus of the qualification for which they are studying.

Is there a learner entry requirement?

As a centre it is your responsibility to ensure that learners who are recruited have a reasonable expectation of success on the programme. There are no formal entry requirements but we expect learners to have qualifications at or equivalent to Level 2.

Learners are most likely to succeed if they have:

- five GCSEs at good grades and/or
- BTEC qualification(s) at Level 2
- achievement in English and mathematics through GCSE or Functional Skills.

Learners may demonstrate ability to succeed in various ways. For example, learners may have relevant work experience or specific aptitude shown through diagnostic tests or non-educational experience.

What is involved in becoming an approved centre?

All centres must be approved before they can offer these qualifications – so that they are ready to assess learners and so that we can provide the support that is needed. Further information is given in *Section 8*.

What level of sector knowledge is needed to teach these qualifications?

We do not set any requirements for teachers but recommend that centres assess the overall skills and knowledge of the teaching team to ensure that they are relevant and up to date. This will give learners a rich programme to prepare them for employment in the sector.

What resources are required to deliver these qualifications?

As part of your centre approval you will need to show that the necessary material resources and work spaces are available to deliver BTEC Nationals. For some units, specific resources are required. This is indicated in the units.

How can myBTEC help with planning for these qualifications?

myBTEC is an online toolkit that supports the delivery, assessment and quality assurance of BTECs in centres. It supports teachers with activities, such as choosing a valid combination of units, creating assignment briefs and creating assessment plans. For further information see *Section 10*.

Which modes of delivery can be used for these qualifications?

You are free to deliver BTEC Nationals using any form of delivery that meets the needs of your learners. We recommend making use of a wide variety of modes, including direct instruction in classrooms or work environments, investigative and practical work, group and peer work, private study and e-learning.

What are the recommendations for employer involvement?

BTEC Nationals are vocational qualifications and, as an approved centre, you are encouraged to work with employers on the design, delivery and assessment of the course to ensure that learners have a programme of study that is engaging and relevant and that equips them for progression. There are suggestions in many of the units about how employers could become involved in delivery and/or assessment but these are not intended to be exhaustive and there will be other possibilities at local level.

What support is available?

We provide a wealth of support materials, including curriculum plans, delivery guides, authorised assignment briefs, additional papers for external assessments and examples of marked learner work.

You will be allocated a Standards Verifier early on in the planning stage to support you with planning your assessments. There will be extensive training programmes as well as support from our Subject Advisor team.

For further details see *Section 10*.

How will my learners become more employable through these qualifications?

All BTEC Nationals are mapped to relevant occupational standards (see *Appendix 1*).

Employability skills, such as team working and entrepreneurialism, and practical hands-on skills have been built into the design of the learning aims and content. This gives you the opportunity to use relevant contexts, scenarios and materials to enable learners to develop a portfolio of evidence that demonstrates the breadth of their skills and knowledge in a way that equips them for employment.

5 Assessment structure and external assessment

Introduction

BTEC Nationals are assessed using a combination of *internal assessments*, which are set and marked by teachers, and *external assessments* which are set and marked by Pearson:

- mandatory units have a combination of internal and external assessments
- all optional units are internally assessed.

We have taken great care to ensure that the assessment method chosen is appropriate to the content of the unit and in line with requirements from employers and higher education.

In developing an overall plan for delivery and assessment for the programme, you will need to consider the order in which you deliver units, whether delivery is over short or long periods and when assessment can take place. Some units are defined as synoptic units (see *Section 2*). Normally, a synoptic assessment is one that a learner would take later in a programme and in which they will be expected to apply learning from a range of units. Synoptic units may be internally or externally assessed. Where a unit is externally assessed you should refer to the sample assessment materials (SAMs) to identify where there is an expectation that learners draw on their wider learning. For internally-assessed units, you must plan the assignments so that learners can demonstrate learning from across their programme. A unit may be synoptic in one qualification and not another because of the relationship it has to the rest of the qualification.

We have addressed the need to ensure that the time allocated to final assessment of internal and external units is reasonable so that there is sufficient time for teaching and learning, formative assessment and development of transferable skills.

In administering internal and external assessment, the centre needs to be aware of the specific procedures and policies that apply, for example to registration, entries and results. An overview with signposting to relevant documents is given in *Section 7*.

Internal assessment

Our approach to internal assessment for these qualifications will be broadly familiar to experienced centres. It offers flexibility in how and when you assess learners, provided that you meet assessment and quality assurance requirements. You will need to take account of the requirements of the unit format, which we explain in *Section 3*, and the requirements for delivering assessment given in *Section 6*.

External assessment

A summary of the external assessment for this qualification is given in *Section 2*. You should check this information carefully, together with the unit specification and the sample assessment materials, so that you can timetable learning and assessment periods appropriately.

Learners must be prepared for external assessment by the time they undertake it. In preparing learners for assessment you will want to take account of required learning time, the relationship with other external assessments and opportunities for retaking. You should ensure that learners are not entered for unreasonable amounts of external assessment in one session. Learners may resit an external assessment to obtain a higher grade of near pass or above. If a learner has more than one attempt, then the best result will be used for qualification grading, up to the permitted maximum. It is unlikely that learners will need to or benefit from taking all assessments twice so you are advised to plan appropriately. Some assessments are synoptic and learners are likely to perform best if these assessments are taken towards the end of the programme.

Key features of external assessment in computing

In computing, after consultation with stakeholders, we have developed the following.

- *Unit 1: Principles of Computer Science* is a scenario-based assessment. Learners will be asked to respond to a range of short and extended questions in four set tasks to show the application of their computational thinking skills to solve computing problems. This unit includes the logical and structured ways that computer systems process data to develop programs, processes and systems that solve specific problems. It examines the features of effective computer programming, the application of accepted computing and programming paradigms, the analysis, development and evaluation of algorithms and computer code and the proposal and application of solutions to ensure that computer systems are fit for purpose.
- *Unit 2: Fundamentals of Computer Systems* is a scenario-based assessment. Learners will be asked to respond to a range of short and extended questions in four set tasks to show their knowledge and understanding of the relationship between hardware and software as part of a computer system. This unit includes the way in which computer components work both individually and together to store and process data, and the way in which data is transmitted and used in computer systems. It also examines the impact that computing systems have on organisations and individuals.
- *Unit 3: Planning and Management of Computing Projects* is a scenario-based assessment. Learners will show the application of their knowledge, skills of project planning and management of a given computing project. The assessment takes place in two windows. In the first window, learners carry out project planning related activities. In the second window, learners respond to given project circumstances to produce a project checkpoint report and other documentation requirements to the completion and closure of the project. Learners are required to respond to stimuli materials to complete project planning and management templates and use project software to produce other essential project related documents. The unit includes the analysis of project information, task scheduling, budgeting, risk management, time management, quality management, and communication with all stakeholders throughout the life cycle of the project.
- *Unit 4: Software Development and Design Project* is a scenario-based assessment. Learners will apply their knowledge and understanding of software design and development. This unit includes the use of standard conventions and ways of working to create solutions to problems. This unit includes the analysis of a given scenario to develop effective design solutions, the production of a piece of software and the testing requirements for each stage of the development process. Finally, it includes evaluating the effectiveness of the software solution.
  In this synoptic unit, learners will be drawing together learning from previous units in the qualification. The unit consolidates software related understanding and skills to produce software that meets client requirements.

