



# Oakswood College

Empowering Through Education



## ATHE Level 4

### *Diploma in Computing*

PROMOTING EXCELLENCE • ENSURING COMPLIANCE  
SUPPORTING OUR COMMUNITY



GOVERNANCE



QUALITY



COMPLIANCE



EXCELLENCE

**ATHE qualification specification for:**

**ATHE Level 4 Diploma in Computing**

610/3263/3

**ATHE Level 4 Extended Diploma in Computing**

610/3264/5

Pathways:

ATHE Level 4 Extended Diploma in Computing (Data Analyst)

ATHE Level 4 Extended Diploma in Computing (Software Developer)

ATHE Level 4 Extended Diploma in Computing (Cyber Security Technologist)

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## Introduction

### About ATHE

Awards for Training and Higher Education (ATHE) is a global awarding organisation regulated by Ofqual and other United Kingdom and international regulators. We provide centres with a wide variety of qualifications including, but not limited to, business and management, administrative management, law, computing, health and social care and religious studies.

For the full list please visit our website: [www.athe.co.uk](http://www.athe.co.uk)

ATHE has also developed a range of bespoke qualifications for clients.

**The ATHE mission** is to provide outstanding qualifications, customer service and support, enabling centres to thrive and their learners to achieve and progress. We will support this mission by:

- providing qualifications which enable learners to fulfil their potential and make a positive contribution to society both socially and economically.
- delivering the highest standards of customer service.
- delivering support and guidance which meet the needs of all centres and enable them to improve performance.
- upholding and maintaining the quality and standards of qualifications and assessments.
- having a commitment to lifelong learning and development.

### Our Qualifications

Our qualifications have been created with the involvement of expert input from managers and staff in colleges, industry professionals and our qualification development team. We have also taken into account feedback from learners and consulted with higher education institutions to ensure the qualifications facilitate progression to higher levels. We offer a suite of awards, certificates and diplomas across many RQF levels.

Key features of the qualifications include:

- regular reviews of the units and the associated support materials so they are current and meet the needs of learners.
- alignment of the programmes of learning to degree and higher degree qualifications in HEIs in the UK and international institutions so there is comparability and smooth progression for learners.
- core units that are common to different sectors offering the opportunity for learners to move between sectors or delay decisions on particular specialisms.
- optional units offering the opportunity for learners to choose specialist units which best match their job, interests and progression aspirations.
- small qualifications that can be used for professional development for those in employment or for learners who do not have the time to undertake a full-time programme.
- challenging and relevant learning with flexible methods of assessment allowing tutors to select the most appropriate methods for their learners.
- opportunities for learners to achieve higher grades by unit and overall qualification and reach their maximum potential.
- learning that develops knowledge, understanding and skills e.g. problem solving, interpersonal skills needed by effective managers.

## Support for Centres

We are committed to supporting our centres and offer a range of training, support and consultancy services including:

- a comprehensive guide for centres on delivering ATHE qualifications.
- qualification guidance, assessor guidance, suggested resources and sample assignments for all units which have been written and verified by experienced practitioners.
- verification and guidance with internally devised assignments.
- guidance on how to deliver, assess and quality assure the qualifications.
- an ATHE centre support officer who guides centres through the recognition process, learner registration and learner results submission.
- health check visits to highlight areas of good practice and any areas for development.
- an allocated member of our team who can work with centres to support further improvements in the quality of teaching, learning and assessment.
- the services of a team of experienced external quality assurers.
- opportunities for training and staff development.
- access to free webinars to support delivery, assessment and QA processes.
- support for business development.

## ATHE Qualifications at Level 4 in this Specification

This document provides key information on the following ATHE Level 4 Computing qualifications:

- ATHE Level 4 Diploma in Computing
- ATHE Level 4 Extended Diploma in Computing

including the rules of combination, the content of all the units and guidance on assessment and curriculum planning. It should be used in conjunction with the ATHE handbook “Delivering ATHE Qualifications”. Further guidance and supporting documentation on curriculum planning, internal verification and assessment is provided separately in the Delivering ATHE Qualifications Guide and via the ATHE website.

These qualifications are regulated by Ofqual and are listed on Ofqual’s Register of Regulated Qualifications. Each qualification has a Qualification Number (QN). This number will appear on the learner’s final certification documentation. Each unit within a qualification also has a Unit Reference Number.

The QN numbers for these qualifications are as follows:

ATHE Level 4 Diploma in Computing	610/3263/3
ATHE Level 4 Extended Diploma in Computing	610/3264/5

## **Regulation Dates**

These qualifications are regulated from October 2023 and their operational start dates in centres are 9<sup>th</sup> October 2023.

## **Availability**

These qualifications are available to learners who are registered at a recognised ATHE centre which is based in England, Wales or internationally, outside of the United Kingdom.

## **ATHE's Level 4 Qualifications in Computing**

These qualifications have been developed to conform to the requirements of the Ofqual Regulated Qualifications Framework (RQF), to meet the requirements of higher education and employers and to meet the needs of learners.

Learners looking to achieve a Level 4 qualification should be advised of all the opportunities available at this level (eg Higher Apprenticeships, Higher Technical Qualifications, Undergraduate Degree programmes) and the possible funding (ie loan opportunities) available for these.

The aim of these qualifications is to develop knowledge, skill and understanding in a number of current and key areas of Computing. Building on core learning developed at Level 3, the Diploma qualification provides essential Level 4 learning in the main Computing subject areas: systems analysis, programming, databases, networks and security, and legislation & regulation. For learners seeking to develop their occupational skills in Computing, this provides the initial step for learners to then progress to specific pathway developments in either data analysis, software development and cyber security or to construct their own qualification outcome based upon academic/professional requirements.

Each of the pathways is fully mapped to the current UK IfATE standards for the following occupational roles:

**Level 4 Data Analyst**

**Level 4 Software Developer**

**Level 4 Cyber Security Technologist**

You can view the details of these roles by visiting the IfATE website: [Home / Institute for Apprenticeships and Technical Education](#)

In this way, learners taking a specific pathway can be assured that their learning and achievement is fully compatible with Computing industry expectations for these industry roles.

Equally, the breadth of coverage within the qualification's 21 units ensures that learners pursuing broader, more academic/professional development interests can create programmes of learning that are diverse and tailor-made.

Unit content and skill areas are explored systematically. Learners are expected to demonstrate both what they know and understand of the unit content, and how they apply it to a practical problem or situation. Learners will have the opportunity to develop their practical computing skills across a number of related Computing skill areas, eg programming and scripting, database analysis and design, web development, app design, network design and cyber security architecture.

The qualifications have a synoptic focus. Unit 21 is a synoptic project that requires that learners utilise the skills and knowledge that they have learnt in previous units. Each unit has signposting to synoptic learning and assessment opportunities across the entire suite of units, ensuring that learning and assessment is connected and holistic. Learners and tutors can see and understand the relationship between aspects of unit content clearly and easily.

The qualifications also focus on the development of those study and transferable skills necessary for learners to develop and grow both personally and in the working environment. Each unit is signposted to Study Skills and Employability Skills opportunities derived from ATHE's standards. This ensures that learners and tutors have the opportunity to relate aspects of learning to broader study and work-related skills.

These qualifications are, therefore, designed to provide a strong base for continued learning and a desire to constantly develop as an individual, further improving knowledge, understanding and skills.

The qualifications are suitable for learners to study both in college/classroom settings and as distance-learning programmes. Each unit is supported by an ATHE assignment which, requires the learner to complete a small number of focussed tasks designed to demonstrate relevant knowledge and skill.

More details on each specific qualification can be found below.

## **Introduction to the ATHE Level 4 Diploma in Computing**

### **Aims of the Qualification**

The Level 4 Diploma in Computing (60-credit) offers learners a short but relatively extensive introduction to essential Level 4 Computing knowledge and skills. As an outcome, the Level 4 Diploma offers learners current and integrated learning across programming, data analysis, networks and cyber security, situating these main knowledge skill sets within the context of computing practical analysis skills and cross-cutting legal and regulatory requirements.

As a springboard into the larger 120 credit Extended Diploma, the Level 4 Diploma is a key foundation to learners moving forward with either a specialist pathway or their own combination of unit learning.

## **Introduction to the ATHE Level 4 Extended Diploma in Computing**

### **Aims of the Qualification**

The Level 4 Extended Diploma in Computing (120-credit) builds on the broad Computing foundation offered by the Diploma and offers learners access to both further, IfATE-compliant pathway learning for role-based occupational development, or broader and diverse opportunities for more academic and professional learning development.

Unit 21's synoptic project is the culmination of the qualification requiring learners to synthesise what they have learnt across the qualification.

### **Entry Requirements**

These qualifications are designed for learners who are typically aged 18+.

ATHE's policy regarding access to our qualifications is that:

- they should be available to everyone who is capable of reaching the required standards
- they should be free from any barriers that restrict access and progression
- there should be equal opportunities for all those wishing to access the qualifications

Centres should review the prior qualifications and experience of each learner and consider whether they provide the necessary foundations to undertake the programme of study at Level 4. If there are exceptional entrants, centres are advised to contact ATHE. For learners with disabilities and other specific needs, this review will need to take account of the support available to the learner during teaching and assessment of the qualification.

For learners who have recently been in education or training the entry profile is likely to include one of following:

- a GCE Advanced level profile with achievement in 2 or more subjects supported by 5 or more GCSEs at grades 4/C and above
- other related level 3 subjects such as ATHE level 3 Diplomas
- an Access to Higher Education Certificate delivered by an approved further education institute and validated by an Access Validating Agency
- other equivalent international qualifications

Learners must also have an appropriate standard of English to enable them to access relevant resources and complete the unit assignments.

For those whom English is not their first language we recommend the following standards of proficiency in English language skills or an approved equivalent for these qualifications:

- IELTS 5.5
- Common European Framework of Reference (CEFR) B2
- Cambridge English Advanced (CAE) 162 or above
- Pearson Test of English (PTE) Academic 42-49

Mature learners may present a more varied profile of achievement that is likely to include relevant work experience (paid and/or unpaid) with levels of responsibility, participation and/or achievement of relevant professional qualifications. This may be used for recognition of prior learning (RPL). Learners may also hold RQF qualifications which will enable them to claim an exemption from part of the qualification.