Units

The externally-assessed units have a specific format which we explain in *Section 3*. The content of units will be sampled across external assessments over time through appropriate papers and tasks. The ways in which learners are assessed are shown through the assessment outcomes and grading descriptors. External assessments are marked and awarded using the grade descriptors. The grades available are Distinction (D), Merit (M), Pass (P) and Near Pass (N). The Near Pass (N) grade gives learners credit below a Pass, where they have demonstrated evidence of positive performance which is worth more than an unclassified result but not yet at the Pass standard.

Sample assessment materials

Each externally-assessed unit has a set of sample assessment materials (SAMs) that accompanies this specification. The SAMs are there to give you an example of what the external assessment will look like in terms of the feel and level of demand of the assessment. In the case of units containing synoptic assessment, the SAMs will also show where learners are expected to select and apply from across the programme.

The SAMs show the range of possible question types that may appear in the actual assessments and give you a good indication of how the assessments will be structured. While SAMs can be used for practice with learners, as with any assessment the content covered and specific details of the questions asked will change in each assessment.

A copy of each of these assessments can be downloaded from our website. An additional sample of each of the Pearson-set units will be available before the first sitting of the assessment to allow your learners further opportunities for practice.

6 Internal assessment

This section gives an overview of the key features of internal assessment and how you, as an approved centre, can offer it effectively. The full requirements and operational information are given in the *Pearson Quality Assurance Handbook*. All members of the assessment team need to refer to this document.

For BTEC Nationals it is important that you can meet the expectations of stakeholders and the needs of learners by providing a programme that is practical and applied. Centres can tailor programmes to meet local needs and use links with local employers and the wider vocational sector.

When internal assessment is operated effectively it is challenging, engaging, practical and up to date. It must also be fair to all learners and meet national standards.

Principles of internal assessment

Assessment through assignments

For internally-assessed units, the format of assessment is an assignment taken after the content of the unit, or part of the unit if several assignments are used, has been delivered. An assignment may take a variety of forms, including practical and written types. An assignment is a distinct activity completed independently by learners that is separate from teaching, practice, exploration and other activities that learners complete with direction from, and formative assessment by, teachers.

An assignment is issued to learners as an assignment brief with a defined start date, a completion date and clear requirements for the evidence that they need to provide. There may be specific observed practical components during the assignment period. Assignments can be divided into tasks and may require several forms of evidence. A valid assignment will enable a clear and formal assessment outcome based on the assessment criteria.

Assessment decisions through applying unit-based criteria

Assessment decisions for BTEC Nationals are based on the specific criteria given in each unit and set at each grade level. To ensure that standards are consistent in the qualification and across the suite as a whole, the criteria for each unit have been defined according to a framework. The way in which individual units are written provides a balance of assessment of understanding, practical skills and vocational attributes appropriate to the purpose of qualifications.

The assessment criteria for a unit are hierarchical and holistic. For example, if an M criterion requires the learner to show 'analysis' and the related P criterion requires the learner to 'explain', then to satisfy the M criterion a learner will need to cover both 'explain' and 'analyse'. The unit assessment grid shows the relationships among the criteria so that assessors can apply all the criteria to the learner's evidence at the same time. In *Appendix 2* we have set out a definition of terms that assessors need to understand.

Assessors must show how they have reached their decisions using the criteria in the assessment records. When a learner has completed all the assessment for a unit then the assessment team will give a grade for the unit. This is given simply according to the highest level for which the learner is judged to have met all the criteria. Therefore:

- to achieve a Distinction, a learner must have satisfied all the Distinction criteria (and therefore the Pass and Merit criteria); these define outstanding performance across the unit as a whole
- to achieve a Merit, a learner must have satisfied all the Merit criteria (and therefore the Pass criteria) through high performance in each learning aim
- to achieve a Pass, a learner must have satisfied all the Pass criteria for the learning aims, showing coverage of the unit content and therefore attainment at Level 3 of the national framework.

The award of a Pass is a defined level of performance and cannot be given solely on the basis of a learner completing assignments. Learners who do not satisfy the Pass criteria should be reported as Unclassified.

The assessment team

It is important that there is an effective team for internal assessment. There are three key roles involved in implementing assessment processes in your centre, each with different interrelated responsibilities, the roles are listed below. Full information is given in the *Pearson Quality Assurance Handbook*.

- The Lead Internal Verifier (the Lead IV) has overall responsibility for the programme, its assessment and internal verification to meet our requirements, record keeping and liaison with the Standards Verifier. The Lead IV registers with Pearson annually. The Lead IV acts as an assessor, supports the rest of the assessment team, makes sure that they have the information they need about our assessment requirements and organises training, making use of our guidance and support materials.
- Internal Verifiers (IVs) oversee all assessment activity in consultation with the Lead IV. They check that assignments and assessment decisions are valid and that they meet our requirements. IVs will be standardised by working with the Lead IV. Normally, IVs are also assessors but they do not verify their own assessments.
- Assessors set or use assignments to assess learners to national standards. Before taking any assessment decisions, assessors participate in standardisation activities led by the Lead IV. They work with the Lead IV and IVs to ensure that the assessment is planned and carried out in line with our requirements.

Effective organisation

Internal assessment needs to be well organised so that the progress of learners can be tracked and so that we can monitor that assessment is being carried out in line with national standards. We support you through, for example, providing training materials and sample documentation. Our online myBTEC service can help support you in planning and record keeping. Further information on using myBTEC can be found in *Section 10* and on our website.

It is particularly important that you manage the overall assignment programme and deadlines to make sure that learners are able to complete assignments on time.

Learner preparation

To ensure that you provide effective assessment for your learners, you need to make sure that they understand their responsibilities for assessment and the centre's arrangements.

From induction onwards, you will want to ensure that learners are motivated to work consistently and independently to achieve the requirements of the qualifications. Learners need to understand how assignments are used, the importance of meeting assignment deadlines, and that all the work submitted for assessment must be their own.

You will need to give learners a guide that explains how assignments are used for assessment, how assignments relate to the teaching programme, and how learners should use and reference source materials, including what would constitute plagiarism. The guide should also set out your approach to operating assessment, such as how learners must submit work and request extensions.

Setting effective assignments

Setting the number and structure of assignments

In setting your assignments, you need to work with the structure of assignments shown in the *Essential information for assignments* section of a unit. This shows the structure of the learning aims and criteria that you must follow and the recommended number of assignments that you should use. For some units we provide authorised assignment briefs, for all the units we give you suggestions on how to create suitable assignments. You can find these materials along with this specification on our website. In designing your own assignment briefs you should bear in mind the following points.

- The number of assignments for a unit must not exceed the number shown in *Essential information for assignments*. However, you may choose to combine assignments, for example to create a single assignment for the whole unit.
- You may also choose to combine all or parts of different units into single assignments, provided that all units and all their associated learning aims are fully addressed in the programme overall. If you choose to take this approach, you need to make sure that learners are fully prepared so that they can provide all the required evidence for assessment and that you are able to track achievement in the records.
- A learning aim must always be assessed as a whole and must not be split into two or more tasks.
- The assignment must be targeted to the learning aims but the learning aims and their associated criteria are not tasks in themselves. Criteria are expressed in terms of the outcome shown in the evidence.
- You do not have to follow the order of the learning aims of a unit in setting assignments but later learning aims often require learners to apply the content of earlier learning aims and they may require learners to draw their learning together.
- Assignments must be structured to allow learners to demonstrate the full range of achievement at all grade levels. Learners need to be treated fairly by being given the opportunity to achieve a higher grade if they have the ability.
- As assignments provide a final assessment, they will draw on the specified range of teaching content for the learning aims. The specified content is compulsory. The evidence for assessment need not cover every aspect of the teaching content as learners will normally be given particular examples, case studies or contexts in their assignments. For example, if a learner is carrying out one practical performance, or an investigation of one organisation, then they will address all the relevant range of content that applies in that instance.

Providing an assignment brief

A good assignment brief is one that, through providing challenging and realistic tasks, motivates learners to provide appropriate evidence of what they have learned.

An assignment brief should have:

- a vocational scenario, this could be a simple situation or a full, detailed set of vocational requirements that motivates the learner to apply their learning through the assignment
- clear instructions to the learner about what they are required to do, normally set out through a series of tasks
- an audience or purpose for which the evidence is being provided
- an explanation of how the assignment relates to the unit(s) being assessed.

Forms of evidence

BTEC Nationals have always allowed for a variety of forms of evidence to be used, provided that they are suited to the type of learning aim being assessed. For many units, the practical demonstration of skills is necessary and for others, learners will need to carry out their own research and analysis. The units give you information on what would be suitable forms of evidence to provide learners with the opportunity to apply a range of employability or transferable skills. Centres may choose to use different suitable forms for evidence to those proposed. Overall, learners should be assessed using varied forms of evidence.

Full definitions of types of assessment are given in *Appendix 2*. These are some of the main types of assessment:

- written reports
- projects
- time-constrained practical assessments with observation records and supporting evidence
- recordings of performance
- sketchbooks, working logbooks, reflective journals
- presentations with assessor questioning.

The form(s) of evidence selected must:

- allow the learner to provide all the evidence required for the learning aim(s) and the associated assessment criteria at all grade levels
- allow the learner to produce evidence that is their own independent work
- allow a verifier to independently reassess the learner to check the assessor's decisions.

For example, when you are using performance evidence, you need to think about how supporting evidence can be captured through recordings, photographs or task sheets.

Centres need to take particular care that learners are enabled to produce independent work. For example, if learners are asked to use real examples, then best practice would be to encourage them to use their own or to give the group a number of examples that can be used in varied combinations.

Making valid assessment decisions

Authenticity of learner work

Once an assessment has begun, learners must not be given feedback on progress towards fulfilling the targeted criteria.

An assessor must assess only learner work that is authentic, i.e. learners' own independent work. Learners must authenticate the evidence that they provide for assessment through signing a declaration stating that it is their own work.

Assessors must ensure that evidence is authentic to a learner through setting valid assignments and supervising them during the assessment period. Assessors must take care not to provide direct input, instructions or specific feedback that may compromise authenticity.

Assessors must complete a declaration that:

- the evidence submitted for this assignment is the learner's own
- the learner has clearly referenced any sources used in the work
- they understand that false declaration is a form of malpractice.

Centres can use Pearson templates or their own templates to document authentication.

During assessment, an assessor may suspect that some or all of the evidence from a learner is not authentic. The assessor must then take appropriate action using the centre's policies for malpractice. Further information is given in *Section 7*.

Making assessment decisions using criteria

Assessors make judgements using the criteria. The evidence from a learner can be judged using all the relevant criteria at the same time. The assessor needs to make a judgement against each criterion that evidence is present and sufficiently comprehensive. For example, the inclusion of a concluding section may be insufficient to satisfy a criterion requiring 'evaluation'.

Assessors should use the following information and support in reaching assessment decisions:

- the *Essential information for assessment decisions* section in each unit gives examples and definitions related to terms used in the criteria
- the explanation of key terms in *Appendix 2*
- examples of assessed work provided by Pearson
- your Lead IV and assessment team's collective experience, supported by the standardisation materials we provide.

Pass and Merit criteria relate to individual learning aims. The Distinction criteria as a whole relate to outstanding performance across the unit. Therefore, criteria may relate to more than one learning aim (for example A.D1) or to several learning aims (for example DE.D3). Distinction criteria make sure that learners have shown that they can perform consistently at an outstanding level across the unit and/or that they are able to draw learning together across learning aims.

Dealing with late completion of assignments

Learners must have a clear understanding of the centre policy on completing assignments by the deadlines that you give them. Learners may be given authorised extensions for legitimate reasons, such as illness at the time of submission, in line with your centre policies.

For assessment to be fair, it is important that learners are all assessed in the same way and that some learners are not advantaged by having additional time or the opportunity to learn from others. Therefore, learners who do not complete assignments by your planned deadline or the authorised extension deadline may not have the opportunity to subsequently resubmit.

If you accept a late completion by a learner, then the assignment should be assessed normally when it is submitted using the relevant assessment criteria.

Issuing assessment decisions and feedback

Once the assessment team has completed the assessment process for an assignment, the outcome is a formal assessment decision. This is recorded formally and reported to learners.

The information given to the learner:

- must show the formal decision and how it has been reached, indicating how or where criteria have been met
- may show why attainment against criteria has not been demonstrated
- must not provide feedback on how to improve evidence
- must be validated by an IV before it is given to the learner.

Resubmission of improved evidence

An assignment provides the final assessment for the relevant learning aims and is normally a final assessment decision, except where the Lead IV approves one opportunity to resubmit improved evidence based on the completed assignment brief.