Centres are required to recruit learners to qualifications with integrity. Centres must carry out robust initial assessment to ensure that learners, who undertake qualifications, have the necessary background knowledge, understanding and skills to undertake the learning and assessment at Level 4. This assessment should take account of any support available to the learner within the centre during the programme of study and any support that may be required to allow the learner to access the assessment for the units within the qualification.

ATHE will review centre recruitment policies as part of their monitoring processes.

## **Reasonable Adjustments and Special Considerations**

ATHE's policy on reasonable adjustments and special consideration aims to enhance access to the qualifications for learners with disabilities and other difficulties (as defined by the Equality Act 2010) without compromising the assessment of skills, knowledge and understanding. Where the learner has been awarded a Reasonable Adjustment or Special Consideration this must be recorded on the assessment sheet and the learner record. External Quality Assurers will take account of this information at the external quality assurance of learner work. Further details on Reasonable Adjustments and Special Considerations are provided in the policy document, which can be found on our website. Please contact ATHE if you are uncertain about adjustments for certain learners.

## **Progression**

On successful completion of these qualifications, learners will have a number of progression options. Learners may progress to:

- employment in a computing role or have increased opportunities for progression in their current role
- larger qualifications at the same level e.g. from a Diploma to the Extended Diploma in Computing
- a Level 5 ATHE qualification such as the ATHE Level 5 Diploma/Extended Diploma in Computing
- the second year of degree programmes at universities supporting the ATHE progression route (see HE Progression Routes on the ATHE website)
- Higher Technical Qualifications (HTQs) and Higher-Level Apprenticeships at Level 5 in computing-related areas

## **ATHE Recognition of Prior Learning (RPL)**

There will be occasions where learners wish to claim recognition of prior learning that has not been formally assessed and accredited. ATHE has provided detailed guidance on RPL which is available for centres on the ATHE website. Centres may also contact ATHE directly to obtain further clarification or discuss the requirements for RPL.

## **Resources Required by Centres**

ATHE expects centres to provide the right human and physical resources needed to ensure the quality of the learner experience. Centres must ensure that staff have the appropriate level of subject knowledge and are normally qualified to at least a degree standard. It is desirable that staff have a teaching and/or assessing qualification and practical experience of this sector.

The physical resources required will vary depending on the style of delivery. Where distance or blended learning is used, ATHE expects centres to have appropriate learning support materials, infrastructure and technology in place to meet student needs.

This information will be checked by external quality assurers on their visits to centres.

## **Modes of Delivery**

Subject to checks by external quality assurers' centres can deliver these qualifications using the following modes of delivery in order to meet the needs of their learners.

This can include:

- full time
- part-time
- blended learning
- distance learning

### **Qualification size**

The size of a qualification is expressed in **Total Qualification Time (TQT)**.

### **Total Qualification Time – TQT**

TQT is the total amount of time, in hours, expected to be spent by a student to achieve a qualification.

### **TQT is comprised of:**

1. **Guided Learning Hours (GLH)**
2. **Additional non-supervised learning**

### **Guided Learning Hours – GLH**

This is the amount of time the average student is expected to spend in lectures and other tutor-supervised learning and activities, including induction, face to face training, e-learning with the co-presence of learner and tutor, invigilated exams.

Guided Learning Hours (GLH) are an estimate of the amount of time, on average, that a lecturer, supervisor, tutor or other appropriate provider of education or training, **will immediately guide or supervise** the learner to complete the learning outcomes of a unit to the appropriate standard. GLH are intended to provide guidance for centres on the amount of time required to deliver the programme and support learners.

### **Additional non-supervised learning**

This is an estimate of the number of hours a Learner will reasonably be likely to spend in preparation, study or any other form of participation in education or training, including assessment, which takes place as directed by – but, unlike Guided Learning, not under the Immediate Guidance or Supervision of – a lecturer, supervisor, tutor or other appropriate provider of education or training.

These activities may include webinars, podcasts, research, work-based learning, private and online study, compilation of a portfolio of evidence and non-invigilated assessment.

### **How TQT is calculated**

Values for Total Qualification Time, Guided Learning Hours and Credit, are calculated by considering the different activities that a learner would typically complete in order to achieve the learning outcomes of a qualification at the standards provided.

The needs of individual learners and the differing teaching styles used mean there will be variation in the actual time taken to complete a qualification.

Values for Total Qualification Time, Guided Learning Hours and Credit are estimates.

## Credit

Each ATHE qualification has a Credit value. Credit is calculated by dividing the TQT by ten. For example, a qualification with TQT of 120 hrs would have a credit value of 12.

## Level

The level is an indication of relative demand, complexity and depth of achievement and autonomy. These qualifications have been designed to suit learners working towards Level 4 qualifications. Level descriptors are divided into two categories:

- I. Knowledge and understanding
- II. Skills

There is a knowledge descriptor and a skills descriptor for each Level within the framework. The descriptors set out the generic knowledge and skills associated with the typical holder of a qualification at that Level. The knowledge and skills for Level 4 are:

### Knowledge descriptor (the holder....)

- Has practical, theoretical or technical knowledge and understanding of a subject or field of work to address problems that are well defined but complex and non-routine.
- Can analyse, interpret and evaluate relevant information and ideas.
- Is aware of the nature of approximate scope of the area of study or work.
- Has an informed awareness of different perspectives or approaches within the area of study or work

### Skills descriptor (the holder can....)

- Identify, adapt and use appropriate cognitive and practical skills to inform actions and address problems that are complex and non-routine while normally fairly well-defined.
- Review the effectiveness and appropriateness of methods, actions and results.

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## Rules of Combination

Each qualification has agreed rules of combination which indicates the number of credits to be achieved, the units that are mandatory and the choice of optional units. The rules of combination for these qualifications are given below.

### Qualification Structure

#### ATHE Level 4 Diploma in Computing

ATHE Level 4 Diploma in Computing is a 60-credit qualification.

#### Rules of combination

Learners must achieve all 5 units.

**The Total Qualification Time is 600 Hours**

**The Total Guided Learning Hours is 270**

**The Total Credit value is 60**

Unit code	Unit Title	Level	Credit	GLH
<b>Mandatory units</b>				
Y/650/8502	Unit 1 IT Systems Development	4	15	60
A/650/8503	Unit 2 Programming and Scripting	4	10	40
D/650/8504	Unit 3 Data and Database Systems	4	15	60
F/650/8505	Unit 4 Computer Systems Networks and Security	4	10	50
H/650/8506	Unit 5 Legislation, Regulation, Ethics and Codes of Practice	4	10	60

### ATHE Level 4 Extended Diploma in Computing

ATHE Level 4 Extended Diploma in Computing is a 120-credit qualification.

#### Rules of combination

For learners not following a specific pathway, they must achieve the 5 mandatory units, any 5 optional units and Unit 21 Synoptic Computing Project. Where learners wish to follow a specific pathway, then the unit requirements for each of these is detailed below.

**The Total Qualification Time is 1200 Hours**

**The Total Guided Learning Hours is 510**

**The Total Credit value is 120**

Unit Codes	Unit Title	Level	Credit	GLH
<b>Mandatory units</b>				
Y/650/8502	Unit 1 IT Systems Development	4	15	60
A/650/8503	Unit 2 Programming and Scripting	4	10	40
D/650/8504	Unit 3 Data and Database Systems	4	15	60
F/650/8505	Unit 4 Computer Systems Networks and Security	4	10	50
H/650/8506	Unit 5 Legislation, Regulation, Ethics and Codes of Practice	4	10	60
<b>Optional units</b>				
K/650/8535	Unit 6 Organisational Data Architecture	4	10	40
L/650/8536	Unit 7 Methods and Tools for Analysis	4	10	40
M/650/8537	Unit 8 Data Preparation and Quality Risks	4	10	40
R/650/8538	Unit 9 Statistics for Analysing Datasets	4	10	40
T/650/8539	Unit 10 Analytical Impact through Data Visualisations	4	10	40
L/650/8545	Unit 11 Advanced Programming	4	10	40
R/650/8547	Unit 12 Web Design and Programming	4	10	40
T/650/8548	Unit 13 Mobile Applications Development	4	10	40
Y/650/8549	Unit 14 The Principles of Full-Stack Development	4	10	40
F/650/8550	Unit 15 Software Testing Frameworks and Methodologies	4	10	40
H/650/8551	Unit 16 Principles of Networks	4	10	40
J/650/8552	Unit 17 Concepts and Features of Operating Systems	4	10	40
L/650/8554	Unit 18 Cyber Security Concepts	4	10	40

R/650/8556	Unit 19 Security Architectures	4	10	40
A/650/8559	Unit 20 Cryptography	4	10	40
<b>Mandatory synoptic unit</b>				
H/650/8560	Unit 21 Synoptic Computing Project	4	10	40

### Qualification pathways

Learners taking a qualification pathway must achieve the following relevant combinations of units:

Pathway title	Unit requirements
ATHE Level 4 Extended Diploma in Computing ( <b>Data Analysis</b> )	<p>All 5 mandatory units plus:</p> <p>Unit 6 Organisational Data Architecture  Unit 7 Methods and Tools for Analysis  Unit 8 Data Preparation and Quality Risks  Unit 9 Statistics for Analysing Datasets  Unit 10 Analytical Impact through Data Visualisations</p> <p>Plus:</p> <p>Unit 21 Synoptic Computing Project</p>
ATHE Level 4 Extended Diploma in Computing ( <b>Software Development</b> )	<p>All 5 mandatory units plus:</p> <p>Unit 11 Advanced Programming  Unit 12 Web Design and Programming  Unit 13 Mobile Applications Development  Unit 14 The Principles of Full-Stack Development  Unit 15 Software Testing Frameworks and Methodologies</p> <p>Plus:</p> <p>Unit 21 Synoptic Computing Project</p>
ATHE Level 4 Extended Diploma in Computing ( <b>Cyber Security and Networks</b> )	<p>All 5 mandatory units plus:</p> <p>Unit 16 Principles of Networks  Unit 17 Concepts and Features of Operating Systems  Unit 18 Cyber Security Concepts  Unit 19 Security Architectures  Unit 20 Cryptography</p> <p>Plus:</p> <p>Unit 21 Synoptic Computing Project</p>

### Guidance on Assessment and Grading

Assessment for each unit is completed based on achievement of the Learning Outcome at the standards set by the Assessment Criteria for that unit. The learner can therefore achieve a Pass,

Merit, Distinction or Fail for each unit based on the quality of the work submitted and the assessor's judgements made against the criteria provided.