The Lead IV has the responsibility to make sure that resubmission is operated fairly. This means:

- checking that a learner can be reasonably expected to perform better through a second submission, for example that the learner has not performed as expected
- making sure that giving a further opportunity can be done in such a way that it does not give an unfair advantage over other learners, for example through the opportunity to take account of feedback given to other learners
- checking that the assessor considers that the learner will be able to provide improved evidence without further guidance and that the original evidence submitted remains valid.

Once an assessment decision has been given to the learner, the resubmission opportunity must have a deadline within 15 working days in the same academic year.

A resubmission opportunity must not be provided where learners:

- have not completed the assignment by the deadline without the centre's agreement
- have submitted work that is not authentic.

Retake of internal assessment

A learner who has not achieved the level of performance required to pass the relevant learning aims after resubmission of an assignment may be offered a single retake opportunity using a new assignment. The retake may only be achieved at a pass.

The Lead Internal Verifier must only authorise a retake of an assignment in exceptional circumstances where they believe it is necessary, appropriate and fair to do so. For further information on offering a retake opportunity, you should refer to the *BTEC Centre Guide to Assessment*. We provide information on writing assignments for retakes on our website (www.btec.co.uk/keydocuments).

Planning and record keeping

For internal processes to be effective, an assessment team needs to be well organised and keep effective records. The centre will also work closely with us so that we can quality assure that national standards are being satisfied. This process gives stakeholders confidence in the assessment approach.

The Lead IV must have an assessment plan, produced as a spreadsheet or using myBTEC. When producing a plan, the assessment team may wish to consider:

- the time required for training and standardisation of the assessment team
- the time available to undertake teaching and carry out assessment, taking account of when learners may complete external assessments and when quality assurance will take place
- the completion dates for different assignments
- who is acting as IV for each assignment and the date by which the assignment needs to be verified
- setting an approach to sampling assessor decisions though internal verification that covers all assignments, assessors and a range of learners
- how to manage the assessment and verification of learners' work so that they can be given formal decisions promptly
- how resubmission opportunities can be scheduled.

The Lead IV will also maintain records of assessment undertaken. The key records are:

- verification of assignment briefs
- learner authentication declarations
- assessor decisions on assignments, with feedback given to learners
- verification of assessment decisions.

Examples of records and further information are given in the *Pearson Quality Assurance Handbook.*

7 Administrative arrangements

Introduction

This section focuses on the administrative requirements for delivering a BTEC qualification. It will be of value to Quality Nominees, Lead IVs, Programme Leaders and Examinations Officers.

Learner registration and entry

Shortly after learners start the programme of learning, you need to make sure that they are registered for the qualification and that appropriate arrangements are made for internal and external assessment. You need to refer to the *Information Manual* for information on making registrations for the qualification and entries for external assessments.

Learners can be formally assessed only for a qualification on which they are registered. If learners' intended qualifications change, for example if a learner decides to choose a different pathway specialism, then the centre must transfer the learner appropriately.

Access to assessment

Both internal and external assessments need to be administered carefully to ensure that all learners are treated fairly, and that results and certification are issued on time to allow learners to progress to chosen progression opportunities.

Our equality policy requires that all learners should have equal opportunity to access our qualifications and assessments, and that our qualifications are awarded in a way that is fair to every learner. We are committed to making sure that:

- learners with a protected characteristic are not, when they are undertaking one of our qualifications, disadvantaged in comparison to learners who do not share that characteristic
- all learners achieve the recognition they deserve for undertaking a qualification and that this achievement can be compared fairly to the achievement of their peers.

Further information on access arrangements can be found in the Joint Council for Qualifications (JCQ) document *Access Arrangements, Reasonable Adjustments and Special Consideration for General and Vocational Qualifications*.

Administrative arrangements for internal assessment

Records

You are required to retain records of assessment for each learner. Records should include assessments taken, decisions reached and any adjustments or appeals. Further information can be found in the *Information Manual.* We may ask to audit your records so they must be retained as specified.

Reasonable adjustments to assessment

A reasonable adjustment is one that is made before a learner takes an assessment to ensure that they have fair access to demonstrate the requirements of the assessments. You are able to make adjustments to internal assessments to take account of the needs of individual learners. In most cases this can be achieved through a defined time extension or by adjusting the format of evidence. We can advise you if you are uncertain as to whether an adjustment is fair and reasonable. You need to plan for time to make adjustments if necessary.

Further details on how to make adjustments for learners with protected characteristics are given on our website in the document *Supplementary guidance for reasonable adjustment and special consideration in vocational internally-assessed units.*

Special consideration

Special consideration is given after an assessment has taken place for learners who have been affected by adverse circumstances, such as illness. You must operate special consideration in line with our policy (see previous paragraph). You can provide special consideration related to the period of time given for evidence to be provided or for the format of the assessment if it is equally valid. You may not substitute alternative forms of evidence to that required in a unit, or omit the application of any assessment criteria to judge attainment. Pearson can consider applications for special consideration in line with the policy.

Appeals against assessment

Your centre must have a policy for dealing with appeals from learners. These appeals may relate to assessment decisions being incorrect or assessment not being conducted fairly. The first step in such a policy could be a consideration of the evidence by a Lead IV or other member of the programme team. The assessment plan should allow time for potential appeals after assessment decisions have been given to learners. If there is an appeal by a learner, you must document the appeal and its resolution. Learners have a final right of appeal to Pearson but only if the procedures that you have put in place have not been followed. Further details are given in the document *Enquiries and appeals about Pearson vocational qualifications and end point assessment policy*.

Administrative arrangements for external assessment

Entries and resits

For information on the timing of assessment and entries, please refer to the annual examinations timetable on our website.

Access arrangements requests

Access arrangements are agreed with Pearson before an assessment. They allow students with special educational needs, disabilities or temporary injuries to:

- access the assessment
- show what they know and can do without changing the demands of the assessment.

Access arrangements should always be processed at the time of registration. Learners will then know what type of arrangements are available in place for them.

Granting reasonable adjustments

For external assessment, a reasonable adjustment is one that we agree to make for an individual learner. A reasonable adjustment is defined for the individual learner and informed by the list of available access arrangements.

Whether an adjustment will be considered reasonable will depend on a number of factors, to include:

- the needs of the learner with the disability
- the effectiveness of the adjustment
- the cost of the adjustment; and
- the likely impact of the adjustment on the learner with the disability and other learners.

Adjustment may be judged unreasonable and not approved if it involves unreasonable costs, timeframes or affects the integrity of the assessment.

Special consideration requests

Special consideration is an adjustment made to a student's mark or grade after an external assessment to reflect temporary injury, illness or other indisposition at the time of the assessment. An adjustment is made only if the impact on the learner is such that it is reasonably likely to have had a material effect on that learner being able to demonstrate attainment in the assessment.

Centres are required to notify us promptly of any learners who they believe have been adversely affected and request that we give special consideration. Further information can be found in the special requirements section on our website.

Conducting external assessments

Centres must make arrangements for the secure delivery of external assessments. External assessments for BTEC qualifications include examinations, set tasks and performance.

Each external assessment has a defined degree of control under which it must take place. Some external assessments may have more than one part and each part may have a different degree of control. We define degrees of control as follows.

High control

This is the completion of assessment in formal invigilated examination conditions.

Medium control

This is completion of assessment, usually over a longer period of time, which may include a period of controlled conditions. The controlled conditions may allow learners to access resources, prepared notes or the internet to help them complete the task.

Low control

These are activities completed without direct supervision. They may include research, preparation of materials and practice. The materials produced by learners under low control will not be directly assessed.

Further information on responsibilities for conducting external assessment is given in the document *Instructions for Conducting External Assessments*, available on our website.

Dealing with malpractice in assessment

Malpractice means acts that undermine the integrity and validity of assessment, the certification of qualifications, and/or that may damage the authority of those responsible for delivering the assessment and certification.

Pearson does not tolerate actions (or attempted actions) of malpractice by learners, centre staff or centres in connection with Pearson qualifications. Pearson may impose penalties and/or sanctions on learners, centre staff or centres where incidents (or attempted incidents) of malpractice have been proven.

Malpractice may arise or be suspected in relation to any unit or type of assessment within the qualification. For further details regarding malpractice and advice on preventing malpractice by learners, please see Pearson's *Centre guidance: Dealing with malpractice and maladministration in vocational qualifications*, available on our website.

The procedures we ask you to adopt vary between units that are internally-assessed and those that are externally assessed.

Internally-assessed units

Centres are required to take steps to prevent malpractice and to investigate instances of suspected malpractice. Learners must be given information that explains what malpractice is for internal assessment and how suspected incidents will be dealt with by the centre. The *Centre Guidance: Dealing with Malpractice* document gives full information on the actions we expect you to take.

Pearson may conduct investigations if we believe that a centre is failing to conduct internal assessment according to our policies. The above document gives further information, examples and details the penalties and sanctions that may be imposed.

In the interests of learners and centre staff, centres need to respond effectively and openly to all requests relating to an investigation into an incident of suspected malpractice.

Externally-assessed units

External assessment means all aspects of units that are designated as external in this specification, including preparation for tasks and performance. For these assessments centres must follow the JCQ procedures set out in the latest version of *JCQ Suspected Malpractice in Examinations and Assessments Policies and Procedures* (www.jcq.org.uk).

In the interests of learners and centre staff, centres need to respond effectively and openly to all requests relating to an investigation into an incident of suspected malpractice.

Learner malpractice

Heads of centres are required to report incidents of any suspected learner malpractice that occur during Pearson external assessments. We ask that centres do so by completing a *JCQ Form M1* and emailing it and any accompanying documents (signed statements from the learner, invigilator, copies of evidence, etc.) to the Investigations Team at pqsmalpractice@pearson.com.
The responsibility for determining appropriate sanctions or penalties to be imposed on learners lies with Pearson.

Learners must be informed at the earliest opportunity of the specific allegation and the centre's malpractice policy, including the right of appeal. Learners found guilty of malpractice may be disqualified from the qualification for which they have been entered with Pearson.

Teacher/centre malpractice

Heads of centres are required to inform Pearson's Investigations Team of any incident of suspected malpractice by centre staff, before any investigation is undertaken. Heads of centres are requested to inform the Investigations Team by submitting a *JCQ Form M2(a)* with supporting documentation to pqsmalpractice@pearson.com. Where Pearson receives allegations of malpractice from other sources (for example Pearson staff or anonymous informants), the Investigations Team will conduct the investigation directly or may ask the head of centre to assist.

Incidents of maladministration (accidental errors in the delivery of Pearson qualifications that may affect the assessment of learners) should also be reported to the Investigations Team using the same method.

Heads of centres/Principals/Chief Executive Officers or their nominees are required to inform learners and centre staff suspected of malpractice of their responsibilities and rights; see Section 6.15 of the *JCQ Suspected Malpractice in Examinations and Assessments Policies and Procedures* document.

Pearson reserves the right in cases of suspected malpractice to withhold the issuing of results and/or certificates while an investigation is in progress. Depending on the outcome of the investigation results and/or certificates may be released or withheld.

We reserve the right to withhold certification when undertaking investigations, audits and quality assurances processes. You will be notified within a reasonable period of time if this occurs.

Sanctions and appeals

Where malpractice is proven we may impose sanctions or penalties.

Where learner malpractice is evidenced, penalties may be imposed such as:

- mark reduction for external assessments
- disqualification from the qualification
- being barred from registration for Pearson qualifications for a period of time.

If we are concerned about your centre's quality procedures we may impose sanctions such as:

- working with you to create an improvement action plan
- requiring staff members to receive further training
- placing temporary blocks on your certificates
- placing temporary blocks on registration of learners
- debarring staff members or the centre from delivering Pearson qualifications
- suspending or withdrawing centre approval status.

The centre will be notified if any of these apply.

Pearson has established procedures for centres that are considering appeals against penalties and sanctions arising from malpractice. Appeals against a decision made by Pearson will normally be accepted only from Heads of Centres (on behalf of learners and/or members of staff) and from individual members (in respect of a decision taken against them personally). Further information on appeals can be found in our *Enquiries and appeals about Pearson vocational qualifications and end point assessment policy*, which is on our website. In the initial stage of any aspect of malpractice, please notify the Investigations Team by email via pqsmalpractice@pearson.com who will inform you of the next steps.

Certification and results

Once a learner has completed all the required components for a qualification, even if final results for external assessments have not been issued, then the centre can claim certification for the learner, provided that quality assurance has been successfully completed. For the relevant procedures please refer to our *Information Manual*. You can use the information provided on qualification grading to check overall qualification grades.

Results issue

After the external assessment session, learner results will be issued to centres. The result will be in the form of a grade. You should be prepared to discuss performance with learners, making use of the information we provide and post-results services.

Post-assessment services

Once results for external assessments are issued, you may find that the learner has failed to achieve the qualification or to attain an anticipated grade. It is possible to transfer or reopen registration in some circumstances. The *Information Manual* gives further information.

Changes to qualification requests

Where a learner who has taken a qualification wants to resit an externally-assessed unit to improve their qualification grade, you firstly need to decline their overall qualification grade. You may decline the grade before the certificate is issued. For a learner receiving their results in August, you should decline the grade by the end of September if the learner intends to resit an external assessment.

Additional documents to support centre administration

As an approved centre you must ensure that all staff delivering, assessing and administering the qualifications have access to this documentation. These documents are reviewed annually and are reissued if updates are required.