The assessment of each of the Level 4 qualifications in Computing is completed through the submission of internally assessed learner work.

To achieve a pass for a unit, a learner must have successfully achieved the learning outcomes at the pass standard set by the assessment criteria for that unit. To achieve merit or distinction, the learner must demonstrate that they have achieved the criteria set for these grades. Learners cannot omit completing work to meet the pass standard and simply work to the higher grades, as this would put a pass for the unit in jeopardy. Similarly, learners cannot complete work to meet the criteria for distinction in the anticipation that this will also meet the criteria for merit. However, where work for the pass standard is marginal, assessors can take into account any extension work completed as this may support achievement of the pass standard.

ATHE will provide an assignment for each unit which can be used as the assessment for the unit. These assignments have extension activities, which enable the learners to provide additional evidence to show that the criteria for the higher grades have been met. The assessor therefore must judge the grade for the work submitted on the basis of whether the LO has been met at the standard, specified for the pass, merit or distinction grade for that LO. In making their judgements assessors will continue to check whether the command verbs stated in the AC have been delivered. There is no requirement for learners to produce the additional work required for the higher grades and the tutor may advise the learner to work to the pass standard, where this is appropriate.

The assessor should record their judgements on the ATHE template, stating what grade the learner has achieved and providing evidence for the judgements. The internal verifier can also use the ATHE IV template but the feedback to the assessor must show whether the assessor has made valid judgements for all the learner work, including any extension activities which met the standard for merit and distinction grades. Assessment judgements always require care to ensure that they are reliable and that there is sufficient and specific feedback to the learner to show whether he or she has demonstrated achievement of the LO at the specified standard. The additional grades mean that assessors must take even greater care to assure the validity of their judgements.

We welcome centres developing their own assessment strategies, so you can put assignments in a context that is appropriate for your learners. Any assignments that you devise independently will need to be submitted to ATHE for approval before delivery of the programme. Centres can submit assignments for approval using the 'Centre-Devised Assignment' template documentation available on the ATHE centre portal.

An assignment can relate to a single unit, or an integrated assignment can incorporate more than one unit. Any assignment must show which learning outcomes and assessment criteria from which unit(s) are being covered.

### **Assignment Marking Guidance**

Each ATHE assignment has marking guidance produced with it so that assessors can better understand the requirements for the satisfaction of assessment criteria/learning outcomes. For tutors, it is worthwhile reading and understanding this marking guidance before learners are asked to commence an assignment. It is also worthwhile tutors bringing this marking guidance to the attention of learners before they embark on an assignment. As the marking guidance often captures the expected level of detail of a learner response, it contains additional information that can help learners and tutors better understand the kind of response to a task that best meets the requirements.

Key command verbs from the assessment criteria have also been emboldened in the marking guidance so that tutors and learners can clearly understand the level of response that is expected.

## **Recording Assessment Judgements**

Assessors are required to record assessment judgements for each student by unit. ATHE has provided a template for centres to use to record their judgements and this form should be used. The form enables the centre to record any adjustments due to special considerations or reasonable adjustments. Any adjustments following appeals should also be recorded. These records must be retained as they will be checked at external quality assurance visits. All learner work must be retained for a minimum of 4 years after certification has taken place.

## **Putting an Assessment Strategy in Place**

You will need to demonstrate to your External Quality Assurer that you have a clear assessment strategy supported by robust quality assurance to meet the ATHE requirements for registering learners for a qualification. In devising your assessment strategy, you will need to ensure that:

- Learners are well-briefed on the requirements of the unit and what they must do to meet them.
- Assessors are well-trained and familiar with the content of the unit/s they are assessing.
- There is an internal verification process in place to ensure consistency and standardisation of assessment across the qualification.
- Assessment decisions are clearly explained and justified through the provision of feedback to the learner.  
Work submitted can be authenticated as the learner's own work and that there is clear guidance and implementation of the centres Malpractice Policy.
- There is an assessment plan in place identifying dates for summative assessment of each unit and indicating when external quality assurance will be needed.
- Enough time is included in the assessment planning to allow the learners time for any necessary remedial work that may be needed prior to certification.

## **Grading**

### **Grading system**

The grading algorithms and overall grade thresholds published in any ATHE specification may be subject to change where this is necessary to maintain standards.

Given that these qualifications involve assessment using judgements against 'Pass', 'Merit' and 'Distinction' assessment criteria to make a decision about whether a learner has met the required standard, our grading system is straightforward, and we do not currently envisage the need to change this. However, should a change become necessary, the change would be published in an updated version of the specification with a clearly revised version number and a new 'valid from' date on the front cover. We will write to all centres in good time to inform them of this change so that plans for any changes can be made to your programme delivery, internal assessment, and quality assurance arrangements.

The ATHE grading system where a qualification result can be Pass, Merit, Distinction or Fail is as currently follows and we plan to maintain this system for the foreseeable future:

- Learner meets all Learning Outcomes at Pass standards stated in the assessment criteria in a unit > Learner gains a Pass for the unit.
- Learner meets all Learning Outcomes at Pass standards, and where available also at Merit standards stated in the assessment criteria in a unit > Learner gains a Merit for the unit.
- Learner meets all Learning Outcomes at Pass standards, and where available also at Merit and Distinction standards stated in the assessment criteria in a unit > Learner gains a Distinction for the unit.
- Learner does not meet all Learning Outcomes at Pass standards stated in the assessment criteria in a unit > Learner gains a Fail for the unit.
- Learner meets the rules of combination in a qualification and points for achieving units are added up > points are converted to an overall qualification grade > learner meets minimum number of points required > learner achieves a Pass, Merit or Distinction for the qualification.
- Learner does not meet rules of combination > learner achieves a Fail for the qualification but may receive unit certification for those units achieving a Pass.

### Qualification Grading Structure

Each unit is graded pass, merit, or distinction. As well as receiving a grade for each individual unit learners will receive an overall grade for the qualification. The calculation of the overall qualification grade is based on the student's performance in all units and the points gained from all credits required for the Diploma or Extended Diplomas. The learner must have attempted a valid combination of units. The formula for establishing the overall grade is as follows.

#### Points for each 10-credit unit allocated are:

Pass (achieves Learning Outcomes at the standards stated in pass assessment criteria) – **30 points.**  
 Merit (achieves Learning Outcomes at the standards stated in pass and all merit assessment criteria) – **40 points.**  
 Distinction (achieves Learning Outcomes at the standards stated in pass, all merit and all distinction Assessment Criteria) – **50 points.**

#### Points for each 15-credit unit allocated are:

Pass (achieves Learning Outcomes at the standards stated in pass assessment criteria) – **45 points.**  
 Merit (achieves Learning Outcomes at the standards stated in pass and all merit assessment criteria) – **60 points.**  
 Distinction (achieves Learning Outcomes at the standards stated in pass, all merit and all distinction Assessment Criteria) – **75 points.**

Total points required for each qualification grade:

#### ATHE Level 4 Diploma in Computing (**60 credits**)

Pass	180 - 215
Merit	216 - 269
Distinction	270

#### ATHE Level 4 Extended Diploma in Computing (**120 credits**)

Pass	360 - 431
Merit	432 - 539
Distinction	540

## Example grading for Level 4 Diploma in Computing

### Example 1

Marina has achieved a total of 220 points for the qualification:

Unit no.		Unit result	Unit points
1		Pass	45
2		Pass	30
3		Distinction	75
4		Pass	30
5		Merit	40
		<i>Total</i>	<i>220</i>

Marina has achieved 220 points and will be awarded a Merit grade for the qualification as the requirement for a Merit is 216 - 269 points.

### Quality Assurance of Centres

Centres delivering ATHE qualifications must be committed to ensuring the quality of teaching and learning so that the learner experience is assured. Quality assurance will include a range of processes as determined by the centre and this could include, gathering learner feedback, lesson observation, analysis of qualitative and quantitative data etc. There must also be effective standardisation of assessors and verification of assessor decisions. ATHE will rigorously monitor the application of quality assurance processes in centres.

ATHE's quality assurance processes will include:

- Centre approval for those centres which are not already recognised to deliver ATHE RQF qualifications.
- Monitoring visits to ensure the centre continues to work to the required standards.
- External quality assurance of learner work.

Centres will be required to undertake training, internal verification and standardisation activities as agreed with ATHE. Details of ATHE's quality assurance processes are provided in the ATHE Guide: "Delivering ATHE Qualifications" which is available on our website.

### Malpractice

Centres must have a robust Malpractice Policy in place, with a clear procedure for implementation. Centres must ensure that any work submitted for quality assurance can be authenticated as the learner's own. Any instance of plagiarism detected by the External Quality Assurer during sampling, will be investigated and could lead to sanctions against the centre.

Centres should refer to the Delivering ATHE Qualifications Guide and the ATHE Malpractice and Maladministration Policy on the ATHE website.

### Guidance for Teaching and Learning

Learners learn best when they are actively involved in the learning process. We would encourage practitioners delivering our qualifications to use a range of teaching methods and classroom-based activities to help them get information across and keep learners engaged in the topics they are studying. Learners should be encouraged to take responsibility for their learning and need to be able to demonstrate a high degree of independence in applying the skills of research and

evaluation. You can facilitate this by using engaging methods of delivery that involve active learning rather than relying on traditional methods of lecture delivery to impart knowledge.

Your approach to delivery should give the learners enough structure and information on which to build without you doing the work for them. In achieving the right balance, you will need to produce well-planned sessions that follow a logical sequence and build on the knowledge, understanding and skills already gained.