- *Pearson Quality Assurance Handbook*: this sets out how we will carry out quality assurance of standards and how you need to work with us to achieve successful outcomes.
- *Information Manual*: this gives procedures for registering learners for qualifications, transferring registrations, entering for external assessments and claiming certificates.
- *Lead Examiners' Reports*: these are produced after each series for each external assessment and give feedback on the overall performance of learners in response to tasks or questions set.
- *Instructions for the Conduct of External Assessments (ICEA)*: this explains our requirements for the effective administration of external assessments, such as invigilation and submission of materials.
- *Regulatory policies*: our regulatory policies are integral to our approach and explain how we meet internal and regulatory requirements. We review the regulated policies annually to ensure that they remain fit for purpose. Policies related to this qualification include:
  - adjustments for candidates with disabilities and learning difficulties, access arrangements and reasonable adjustments for general and vocational qualifications
  - age of learners
  - centre guidance for dealing with malpractice
  - recognition of prior learning and process.

This list is not exhaustive and a full list of our regulatory policies can be found on our website.

8 Quality assurance

Centre and qualification approval

As part of the approval process, your centre must make sure that the resource requirements listed below are in place before offering the qualification.

- Centres must have appropriate physical resources (for example, equipment, IT, learning materials, teaching rooms) to support the delivery and assessment of the qualification.
- Staff involved in the assessment process must have relevant expertise and/or occupational experience.
- There must be systems in place to ensure continuing professional development for staff delivering the qualification.
- Centres must have in place appropriate health and safety policies relating to the use of equipment by learners.
- Centres must deliver the qualification in accordance with current equality legislation.
- Centres should refer to the teacher guidance section in individual units to check for any specific resources required.

Continuing quality assurance and standards verification

On an annual basis, we produce the *Pearson Quality Assurance Handbook.* It contains detailed guidance on the quality processes required to underpin robust assessment and internal verification.

The key principles of quality assurance are that:

- a centre delivering BTEC programmes must be an approved centre, and must have approval for the programmes or groups of programmes that it is delivering
- the centre agrees, as part of gaining approval, to abide by specific terms and conditions around the effective delivery and quality assurance of assessment; it must abide by these conditions throughout the period of delivery
- Pearson makes available to approved centres a range of materials and opportunities, through online standardisation, intended to exemplify the processes required for effective assessment, and examples of effective standards. Approved centres must use the materials and services to ensure that all staff delivering BTEC qualifications keep up to date with the guidance on assessment
- an approved centre must follow agreed protocols for standardisation of assessors and verifiers, for the planning, monitoring and recording of assessment processes, and for dealing with special circumstances, appeals and malpractice.

The approach of quality-assured assessment is through a partnership between an approved centre and Pearson. We will make sure that each centre follows best practice and employs appropriate technology to support quality-assurance processes, where practicable. We work to support centres and seek to make sure that our quality-assurance processes do not place undue bureaucratic processes on centres. We monitor and support centres in the effective operation of assessment and quality assurance.

The methods we use to do this for BTEC Level 3 include:

- making sure that all centres complete appropriate declarations at the time of approval
- undertaking approval visits to centres
- making sure that centres have effective teams of assessors and verifiers who are trained to undertake assessment
- assessment sampling and verification, through requested samples of assessments, completed assessed learner work and associated documentation
- an overarching review and assessment of a centre's strategy for delivering and quality assuring its BTEC programmes, for example making sure that synoptic units are placed appropriately in the order of delivery of the programme.

Centres that do not fully address and maintain rigorous approaches to delivering, assessing and quality assurance cannot seek certification for individual programmes or for all BTEC Level 3 programmes. An approved centre must make certification claims only when authorised by us and strictly in accordance with requirements for reporting.

Centres that do not comply with remedial action plans may have their approval to deliver qualifications removed.

9 Understanding the qualification grade

Awarding and reporting for the qualification

This section explains the rules that we apply in awarding a qualification and in providing an overall qualification grade for each learner. It shows how all the qualifications in this sector are graded.

The awarding and certification of these qualifications will comply with regulatory requirements.

Eligibility for an award

In order to be awarded a qualification, a learner must complete all units, achieve a Near Pass (N) or above in all external units and a pass or above in all mandatory units unless otherwise specified. Refer to the structure in *Section 2*.

To achieve any qualification grade, learners must:

- complete and **have an outcome** (D, M, P, N or U) for all units within a valid combination
- achieve the **required units at Pass or above** shown in *Section 2*, and for the Extended Diploma achieve a minimum 900 GLH at Pass or above (or N or above in external units)
- achieve the **minimum number of points** at a grade threshold.

It is the responsibility of a centre to ensure that a correct unit combination is adhered to. Learners who do not achieve the required minimum grade (N or P) in units shown in the structure will not achieve a qualification.

Learners who do not achieve sufficient points for a qualification or who do not achieve all the required units may be eligible to achieve a smaller qualification in the same suite provided they have completed and achieved the correct combination of units and met the appropriate qualification grade points threshold.

Calculation of the qualification grade

The final grade awarded for a qualification represents an aggregation of a learner's performance across the qualification. As the qualification grade is an aggregate of the total performance, there is some element of compensation in that a higher performance in some units may be balanced by a lower outcome in others.

In the event that a learner achieves more than the required number of optional units, the mandatory units along with the optional units with the highest grades will be used to calculate the overall result, subject to the eligibility requirements for that particular qualification title.

BTEC Nationals are Level 3 qualifications and are awarded at the grade ranges shown in the table below.

Qualification	Available grade range
Certificate, Extended Certificate, Foundation Diploma	P to D*
Diploma	PP to D*D*
Extended Diploma	PPP to D*D*D*

The *Calculation of qualification grade* table, shown further on in this section, shows the minimum thresholds for calculating these grades. The table will be kept under review over the lifetime of the qualification. In the event of any change, centres will be informed before the start of teaching for the relevant cohort and an updated table will be issued on our website.

Learners who do not meet the minimum requirements for a qualification grade to be awarded will be recorded as Unclassified (U) and will not be certificated. They may receive a Notification of Performance for individual units. The *Information Manual* gives full information.

Points available for internal units

The table below shows the number of **points** available for internal units. For each internal unit, points are allocated depending on the grade awarded.

	Unit size	
	60 GLH	**90 GLH**
U	0	0
Pass	6	9
Merit	10	15
Distinction	16	24

Points available for external units

Raw marks from the external units will be awarded **points** based on performance in the assessment. The table below shows the **minimum number of points** available for each grade in the external units.

	Unit size	
	90 GLH	**120 GLH**
U	0	0
Near Pass	6	8
Pass	9	12
Merit	15	20
Distinction	24	32

Pearson will automatically calculate the points for each external unit once the external assessment has been marked and grade boundaries have been set. For more details about how we set grade boundaries in the external assessment please go to our website.