### **Top Tips for Delivery**

- Adopt a range of teaching and learning methods, including active learning.
- Plan sessions well to ensure a logical sequence of skills development.
- Include study skills aspects, e.g., how to construct a report or Harvard Referencing. Build time into your Scheme of Work and Session Plans to integrate study skills teaching.
- Set structured additional reading and homework tasks to be discussed in class.
- Elicit feedback from your students. Get them to identify where the work they have done meets the assessment criteria.
- Contextualise your activities, e.g., using real case studies as a theme through the sessions.
- Use learner experience from the workplace or other personal learning.
- Take an integrated approach to teaching topics across units, where appropriate, rather than always taking a unit-by-unit approach. In this way, learners will be able to see the links between the content of the different units.

### **Unit Specifications – key features**

#### Unit Format

Each unit in ATHE's suite of qualifications is presented in a standard format. This format provides guidance on the requirements of the unit for learners, tutors, assessors, and external quality assurers.

Each unit has the following sections:

#### Unit Title

The unit title reflects the content of the unit. The title of each unit completed will appear on a learner's statement of results.

#### Unit Aims

The unit aims section summarises the content of the unit.

#### Unit Code

Each unit is assigned an RQF unit code that appears with the unit title on the Register of Regulated Qualifications.

#### RQF Level

All units and qualifications in the RQF have a level assigned to them which represents the level of achievement. The level of each unit is informed by the RQF level descriptors. The RQF level descriptors are available on the ATHE website.

#### Credit Value

The credit value is the number of credits that may be awarded to a learner for the successful achievement of the learning outcomes of a unit.

### Guided Learning Hours (GLH)

Guided learning hours are an estimate of the amount of time, on average, that a tutor, trainer, workshop facilitator etc., will work with a learner, to enable the learner to complete the learning outcomes of a unit to the appropriate standard.

### Learning Outcomes

The learning outcomes set out what a learner is expected to know, understand or be able to do as the result of the learning process.

### Assessment Criteria

The assessment criteria describe the requirements a learner is expected to meet to demonstrate that the learning outcome has been achieved. Command verbs reflect the level of the qualification e.g., at Level 5 you would see words such as analyse and evaluate.

### Unit Indicative Content

The unit indicative content section provides details of the range of subject material for the programme of learning for the unit. Learners should ensure that they use this content when preparing their responses to assignment tasks.

### Suggested Resources

This comprises a list of relevant and current textual/online sources of information that will underpin learning for the unit. It is not an exhaustive list and learners/tutors might find other resources that equally serve their purposes.

### Opportunities for Synoptic Teaching and Learning

This section identifies the links between the unit's learning outcomes and other unit learning outcomes and assessment criteria within the qualification that are thematically related. This enables learners and tutors the opportunity to connect learning across the qualification to ensure that learners have a joined-up experience of each unit.

### Opportunities for Synoptic Assessment

This section identifies the way in which a unit's assessment links internally different parts of a unit or links more broadly to other parts of the overall qualification. In each unit, there are shared Merit and Distinction AC which draw together different but related learning from different LOs. These are labelled throughout each unit:

Eg, Unit 1  
**LO3 + LO4**

3D1 Evaluate the effectiveness of using a range of documentation tools to communicate the results of analysis and design.

For certain units, eg Unit 21 Synoptic Computing Project, these represent larger opportunities for assessment to be informed by knowledge and understanding developed in previous units.

### Opportunities for Skills Development

This section contains two important elements of signposting: signposting to ATHE Study Skills and signposting to ATHE Employability Skills. These enable learners and tutors the opportunity to see where each unit's LO/AC link into underpinning Study Skills and Employability Skills categories, eg Digital Skills, Thinking Skills etc, and to promote possible programme/curriculum opportunities for

the development of these skills. The ATHE Study Skills and Employability Skills are drawn from the standards documents for each skill. These standards documents are on the ATHE Centre Portal.

## Unit specifications

<b>Unit 1 IT Systems Development: Preparation, Analysis, Design and Problem-solving</b>			
<b>Unit aims</b>	This unit draws together concepts from Systems Analysis and Project Management to help learners develop the skills and techniques needed to confidently respond to a client brief, to identify a problem or opportunity, analyse an existing system, identify possible solutions to the problem before choosing the most appropriate solution and producing a suitable design. Learners will present their final solution design to their client and respond to feedback.		
<b>Unit level</b>	4		
<b>Unit code</b>	Y/650/8502		
<b>GLH</b>	60		
<b>Credit value</b>	15		
<b>Unit grading structure</b>	Pass, Merit and Distinction		
<b>Assessment guidance</b>	In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.		
<b>Learning outcomes</b>	<b>Assessment criteria</b>		
The learner will demonstrate that they:	The learner can:		
	<b>Pass</b>	<b>Merit</b>	<b>Distinction</b>
1. Understand the stages and purpose of the lifecycle and lifecycle models in development activities.	1.1 Explain the purpose of the lifecycle in development activities. 1.2 Describe the stages of the development lifecycle. 1.3 Explain the role of systems analysis in development and redevelopment.	1M1 Select and justify your choice of methodology for a development.	1D1 Evaluate different development lifecycles and models that can be used in systems development.
2. Understand the key behaviours needed to develop achievable requirements.	2.1 Explain the roles and responsibilities associated with the stages of development lifecycle. 2.2 Describe the importance of demonstrating the key behaviours of problem-solving.	2M1 Assess how the use of project management tools contributes to the successful control of development projects.	

3. Can use analysis techniques to investigate and document an existing system.	<p>3.1 Carry out an analysis using information gathering techniques to review an existing system.</p> <p>3.2 Document an existing system using appropriate tools.</p> <p>3.3 Produce a feasibility report.</p>		<p><b>LO3 and LO4</b></p> <p>3D1 Evaluate the effectiveness of using a range of documentation tools to communicate the results of analysis and design.</p>
4. Can identify, design, and document a possible solution.	<p>4.1 Use the analysis to identify possible solutions to a problem and choose a preferred solution.</p> <p>4.2 Design the solution using appropriate tools to document the proposal (including functionality and interfaces).</p> <p>4.3 Describe a further improvement.</p>	4M1 Justify your choice of preferred solution.	
5. Can present a solution proposal to a client.	5.1 Present your solution to the client using a suitable format.		5D1 Evaluate client's feedback on the proposed solution, explaining how appropriate amendments will be made to the design.

## Indicative Content

### 1. Understand the stages and purpose of the lifecycle and lifecycle models in development activities

- Purpose – to provide a framework for development, improve planning and control, reduce risk
- Development lifecycle stages – Initiate, Investigate, Design, Implement, Test, Deploy/Use, Maintain, Review, Sunset (end of life)
- Identification of inputs and outputs in each stage of the lifecycle
- Development lifecycles – Waterfall, V-shape, Spiral, Iterative
- Development models – SSADM, DSDM, Agile (including Scrum, Kanban), Prototyping, DevOps
- Role of systems analysis – Understand existing systems, identify issues or opportunities (such as reducing errors, improving processing, improving the user experience, to take advantage of emerging opportunities), examine the feasibility of a project or development.

### 2. Understand the key behaviours needed to develop achievable requirements

- Roles and responsibilities:
  - Roles and responsibilities within the development lifecycle (who is responsible for what)
  - Use of project management tools to manage the development lifecycle (e.g. Jira, 6 Sigma, Prince 2, Microsoft Project)
- Key behaviours of problem-solving:
  - Demonstrating objectivity
  - Undertaking exploration
  - Avoiding assumption
  - Managing stakeholder communication as an ongoing process particularly where stakeholders are involved in iterative developments (e.g. Minimum Viable Product (MVP))
  - Managing stakeholder expectations to avoid scope creep
  - Identifying development risks.

### 3. Can use analysis techniques to investigate and document an existing system

- Information gathering techniques:
  - Questionnaires (including online surveys)
  - Interviews
  - Observation
  - Documentation investigation
  - Surveys/Focus groups
- Documentation tools:
  - Data Flow Diagrams (DFD)
  - Entity Relationship Diagrams (ERD)
  - Flowcharts
  - Unified Modelling Language (UML)
  - Wireframing (for screen designs and navigation)
- Feasibility report:
  - Define the problem and its scope
  - Provide an overview of a potential new system and its rationale

- Identify and record any constraints
- Identify and record any risks.

#### 4. Can identify, design and document a possible solution

- Solutions can use any appropriate technologies (e.g. Off-the-shelf (OTS) solutions such as accounting programs or proprietary databases, tailored solutions using applications software such as MS Access or Excel, bespoke programs designed and built for a specific client and context)
- Use appropriate tools to document your proposed solution
- Justification of solution:
  - How the solution meets the brief
  - How the solution meets the needs of users
- Further improvements:
  - Additional features
  - Additional functionality.

#### 5. Can present a solution proposal to the client

- Presentation formats could include presentation slides, supporting documentation and a viva-voce
- Respond to feedback.