Claiming the qualification grade

Subject to eligibility, Pearson will automatically calculate the qualification grade for your learners when the internal unit grades are submitted and the qualification claim is made. Learners will be awarded qualification grades for achieving the sufficient number of points within the ranges shown in the relevant *Calculation of qualification grade* table for the cohort.

Calculation of qualification grade

Applicable for registration from 1 September 2016.

Certificate		Extended Certificate		Foundation Diploma		Diploma		Extended Diploma	
180 GLH		360 GLH		510 GLH		720 GLH		1080 GLH	
Grade	**Points threshold**	**Grade**	**Points threshold**	**Grade**	**Points threshold**	**Grade**	**Points threshold**	**Grade**	**Points threshold**
U	0	U	0	U	0	U	0	U	0
Pass	18	P	36	P	51	PP	72	PPP	108
						MP	88	MPP	124
								MMP	140
Merit	26	M	52	M	73	MM	104	MMM	156
						DM	124	DMM	176
								DDM	196
Distinction	42	D	74	D	104	DD	144	DDD	216
						D*D	162	D*DD	234
								D*D*D	252
Distinction*	48	D*	90	D*	130	D*D*	180	D*D*D*	270

The table is subject to review over the lifetime of the qualification. The most up-to-date version will be issued on our website.

Examples of grade calculations based on table applicable to registrations from September 2016

Example 1: Achievement of an Extended Diploma with a PPP grade

	GLH	Type (Int/Ext)	Grade	Unit points
Unit 1	120	Ext	Pass	12
Unit 2	90	Ext	Pass	9
Unit 3	120	Ext	Pass	12
Unit 4	120	Ext	Merit	20
Unit 7	90	Int	Pass	9
Unit 8	90	Int	Pass	9
Unit 9	90	Int	Merit	15
Unit 10	60	Int	U	0
Unit 11	60	Int	Pass	6
Unit 15	60	Int	Merit	10
Unit 16	60	Int	Pass	6
Unit 19	60	Int	Pass	6
Unit 20	60	Int	Pass	6
Totals	**1080**		**PPP**	**120**

The learner has achieved N or higher in Units 1, 2, 3 and 4 and P or higher in Units 7, 8 and 9.

The learner has sufficient points for a PPP grade

Example 2: Achievement of an Extended Diploma with a DDD grade

	GLH	Type (Int/Ext)	Grade	Unit points
Unit 1	120	Ext	Merit	20
Unit 2	90	Ext	Near Pass	6
Unit 3	120	Ext	Distinction	32
Unit 4	120	Ext	Merit	20
Unit 7	90	Int	Distinction	24
Unit 8	90	Int	Distinction	24
Unit 9	90	Int	Merit	15
Unit 10	60	Int	Distinction	16
Unit 11	60	Int	Distinction	16
Unit 15	60	Int	Merit	10
Unit 16	60	Int	Merit	10
Unit 19	60	Int	Distinction	16
Unit 20	60	Int	Merit	10
Totals	**1080**		**DDD**	**219**

The learner has sufficient points for a DDD grade

Example 3: An Unclassified result for an Extended Diploma

	GLH	Type (Int/Ext)	Grade	Unit points
Unit 1	120	Ext	Pass	12
Unit 2	90	Ext	Merit	15
Unit 3	120	Ext	Pass	12
Unit 4	120	Ext	Merit	20
Unit 7	90	Int	Pass	9
Unit 8	90	Int	Merit	15
Unit 9	90	Int	Distinction	24
Unit 10	60	Int	Merit	10
Unit 11	60	Int	Unclassified	0
Unit 15	60	Int	Merit	10
Unit 16	60	Int	Unclassified	0
Unit 19	60	Int	Unclassified	0
Unit 20	60	Int	Unclassified	0
Totals	**1080**		**U**	**127**

The learner has 240 GLH at U.

The learner has sufficient points for an MPP and has achieved N or higher in Units 1, 2, 3 and 4, and P or higher in Units 7, 8 and 9 but has not met the minimum requirement for 900 GLH at Pass or above.

10 Resources and support

Our aim is to give you a wealth of resources and support to enable you to deliver BTEC National qualifications with confidence. On our website you will find a list of resources to support teaching and learning, and professional development.

Support for setting up your course and preparing to teach

Specification

This **specification** (for teaching from September 2016) includes details on the administration of qualifications and information on all the units for the qualification.

Delivery Guide

This free guide gives you important advice on how to choose the right course for your learners and how to ensure you are fully prepared to deliver the course. It explains the key features of BTEC Nationals (for example employer involvement and employability skills). It also covers guidance on assessment (internal and external) and quality assurance. The guide tells you where you can find further support and gives detailed unit-by-unit delivery guidance. It includes teaching tips and ideas, assessment preparation and suggestions for further resources.

Schemes of work

Free sample schemes of work are provided for each mandatory unit. These are available in Word™ format for ease of customisation.

Curriculum models

These show how the BTECs in the suite fit into a 16–19 study programme, depending on their size and purpose. The models also show where other parts of the programme, such as work experience, maths and English, tutorial time and wider study, fit alongside the programme.

Study skills activities

A range of case studies and activities is provided; they are designed to help learners develop the study skills they need to successfully complete their BTEC course. The case studies and activities are provided in Word™ format for easy customisation.

myBTEC

myBTEC is a free, online toolkit that lets you plan and manage your BTEC provision from one place. It supports the delivery, assessment and quality assurance of BTECs in centres and supports teachers with the following activities:

- checking that a programme is using a valid combination of units
- creating and verifying assignment briefs (including access to a bank of authorised assignment briefs that can be customised)
- creating assessment plans and recording assessment decisions
- tracking the progress of every learner throughout their programme.

To find out more about myBTEC, visit the myBTEC page on the support services section of our website. We will add the new BTEC National specifications to myBTEC as soon as possible.

Support for teaching and learning

Pearson Learning Services provides a range of engaging resources to support BTEC Nationals, including:

- textbooks in e-book and print formats
- revision guides and revision workbooks in e-book and print formats
- teaching and assessment packs, including e-learning materials via the Active Learn Digital Service.

Teaching and learning resources are also available from a number of other publishers. Details of Pearson's own resources and of all endorsed resources can be found on our website.

Support for assessment

Sample assessment materials for externally-assessed units

Sample assessments are available for the Pearson-set units. One copy of each of these assessments can be downloaded from the website/available in print. For each suite an additional sample for one of the Pearson-set units is also available, allowing your learners further opportunities for practice.

Further sample assessments will be made available through our website on an ongoing basis.

Sample assessment materials for internally-assessed units

We do not prescribe the assessments for the internally-assessed units. Rather, we allow you to set your own, according to your learners' preferences and to link with your local employment profile.

We do provide a service in the form of Authorised Assignment Briefs, which are approved by Pearson Standards Verifiers. They are available via our website or free on myBTEC.