#### Suggested Resources

Cottrell S., 2023, Critical Thinking Skills: Effective Analysis, Argument and Reflection, Bloomsbury Academic

Brennan K.J., et al., 2022, Digital Product Management, BCS (The Chartered Institute for IT)

Bigrocks Thinking, 2022, Critical thinking, Logic & Problem Solving: The Ultimate Guide to Better Thinking, Systematic Problem Solving and Making Impeccable Decisions with Secret Tips to Detect Logical Fallacies, Independently published

Roche M., 2022, Business Communication in Plain English: How to Use Grammar, Punctuation & Style to Communicate Effectively in Business and Professional Settings: Business English Originals, IDM Business English

Kaczmarek S., Locker K., 2013, Business Communication: Building Critical Skills, McGraw-Hill

Sternad D., 2021, Solve It!: The Mindset and Tools of Smart Problem Solvers, Independently published

#### Websites

[www.skillsyouneed.com](http://www.skillsyouneed.com)

[www.coursera.org](http://www.coursera.org)

[How to develop an effective digital solution](#)

[Designing digital solutions to drive positive change in society](#)

Supporting information	
Opportunities for Synoptic Teaching and Learning	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	Teaching and learning links to other unit LO/AC
<b>LO1</b> Understand the stages and purpose of the lifecycle and lifecycle models in development activities	Computing projects rely heavily on models, frameworks and methodologies to give structure to activities. <b>U1 LO1</b> focuses on a concept of a lifecycle as a model or framework which has features that are replicated in many other models, frameworks and methodologies. <b>U1 LO1</b> therefore links directly with <b>U6 LO2</b> in the Data Analyst pathway, <b>U11 LO1</b> in the Software Development pathway and <b>U16 LO3</b> in the Cyber Security Technologist pathway.
<b>LO2</b> Understand the key behaviours needed to develop achievable requirements	IT practitioners are expected to demonstrate a range of behaviours that help them navigate teamwork, take part in effective projects and manage interactions with clients. <b>U1 LO2</b> , <b>U10 LO1</b> and <b>U11 LO3</b> have strong links with <b>U5 LO4</b> where learners explore the requirements of professional bodies and professional standards.
<b>LO3</b> Can use analysis techniques to investigate and document an existing system	Any development or improvement activity in IT requires practitioners to examine what is, and design what comes next. <b>U1 LO3</b> introduces the three basic components of analysis: information gathering, investigation documentation tools and written reports. Together these help practitioners to define customer needs and set success criteria to measure the success or failure of projects. This links with <b>U7 LO3</b> , <b>U11 LO1</b> and <b>U16 LO1</b> .
<b>LO4</b> Can identify, design and document a possible solution	Knowing what a solution could look like is not enough in modern computing. It is essential that problems can be defined and solutions (often more than one solution) can be designed and documented to ensure that projects stay on track. The skills developed in <b>U1 LO4</b> are used in <b>U3 LO2/LO3</b> , <b>U6 LO3</b> , and to support all activity in <b>U11</b> to <b>U14</b> and all activity <b>U16</b> to <b>U20</b> .
<b>LO5</b> Can present a solution proposal to the client	Whether learners are developing a solution for an internal or an external client, it is essential that they develop presentation skills that enable them to confidently and coherently share their findings and/or ideas with clients (both technical and non-technical). The skills developed here will support the activity of all pathways and the final Synoptic Project <b>U21</b> .
Opportunities for Synoptic Assessment	
Some of the Merit and Distinction criteria require knowledge from one or more of the LOs. In this unit AC 3D1 includes assessment across LO3 and LO4.	
In addition, Unit 21 provides an opportunity to demonstrate an understanding of the concepts of this unit when learners identify and develop a project idea choosing appropriate tools and techniques to find the solution to a problem, whilst demonstrating best professional practice.	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
<p><b>Problem-solving</b> – Understanding the need for structured processes (LO1) and developing key behaviours to ensure successful projects (e.g. avoiding assumption, demonstrating objectivity) (LO2). Using analytical skills, e.g. research skills, handling information, consulting multiple sources, interpreting and using information (LO1, LO2, LO3, LO4).</p> <p><b>Communication</b> - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation &amp; grammar (SPAG) (LO1, LO2, LO3, LO4, LO5). Oral communication, e.g. presenting and choosing appropriate presentation formats (LO5).</p> <p><b>Working independently</b> - Using own initiative, self-organisation, maintaining motivation/focus, managing tasks (LO1, LO2, LO3, LO4, LO5).</p> <p><b>Digital Skills</b> – Using appropriate digital devices, handling and judging the reliability of information, problem-solving (eg online research, presenting data) (LO1, LO2, LO3, LO4, LO5).</p>	<p><b>Using source of information</b> – Accessing information, e.g. choosing current, sufficient, relevant and reliable sources (LO1, LO2, LO3, LO4).</p> <p><b>Reading Skills</b> – Identifying different sources of information, reading with a purpose. (LO1, LO2, LO3, LO4).</p> <p><b>Thinking Skills</b> – Using critical thinking skills, e.g. reading all information, identifying and interpreting others’ positions, arguments and conclusions, weighing up opposing arguments, drawing conclusions (LO1, LO2, LO3, LO4, LO5).</p> <p><b>Writing Skills</b> - Understanding the purpose of writing; understanding writing styles and forms; ensuring that written output is suitable for the intended audience (LO1, LO2, LO3, LO4, LO5).</p>

<b>Unit 2 Programming and Scripting</b>	
<b>Unit aims</b>	<p>This unit focuses on the principles of programming and scripting using Python. Python is a general-purpose language that is used for a wide range of contexts. For example, it can be used to create applications such as utilities, web apps and bespoke applications. It can also be used for scripting. For example, for one-off, quick scripts to solve a problem. It could be used to automate common tasks or to create data pipelines (e.g. ETL). It is commonly used for AI and machine learning, for data analytics, and for the creation of simple APIs and for DevOps automation.</p> <p>Note: learners will have opportunities to explore other languages in the Advanced Programming unit for the Software Development pathway.</p>
<b>Unit level</b>	4
<b>Unit code</b>	A/650/8503
<b>GLH</b>	40
<b>Credit value</b>	10
<b>Unit grading structure</b>	Pass, Merit and Distinction
<b>Assessment guidance</b>	<p>In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.</p> <p>To study and achieve this unit students will need to have access to a Python interpreter. In addition, there are many IDEs that could be downloaded and installed, and which one learners choose to use will depend on their operating system and platform. Here are some common examples:</p> <p><a href="#">Python Releases for macOS   Python.org</a>  <a href="#">Python Releases for Windows   Python.org</a>  <a href="#">Visual Studio Python IDE - Python Development Tools for Windows (microsoft.com)</a></p> <p>You may find it easier to instruct learners to download whichever version you will be using during any formal classes as the interfaces can look quite different.</p>

<b>Learning outcomes</b>	<b>Assessment criteria</b>		
The learner will demonstrate that they:	The learner can:		
	<b>Pass</b>	<b>Merit</b>	<b>Distinction</b>
1. Understand principles of computer programming.	1.1 Explain key programming paradigms. 1.2 Explain the language constructs to be used within a program, with an emphasis on Python. 1.3 Explain the key differences between programming and scripting with examples.		
2. Can design a computer program to a client brief with a consideration of the user interface.	2.1 Design and document the functionality for a computer program to meet a client brief. 2.2 Design and document the user interface to meet a client brief.	2M1 Justify your design decisions for both the functionality and the user interface.	
3. Can develop a computer program to a client brief.	3.1 Implement the solution in line with the design to meet the needs of the client brief, demonstrating an understanding of appropriate coding standards in Python. 3.2 Apply validation to improve integrity of inputs.	3M1 Demonstrate Git repository commands and their purpose.	3D1 Evaluate the value of version control in the development of coded solutions.

<p>4. Can test and evaluate a computer program.</p>	<p>4.1 Create a test plan to test a computer program that has been developed.</p> <p>4.2 Analyse test results against expected results to identify discrepancies and corrective actions.</p> <p>4.3 Carry out user testing.</p>	<p>4M1 Make recommendations in relation to solution handover.</p>	<p>4D1 Evaluate the solution against the original client brief.</p>
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## Indicative Content

### 1. Understand principles of computer programming

- Programming paradigms: Procedural programming, Modular programming, Functional programming, Object-oriented programming
- Programming language constructs: Variables, Constants, Operators, Sequence, Selection and Iteration, Python Libraries, Built-in functions and User Defined functions
- Difference between programming and scripting
- Typical uses of scripting: extracting data from datasets, data pipelines, back-end web development and task automation.

### 2. Can design a computer program to a client brief with a consideration of the user interface

- Solution design tools: Flow charts, Entity Relationship Diagrams (ERDs), Data Flow Diagrams (DFDs), Unified Modelling Language (UML), data models, pseudocode, user stories
- Interface design tools: Storyboards, Navigation, Screen content, Wireframe (e.g. using suitable UI/UX tools, such as Sketch, Proto.io, LucidChart, Adobe XD, FlowMapp).

### 3. Can develop a computer program to a client brief

- Code the solution using programming constructs
- Validation (e.g. user input)
- Style guide - PEP 8 Style Guide for Python Code:
  - Naming conventions
  - Code layout
  - Indentation
  - Comments
  - Whitespace in Expressions and Statements
- Version control:
  - Role of version control software in development activities
  - Common Git repository commands: git add, git commit, git push, git pull, git checkout.

#### 4. Can test and evaluate a computer program

- Testing a program:
  - Identification of program elements that require testing.
  - Creation of a test plan
  - Applying testing programming practices (black box and white box)
  - Testing data structures and logical pathways
  - Testing validation
  - User testing
- Analysing test results:
  - Production of testing documentation and reports
  - Annotation to demonstrate corrective action
- Solution handover:
  - The role and importance of software documentation
  - Recommendations for integration, installation, deployment, maintenance
- Implementation strategies:
  - Direct
  - Parallel
  - Phased
- Check solution meets client expectations:
  - User acceptance
  - Evaluation of solution against original brief.