Sample marked learner work

To support you in understanding the expectation of the standard at each grade, examples of marked learner work at PM/MD grades are linked to the Authorised Assignment Briefs.

Training and support from Pearson

People to talk to

There are many people who are available to support you and provide advice and guidance on delivery of your BTEC Nationals. These include:

- Subject Advisors – available for all sectors. They understand all Pearson qualifications in their sector and so can answer sector-specific queries on planning, teaching, learning and assessment
- Standards Verifiers – they can support you with preparing your assignments, ensuring that your assessment plan is set up correctly, and support you in preparing learner work and providing quality assurance through sampling
- Curriculum Development Managers (CDMs) – they are regionally based and have a full overview of the BTEC qualifications and of the support and resources that Pearson provides. CDMs often run network events
- Customer Services – the 'Support for You' section of our website gives the different ways in which you can contact us for general queries. For specific queries, our service operators can direct you to the relevant person or department.

Training and professional development

Pearson provides a range of training and professional development events to support the introduction, delivery, assessment and administration of BTEC National qualifications. These sector-specific events, developed and delivered by specialists, are available both face to face and online.

'Getting Ready to Teach'

These events are designed to get teachers ready for delivery of the BTEC Nationals. They include an overview of the qualifications' structures, planning and preparation for internal and external assessment, and quality assurance.

Teaching and learning

Beyond the 'Getting Ready to Teach' professional development events, there are opportunities for teachers to attend sector- and role-specific events. These events are designed to connect practice to theory; they provide teacher support and networking opportunities with delivery, learning and assessment methodology.

Details of our training and professional development programme can be found on our website.

Appendix 1 Links to industry standards

BTEC Nationals have been developed in consultation with industry and appropriate sector bodies to ensure that the qualification content and approach to assessment aligns closely to the needs of employers. Where they exist, and are appropriate, National Occupational Standards (NOS) and professional body standards have been used to establish unit content.

In the computing sector, the following approaches have been used:

- The Pearson BTEC National Level 3 Extended Certificate, Foundation Diploma, Diploma and Extended Diploma in Computing have been developed to reflect the underpinning knowledge of the Level 2 National Occupational Standards in IT Professional Standards (ITPS) 4.0 to include the range of competencies, knowledge and understanding elements that help students meet the computing sector skills needs. Further information can be found at https://www.thetechpartnership.com/standards-and-quality/it-professional-standards/ and on our website.
- The BCS, the Chartered Institute for IT, have confirmed that the qualifications support progression towards a professional career in IT, such as a Registered IT Technician, or towards further education in computing or information technology.

Appendix 2 Glossary of terms used for internally-assessed units

This is a summary of the key terms used to define the requirements in the units.

Term	Definition
Analyse	Learners present the outcome of methodical and detailed examination either: • breaking down a theme, topic or situation in order to interpret and study the interrelationships between the parts and/or • of information or data to interpret and study key trends and interrelationships.
Apply	Learners' practice evidences the ability to carry out and apply knowledge, understanding and skills in a practical situation.
Assess	Learners present a careful consideration of varied factors or events that apply to a specific situation, or identify those which are the most important or relevant and arrive at a conclusion.
Build	Learners construct (something) by putting parts or material together.
Carry out	Learners demonstrate skills through practical activities.
Compare	Learners can identify the main factors relating to two or more items/situations or aspects of a subject that is extended to explain the similarities, differences, advantages and disadvantages. This is used to show depth of knowledge through selection and isolation of characteristics.
Create	Learners bring something into existence, e.g. drawings.
Define (a problem)	Learners' work, performance or practice states or describes the nature, scope or meaning of a subject as objective facts.
Demonstrate	Learners' work, performance or practice shows the ability to carry out and apply knowledge, understanding and/or skills in a practical situation.
Design	Learners apply skills and knowledge to the process of deciding on the look and functioning of a product or process.
Develop	Learners acquire and apply skills through practical activities.

Term	Definition
Discuss	Learners consider different aspects of: • a theme or topic • how they interrelate • the extent to which they are important. A conclusion is not required.
(Forensically) Document	Learners record and represent or describe something very accurately using words or images.
Enhance	Learners enhance the efficiency of a method, system, process or product which already meets all specified safety and technical requirements.
Explain	Learners' work shows clear details and gives reasons and/or evidence to support an opinion, view or argument. It could show how conclusions are drawn.
Evaluate	Learners draw on varied information, themes or concepts to consider aspects such as: • strengths or weaknesses • advantages or disadvantages • alternative actions • relevance or significance. Learners' enquiries should lead to a supported judgement showing relationship to its context. This will often be in a conclusion.
Examine	Learners select and apply knowledge to less familiar contexts.
Explore	Learners apply their skills and/or knowledge in contexts involving practical testing or trialling.
Implement	Learners consider the relevant factors to put a plan into practice, requiring self-direction in the selection of factors such as planning, research, exploration, outcome and review.
Investigate	Learners' knowledge is based on personal research and development.
Justify	Learners are able to give reasons or evidence to: • support an opinion • prove something right or reasonable.
Optimise	Learners improve a process or product by incremental steps to achieve the best performance possible (given constraints).
Perform	Learners carry out or execute what has to be done in order to complete an identified activity or to demonstrate personal achievement.
Plan	Learners create a way of doing a task or series of tasks to achieve specific requirements or objectives, showing progress from start to finish.

Term	Definition
Produce	Learners' knowledge, understanding and/or skills are applied to develop a particular type of evidence, for example a plan, product or report.
Refine	Learners improve an idea, method, system, process or product by making minor changes.
Review	Learners make a formal assessment. They appraise existing information or prior events, or reconsider information with the intention of making changes if necessary.
Support	Learners select and use appropriate skills to support systems or processes in achieving set aims and meeting identified needs.
Test	Learners take measures to check the quality, performance, or reliability of something, especially before putting it into widespread use or practice.
Understand	Learners demonstrate knowledge related to defined situations.

This is a key summary of the types of evidence used for BTEC Nationals.

Type of evidence	Definition and purpose
Case study	A specific example to which all learners must select and apply knowledge. Used to show application to a realistic context where direct experience cannot be gained.
Individual project	A self-directed, large-scale activity requiring, planning, research, exploration, outcome and review. Used to show self-management, project management and/or deep learning, including synopticity.

BTEC

Pearson BTEC Level 3 Nationals in Computing

Certificate in Computing

Extended Certificate in Computing

Foundation Diploma in Computing

Diploma in Computing

Diplomas in:
- Computer Science
- Computing for Creative Industries
- Computer Systems and Network Support
- Business Information Systems

Extended Diploma in Computing

First teaching from September 2016

First certification from 2018

For more information about Edexcel, BTEC or LCCI qualifications visit qualifications.pearson.com

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