#### Suggested Resources

Fishpool Bernie and Fishpool Mark, 2022 Software Development in Practice, BCS (The Chartered Institute for IT)

Ellison Brady, 2022 Python: 3 books in 1- Your complete guide to python programming with Python for Beginners, Python Data Analysis and Python Machine Learning Paperback, Self-published

Ledger Leonard J., 2022 Python Programming For Beginners: The Ultimate Crash Course to Learn Python Coding Quickly and Easily | Step-by-Step Guide With Hands-on Exercises & Beginners Projects, Self-published

Sanders, Willard D., 2020 Learn python programming for beginners: A beginner's guide comprehending python. Develop your programming skills and learn all the tricks with this crash course, Self-published

Ramalho, Luciano, 2022 Fluent Python: Clear, Concise and Effective Programming, O'Reilly Media

#### Websites

[www.skillsyouneed.com](http://www.skillsyouneed.com)

[www.coursera.org](http://www.coursera.org)

[www.geeksforgeeks.org/introduction-to-programming-languages/](http://www.geeksforgeeks.org/introduction-to-programming-languages/)

[www.python.org](http://www.python.org)

[www.codinground.com/learn-python/](http://www.codinground.com/learn-python/)

<b>Supporting information</b>	
<b>Opportunities for Synoptic Teaching and Learning</b>	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
<b>Learning Outcome</b>	<b>Teaching and learning links to other unit LO/AC</b>
<b>LO1</b> Understand principles of computer programming	<b>U2 LO1</b> provides an introduction to programming by first exploring paradigms, language constructs including the concept of built-in and user defined functions and explores scripting including the use of scripting to extract data from datasets <b>U8 LO1</b> , for use in web development <b>U12 LO2/LO3</b> and which are an underpinning technology for Cyber Security ( <b>U18, U19</b> ) and as the basis for Cryptography ( <b>U20</b> ). In addition, learners are introduced to functions which are the building blocks of code which allow <b>Data Analysts</b> to interrogate data, <b>Software Developers</b> to create programs and <b>Cyber Security Technologists</b> to protect data and systems.
<b>LO2</b> Can design a computer program to a client brief.	Different computing disciplines will use different design tools as part of the design process. Diagramming is one of the most used visual tools to help technical audiences quickly understand an existing system or the framework and processes for a solution. <b>U2 LO2</b> therefore links with <b>U7 LO2, U13 LO1</b> and <b>U16 LO3</b> .
<b>LO3</b> Can develop a computer program to a client brief.	As the learning outcome where programming code is specifically produced, most of <b>U2 LO3</b> will be developed in <b>Units 11 to 14</b> in the <b>Software Development</b> pathway, although the style guide (PEP 8) will only be relevant if Python is used as the development language for the extension units.
<b>LO4</b> Can test and evaluate a computer program.	All IT practitioners should understand that it is not enough to simply create a solution, the solution must be rigorously tested. In a <b>Data Analyst</b> context, the outputs of analysis should be verified before being shared with users. Computer programs developed by <b>Software Developers</b> should be tested to ensure that they work as expected and have the anticipated functionality. <b>Cyber Security</b> solutions should be tested to ensure that data and systems are secure.
<b>Opportunities for Synoptic Assessment</b>	
Unit 21 provides an opportunity to demonstrate an understanding of the concepts of this unit when learners identify and develop a project idea choosing appropriate tools and techniques to find the solution to a problem, whilst demonstrating best professional practice.	

<b>Opportunities for Skills Development within this unit</b>	
<b>Employability Skills</b>	<b>Study Skills</b>

**Problem-solving** – Understanding and knowing when to apply a range of programming principles by choosing an appropriate paradigm, language and technique to solve a problem (LO1) and developing key behaviours by designing solutions to meet a client brief, developing the coded solution and testing it before implementing it in the form of a formal handover (LO2, LO3, LO4). Using analytical skills, e.g. research skills, handling information, consulting multiple sources, interpreting and using information (LO1, LO2, LO3, LO4).

**Communication** - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation & grammar (SPAG) (LO1, LO2, LO3, LO4).

**Working independently** - Using own initiative, self-organisation, maintaining motivation/focus, managing tasks (LO1, LO2, LO3, LO4).

**Digital Skills** – Using appropriate digital devices, handling and judging the reliability of information, problem-solving (eg online research, presenting data) (LO1, LO2, LO3, LO4).

**Using source of information** – Accessing information, e.g. choosing current, sufficient, relevant and reliable sources (LO1, LO2, LO3, LO4).

**Reading Skills** – Identifying different sources of information, reading with a purpose. (LO1, LO2, LO3, LO4).

**Thinking Skills** – Using critical thinking skills, e.g. reading all information, identifying and interpreting others' positions, arguments and conclusions, weighing up opposing arguments, drawing conclusions (LO1, LO2, LO3, LO4).

**Writing Skills** - Understanding the purpose of writing; understanding writing styles and forms; ensuring that written output is suitable for the intended audience (LO1, LO2, LO3, LO4).

<b>Unit 3 Data and Database Systems</b>			
<b>Unit aims</b>	<p>All IT professional roles will bring practitioners into contact with data and databases. For example: Analysts will gather, organise and manipulate data for use in a variety of ways; Cyber Security Technicians will manage the privacy and security of data and data systems; Software Developers and DevOps Engineers will create and maintain systems containing complex data.</p> <p>This unit introduces learners to data and database systems by exploring the concept of data, data modelling and creating systems to hold and manage data. It takes a real-world view of database and database design, without focusing on data manipulation, which will be introduced in a later unit.</p>		
<b>Unit level</b>	4		
<b>Unit code</b>	D/650/8504		
<b>GLH</b>	60		
<b>Credit value</b>	15		
<b>Unit grading structure</b>	Pass, Merit and Distinction		
<b>Assessment guidance</b>	<p>In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.</p> <p>Although this unit focuses on databases and database systems, learners will not be required to build the database that they design. In terms of tools they could use to support this unit, they have the option of using specific diagramming software for example:</p> <p><a href="https://www.lucidchart.com/">https://www.lucidchart.com/</a>  <a href="https://miro.com/">https://miro.com/</a>  <a href="https://draw.io/">https://draw.io/</a></p> <p>Equally, learners could draw the diagrams by hand, as long as they are neat and legible.</p>		
<b>Learning outcomes</b>	<b>Assessment criteria</b>		
The learner will demonstrate that they:	The learner can:		
	<b>Pass</b>	<b>Merit</b>	<b>Distinction</b>
1. Understand what is meant by data.	1.1 Describe different categories of data. 1.2 Explain the differences between structured and unstructured data. 1.3 Explain the concept of data types and structures, and the	1M1 Assess the importance of data classification.	1D1 Evaluate the importance of data to an organisation.

	importance of selecting the most appropriate data type of an identified data item.		
2. Understand database design.	<p>2.1 Explain different types of database.</p> <p>2.2 Describe the different relationship types, join types and types of key.</p> <p>2.3 Explain normalisation and functional dependency within a database.</p> <p>2.4 Describe database administration including integrity and security control.</p>	2M1 Assess the integrity constraints within relational models.	
3. Design a database system.	<p>3.1 Design a relational database to meet a specified design brief.</p> <p>3.2 Apply normalisation to a series of documents to 3NF.</p> <p>3.3 Use database documentation tools to document a design to meet a design brief.</p> <p>3.4 Present your design to the client using a suitable format.</p>	3M1 Identify the opportunities to implement validation and verification to enhance the integrity of the database.	3D1 Evaluate database design and how it meets the technical requirements of the brief following feedback.

## Indicative Content

### 1. Understand what is meant by data

- Categories of data: open and public data, private data, internal data, research data, big data
- Importance of data classification:
  - Compliance with regulations and guidelines
  - Protect data integrity, confidentiality and security
  - Usage rights for levels of access depending on sensitivity
- Structured data: Data is highly organised, factual or based on fact, quantitative. It is usually numeric, textual and contains dates; can be displayed in rows and columns (tabular)

- Semi-structured data: (e.g. log files which can combine structured with unstructured data).
- Unstructured data: Data is varied (e.g. images, audio or video files, emails); cannot be displayed in rows and columns and would be considered qualitative (so could include subjective data).
- Data Types and Structures:
  - Text (character, string)
  - Numeric (byte, integer, long, floating point/decimal, complex)
  - Boolean
  - Date and time
  - Timestamp
  - Sequence (array, stack, queue, linked list, set, dict).
- Importance of understanding data types and structures:
  - In programming:
    - i. to ensure inputs are correctly captured and stored for use in the program (e.g. losing numbers after the point if data incorrectly identified as an integer rather than a float (decimal) in typed languages)
    - ii. to be able to format outputs
    - iii. to be able to access built-in libraries of functions to manipulate data
  - In databases:
    - i. To ensure that identified fields can accurately accept inputs
    - ii. to make use of input masking and validation
    - iii. to be able to calculate the amount of storage needed.

## 2. Understand database design

- Database types: Flat database (row or column based), relational database, NoSQL versus SQL approach.
- Database relationships: types of relationships (1:M, M:M and 1:1 and the implications of each), types of joins (inner, outer (left, right and full)), keys (primary, foreign, compound).
- Integrity constraints: referential integrity, domain integrity, entity integrity, foreign key integrity
- Functional dependencies: schema normalisation, normal forms (EF Codd) (UNF, 1NF, 2NF, 3NF)
- ACID principles (atomicity, consistency, isolation, durability)
- Database schema
- Database administration: the role of the DBA, DBA skills and responsibilities.

## 3. Design a database system

- Relational database design fundamentals, logical vs. physical design
- Database documentation tools: ERD, DFD, data dictionary
- Database evaluation: performance evaluation benchmarks, verification, validation.

## Suggested Resources

Murray Brian, 2023 Data Modelling and Database Design: Turn your data into actionable insights, Self-published

Hamer Malcolm, 2017 Relational Database Practices: Bridging the Gap Between the Theory of Database Design and Real-world Practices, Self-published

Stephens Rod, 2023 Beginning Database Design Solutions: Understanding and Implementing Database Design Concepts for the Cloud and Beyond, Wiley

Date C.J., 2012 Database Design and Relational Theory: Normal Forms and All That Jazz, O'Reilly Media

## Websites

[www.skillsyouneed.com](http://www.skillsyouneed.com)

[www.coursera.org](http://www.coursera.org)

[code.tutsplus.com/tutorials/relational-databases-for-dummies--net-30244](http://code.tutsplus.com/tutorials/relational-databases-for-dummies--net-30244)

[www.digitalocean.com/community/tutorials/understanding-relational-databases](http://www.digitalocean.com/community/tutorials/understanding-relational-databases)

Supporting information	
Opportunities for Synoptic Teaching and Learning	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	Teaching and learning links to other unit LO/AC
<b>LO1</b> Understand what is meant by data	<b>Software Developers</b> and <b>Data Analysts</b> need to have a very strong understanding of data and <b>U3 LO1</b> examines the basics of data (such as classification, structure and type) in the context of a database. <b>U3 LO1</b> links to <b>U6 LO1</b> , and underpins all <b>Software Development</b> units. It is also important to <b>Cyber Security Technicians</b> because the type of data will also influence the technology used to secure it to meet the requirements of Data Protection legislation.
<b>LO2</b> Understand database design	Organisations are data rich and generate thousands of transaction records every day. To efficiently store data, it is necessary to fully understand how data is organised when stored. All learners are introduced to normalisation which is a process used to identify the most appropriate data storage structure. This is then also studied by <b>Data Analysts</b> in <b>U6 LO1</b> when learners consider normalised data (used in relational systems). <b>Software Developers</b> use code to manipulate data systems.
<b>LO3</b> Design a database system	Using diagramming techniques developed in <b>U1 LO3</b> , learners create a design for a relational database, although they do not have to implement this.
Opportunities for Synoptic Assessment	

Unit 21 provides an opportunity to demonstrate an understanding of the concepts of this unit when learners identify and develop a project idea choosing appropriate tools and techniques to find the solution to a problem, whilst demonstrating best professional practice.

**Opportunities for Skills Development within this unit**

**Employability Skills**

**Problem-solving** – Understanding the technologies associated with database design and knowing how to select and apply appropriate technologies to create business solutions (LO1) and developing key behaviours to ensure that databases are designed with integrity in mind (LO2). Using analytical skills, e.g. research skills, handling information, consulting multiple sources, interpreting and using information (LO1, LO2, LO3).

**Communication** - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation & grammar (SPAG) (LO1, LO2). Oral communication, e.g. presenting and choosing appropriate presentation formats (LO3).

**Working independently** - Using own initiative, self-organisation, maintaining motivation/focus, managing tasks (LO1, LO2, LO3).

**Digital Skills** – Using appropriate digital devices, handling and judging the reliability of information, problem-solving (eg online research, presenting data) (LO1, LO2, LO3).

**Study Skills**

**Using source of information** – Accessing information, e.g. choosing current, sufficient, relevant and reliable sources (LO1, LO2, LO3).

**Reading Skills** – Identifying different sources of information, reading with a purpose. (LO1, LO2, LO3).

**Thinking Skills** – Using critical thinking skills, e.g. reading all information, identifying and interpreting others' positions, arguments and conclusions, weighing up opposing arguments, drawing conclusions (LO1, LO2, LO3).

**Writing Skills** - Understanding the purpose of writing; understanding writing styles and forms; ensuring that written output is suitable for the intended audience (LO1, LO2, LO3).

<b>Unit 4 Computer Systems, Networks and Security</b>			
<b>Unit aims</b>	This unit has three primary focuses. Firstly, it explores the technologies that enable computing such as memory, programs and logic. It then examines both hardware and software, connectivity and networking principles before examining risks to computer systems and data. Learners will explore a range of risks, attack techniques, security tools and a range of incidents and vulnerabilities. This is appropriate underpinning knowledge for any IT practitioner/professional who should have a basic understanding of computer security.		
<b>Unit level</b>	4		
<b>Unit code</b>	F/650/8505		
<b>GLH</b>	50		
<b>Credit value</b>	10		
<b>Unit grading structure</b>	Pass, Merit and Distinction		
<b>Assessment guidance</b>	In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.		
<b>Learning outcomes</b>	<b>Assessment criteria</b>		
The learner will demonstrate that they:	The learner can:		
	<b>Pass</b>	<b>Merit</b>	<b>Distinction</b>
1. Understand enabling principles.	1.1 Describe common units and metrics. 1.2 Explain the role of different types of memory. 1.3 Explain data representation. 1.4 Explain stored programs and languages. 1.5 Explain basic logic.		
2. Understand hardware and software.	2.1 Describe the components of different computer systems. 2.2 Explain the use of different software applications to meet specific purposes. 2.3 Explain the principles of networks and network connectivity.	2M1 Assess the function of components within a chosen computer system.	2D1 Recommend and justify a hardware and software solution to meet specific purposes.

<p>3. Understand the risks to computer systems and data.</p>	<p>3.1 Explain a range of attack techniques.  3.2 Examine the nature of security incidents.  3.3 Describe security tools and techniques used to mitigate against a range of attacks.  3.4 Explain a range of security processes and their importance.</p>	<p>3M1 Assess the suitability of a range of security processes and the use of encryption to meet specific purposes.</p>	
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## Indicative Content

### 1. Understand enabling principles

- Common units and metrics
  - Key number bases and their uses, e.g. binary, octal, hexadecimal, base64
  - Use of IEC binary prefixes (i.e. kibi versus kilo)
  - Capacity/sizes, e.g. Kb, Mb, Gb, Tb etc
  - Speeds, e.g. data transfer rates such as megabytes per second (MB/s), megabits per second (Mbit/s)
  - Frequency (e.g. Mhz, Ghz etc)
  - Time (e.g. micro seconds, nano seconds)
- Computer memory
  - Volatile vs. Non-volatile
  - ROM, RAM, EPROM/EEPROM, NAND flash memory
- Data representation
  - Data versus information
  - Data representation, e.g. Character sets (ASCII, Unicode, UTF8 etc.)
  - Use of parity, checksum (e.g. MD5)
- Stored programs and languages
  - CPU architecture
  - Fetch-execute cycle
  - Low level and High-level languages
    - Machine code
    - Assembly language
    - Programming Languages (e.g. Python, Java, Ruby, Rust, C, C++)
  - Translators, e.g. compilers, interpreters
  - Virtual machines and byte code
- Basic logic
  - Boolean algebra
  - Logic gates
    - AND, OR, Not, XOR

### 2. Understand hardware and software

- Hardware:

- Motherboard, RAM, CPU, BIOS/EFI chip, CMOS, GPU, Expansion slots, Trusted Platform Module (TPM)
- Input devices, e.g. keyboard, mouse, scanner, camera, microphone
- Output devices, e.g. monitor, printer (2D, 3D), speakers
- Communications, e.g. Network Interface Card (NIC)
- Backing storage:
  - Hard Disk Drive (HDD)
  - Solid State Drive (SDD)
  - Universal Serial Bus (USB) flash drive
  - Writeable optical drives
  - Network Attached Storage (NAS)
  - Cloud storage
- Software:
  - Operating Systems:
    - The concepts, main functions and features of at least three Operating Systems (OS) (e.g. command line interface (CLI), graphical user interface (GUI)), and their security functions and associated security features.
  - Utility Software
  - Applications/Apps
- Firmware:
  - BIOS, Flashing (updates)
- Connectivity:
  - Wired, e.g. Cat 6, Optical, Ethernet over Power line (EOP)
  - Wireless, e.g. Bluetooth, WiFi 2.4/5 Ghz, Cellular, i.e. 3G, 4G, 5G
- Principles of networks:
  - Simple topologies (star, ring, mesh etc)
  - Types of network, e.g. PAN, LAN, MAN, WAN
  - OSI and TCP/IP models, data, protocols and how they relate to each other; the main routing protocols; the main factors affecting network performance including typical failure modes in protocols and approaches to error control; virtual networking
  - Binding network services; sockets and ports

### 3. Understand the risks to computer systems and data

- Risks: Computer threats, Digital crime, Privacy, Security, Impact of e-everything (e.g. e-marketing, e-banking).
- Attack techniques: Main types of common attack techniques; also the role of human behaviour, including the significance of the 'insider threat'. Including: how attack techniques combine with motive and opportunity to become a threat. Techniques and strategies to defend against attack techniques and mitigate hazards.
- Security tools and techniques: A range of modern security tools and techniques - e.g. threat modelling, vulnerability scanning and dependency checking, with a general awareness of penetration testing - in order to deal with threats and attack vectors within code and across the cyber domain.
- Nature of security incidents:

- Application of overly restrictive controls without understanding business needs and processes that may be impacted by the controls
- Lack of suitably defined organisational processes
- Unexpected pressures of business
- Accidental exposure to threats via the internet
- Weakness not identified due to insufficient testing
- The human element
- Common vulnerabilities: function and features of significant digital system components; typical architectures; common vulnerabilities in digital systems; principles and common practice in digital system security
- Software: anti-virus, anti-spyware, anti-phishing, anti-ransomware, Intrusion Detection Systems (IDS).
- Reasons for regular software updates and security patches.
- Hardware: TPM modules, Drive encryption (BitLocker)
- Security processes:
  - Authentication vs. authorisation; secure logins
  - User permissions, e.g. admin versus normal user
  - File permissions, e.g. read only, write, modify etc.
  - Logging and regular monitoring
- Hashing (as one-way cryptographic function)
- Encryption and cipher suites, strengths
- Virtual Private Networks (VPN)
- HTTPS (TLS), SSL Certificates
- Legislation overview

### **Suggested Resources**

Thornton G., Jones C., 2023, Computer and Network Technology, BCS Level 4 Certificate in IT study guide, BCS (The Chartered Institute for IT)

Hodson C.J., 2019, Cyber Risk Management: Prioritize Threats, Identify Vulnerabilities and Apply Controls, Kogan Page

Englander I., Wong W., 2021, The Architecture of Computer Hardware, Systems Software, and Networking: An Information Technology Approach, 6<sup>th</sup> Edition, Wiley

Mind Tools, 2023, Logic in Computer Science for Everyone: A Practical Guide with Real-World Scenarios, Independently Published

### **Websites**

[www.skillsyouneed.com](http://www.skillsyouneed.com)

[www.coursera.org](http://www.coursera.org)

[Info Security Magazine](#)

[8 hot networking technologies for 2023](#)

[What is network security?](#)

**Supporting information**

**Opportunities for Synoptic Teaching and Learning**

Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.

Learning Outcome	Teaching and learning links to other unit LO/AC
<b>LO1</b> Understand enabling principles	The enabling principles form the base of computing and features such as computer logic provide links to all pathways such as the use of WHERE conditions in <b>U8 LO1</b> . Use of logic in the coding of selections and loops in all <b>Software Development</b> units and the use of logic to produce diagrams in <b>U16 LO3</b> and to map partitions in <b>U17 LO2</b> .
<b>LO2</b> Understand hardware and software	<b>U4 LO2</b> links to all pathways as an underpinning technology but has specific links to <b>U17 LO2</b> in the coverage of operating systems without which computers could not function.
<b>LO3</b> Understand the risks to computer systems and data	The need to manage risk is also present across all pathways. Considering risk begins in <b>U1 LO3</b> where one of the purposes of development is to reduce risk. Risk is also the basis for some aspects of legislation ( <b>U5 LO1</b> ) and it is the reason why organisations develop policies and procedures ( <b>U5 LO3</b> ). It features in <b>U14 LO3</b> in relation to web application development, is the rationale for extensive program testing in <b>U15 LO1</b> and is a founding principle in DevOps. It clearly is also the basis for <b>Cyber Security</b> which seeks to protect data and systems from a range of risks.

**Opportunities for Synoptic Assessment**

Some of the Merit and Distinction criteria require knowledge from one or more of the LOs. In this unit, AC 2D1 includes assessment across LO2 and LO3.

In addition, Unit 21 provides an opportunity to demonstrate an understanding of the concepts of this unit when learners identify and develop a project idea choosing appropriate tools and techniques to find the solution to a problem, whilst demonstrating best professional practice.

**Opportunities for Skills Development within this unit**

Employability Skills	Study Skills
<p><b>Problem-solving</b> – Understanding basic enabling principles of computing, what they are and how they are used in computer systems. Learners will also be able to explain basic logic including logic gates and the application of Boolean algebra (LO1). Understanding different contexts and how software applications can be used to meet specific purposes (LO2). Understanding risk and knowing how to mitigate against a range of attacks (LO3).</p>	<p><b>Using sources of information</b> – This is essential, particularly for keeping up to date in relation to security risks and mitigation techniques. These should be relevant and drawn from reliable sources (LO3).</p> <p><b>Reading Skills</b> – Identifying different sources of information, reading with a purpose. (LO1, LO2, LO3).</p> <p><b>Thinking Skills</b> – Using critical thinking skills, e.g. reading all information, identifying and interpreting others’ positions, arguments and conclusions, weighing up opposing arguments, drawing conclusions (LO1, LO2, LO3).</p>
<p><b>Communication</b> - Written communication, e.g. appropriate formats,</p>	

style and tone, spelling, punctuation & grammar (SPAG) (LO1, LO2, LO3).

**Working independently** - Using own initiative, self-organisation, maintaining motivation/focus, managing tasks (LO1, LO2, LO3).

**Digital Skills** – Using appropriate digital devices, handling and judging the reliability of information, problem-solving (eg online research, communicating information) (LO1, LO2, LO3).

**Writing Skills** - Understanding the purpose of writing; understanding writing styles and forms; ensuring that written output is suitable for the intended audience (LO1, LO2, LO3).

<b>Unit 5 Legislation, Regulation, Ethics and Codes of Practice</b>			
<b>Unit aims</b>	IT practitioners in the modern world should understand how legislation and regulation applies in the IT sector. They should also understand why organisations create policies and procedures to help them to operate on a day-to-day basis. They should have an appreciation of a range of ethical issues and should be aware of the role of professional bodies in setting standards to maintain the industry in the industry. Learners should also be familiar with the concept of professional certification. For example, there are some organisations that require specific professional certification as part of their pre-requisites for industry jobs.		
<b>Unit level</b>	4		
<b>Unit code</b>	H/650/8506		
<b>GLH</b>	60		
<b>Credit value</b>	10		
<b>Unit grading structure</b>	Pass, Merit and Distinction		
<b>Assessment guidance</b>	<p>In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.</p> <p>NB. Although much of the legislation for this unit is UK and EU focused, there is evidence that many other countries are seeking to align their own legislation with the UK and EU. Tutors should be aware of how their own country's legislation compares with the UK and EU and should teach accordingly.</p>		
<b>Learning outcomes</b>	<b>Assessment criteria</b>		
The learner will demonstrate that they:	The learner can:		
	<b>Pass</b>	<b>Merit</b>	<b>Distinction</b>
1. Understand current legal and regulatory issues in IT.	1.1 Describe key legislation in relation to data protection, digital systems and cyber security. 1.2 Explain the relationship between legislation/regulation and data/systems security. 1.3 Explain the importance of complying with legislation in relation to human computer interaction design.	1M1 Assess the importance of organisations meeting the requirements of current legislation and regulation.	1D1 Evaluate the impact of current legal and regulatory issues on a chosen organisation.

2. Understand current ethical issues in IT.	2.1 Describe the concept of ethical best practice. 2.2 Explain ethical issues in relation to IT roles. 2.3 Explain ethical issues in relation to emerging technologies.		
3. Understand the need to create organisational policies and procedures.	3.1 Examine the role of organisational policies and the need for standardised procedures in a range of contexts.	3M1 Assess the importance of standardised policies and procedures.	3D1 Evaluate the impact of standardised policies and procedures.
4. Understand the role of professional bodies and industry certification in maintaining professional standards in industry.	4.1 Describe the core competencies and skills required by an IT professional. 4.2 Identify professional bodies and industry certification that would be beneficial to those seeking work in a chosen professional IT pathway.	4M1 Assess the role of professional bodies and industry certification in the maintenance of professional standards in the industry.	

## Indicative Content

### 1. Understand current legal and regulatory issues in IT

- Data Protection: laws, regulations & standards relating to personal data and privacy (e.g. Data Protection Act 2018 implementing General Data Protection Regulation UK).
- Use of digital systems (e.g. Computer Misuse Act 1990).
- Regulatory standards for cyber security, intelligence collection and law enforcement (e.g. Intelligence Services Act 1994, Regulation of Investigatory Powers Act 2000), standards for good practice in cyber security (e.g. ISO 27001, CyberEssentials, NIST).
- IT contracts: confidentiality agreements, Intellectual Property.
- Impact of legislation in HCI design: functionality, usability, reliability, efficiency, maintainability, portability.
- End User License Agreement (EULA).
- Responsibilities: understanding that IT professionals need to observe legal and regulatory requirements when creating systems for users in other countries (e.g. US Data Privacy Laws in 2023, African Union's Convention on Cyber Security and Personal Data Protection).
- Importance of local issues: creating online games or app content for countries where gambling or other activities are banned, or where information or access to specific content is prohibited by governments.

- Relationship between legislation/regulation and data/systems security: promotes best practice, sets benchmarks for expected behaviours.
- Importance of observing the legal and regulatory requirements: safety of employees, consumer protection, protection of intellectual property (copyright and patents), avoid reputational damage, avoid penalties and/or sanctions.

## **2. Understand current ethical issues in IT**

- Ethical best practice: own responsibilities, responsibilities in relation to colleagues, responsibilities in relation to society (e.g. confidentiality, integrity, relationships), issues raised by users connecting their own kit to organisational systems.
- Ethics in IT roles: systems design and development, cyber security, digital marketing (e.g. data gathering, manipulation and use of personal data, marketing rules in relation to unsolicited sign-ups, channels of contact).
- Ethics in emerging technologies:
  - misuse of personal information
  - misinformation and the potential for using deep fakes in marketing
  - lack of oversight and acceptance of responsibility
  - autonomous technologies
  - dilemmas: potential for health tracking, genetic engineering, weaponisation of technology.

## **3. Understand the need to create organisational policies and procedures**

- Role of organisational policies and the need for standardised procedures:
  - information security management (e.g. governance, organisational structure, roles, policies, in-house computer use rules, standards, guidelines and how these all work together to deliver the identified security outcomes)
  - data management (e.g. storage and treatment of GDPR sensitive data)
  - access control
  - concept of data security in three key states (at rest, in transit, in processing)
  - electronic messaging
  - monitoring
  - remote access
  - server security.
- Importance of standardised policies and procedures:
  - set expectations for employees and managers
  - promotes shared culture
  - promotes transparency and formalises an accountability structure
  - sets out a plan for daily operations
  - promotes efficiency.
- Impact of standardised policies and procedures:
  - can take time to set up
  - may require some financial investment
  - some staff may be resistant to change enforced by new policies and procedures.

## **4. Understand the role of professional bodies and industry certification in maintaining professional standards in industry**

- Professional bodies for the IT industry and industry certification, e.g.:
  - BCS (The Chartered Institute for IT), who offer BCS membership and the opportunity to be included on the RITTech register of technical professionals

- IEEE Computer Society for Electrical and Electronics Engineers
- National Cyber Security Centre (NCSC) in the UK
- National Cyber Security Alliance (NCSA) in the US
- CIS (Centre for Internet Security)
- IoA (The Institute of Analytics and Data Science)
- ITIL Foundation (Information Technology Infrastructure Library)
- PRINCE2 (Project Management certification)
- APM (Association for Project Management).

Although these professional bodies are recognised in many countries around the world, the teacher should add in any relevant local examples.

- Role of professional bodies:
  - set expectations and (sometimes) assess professional practice
  - provide opportunities for professional development
  - provide access to professional networks
  - contribute to codes of conduct that guide professional behaviour
  - publish journals and books that promote best practice.
- IT professional core competencies:
  - technology awareness
  - understanding business practice
  - being adaptable
  - designing technical solutions
  - managing projects
  - communication
  - influencing and persuading.
- Skills required for IT professionals:
  - analysis
  - design
  - development.

## Websites

[www.skillsyouneed.com](http://www.skillsyouneed.com)

[www.coursera.org](http://www.coursera.org)

<https://www.jisc.ac.uk/guides/networking-computers-and-the-law/laws>

<https://www.legislation.gov.uk/ukpga/1990/18/contents>

<https://u.ae/en/information-and-services/justice-safety-and-the-law/cyber-safety-and-digital-security>

<https://www.cio.com/article/189326/how-uae-s-new-data-law-will-change-the-way-enterprises-use-personal-data.html>

<https://www.icdigital.com/post/uae-federal-data-protection-law-for-cybersecurity>

<https://www.lexology.com/library/detail.aspx?g=baef72ee-10bd-4eb9-a614-a990c236bb45>

<https://www.dataguidance.com/jurisdiction/africa>

<https://digital-strategy.ec.europa.eu/en/policies/cybersecurity-act>

<https://gdpr.eu/what-is-gdpr/>

<https://www.computing.co.uk/news/4076979/europes-online-rules-affect-uk-businesses>

Supporting information	
<b>Opportunities for Synoptic Teaching and Learning</b>	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	Teaching and learning links to other unit LO/AC
<b>LO1</b> Understand current legal and regulatory issues in IT	Although there is an emphasis on European and UK legislation, this is appropriate for those analysts, software developers and cyber technicians who intend to operate within the UK and Europe, although a lot of the legislation has been adopted in other parts of the world (see <b>U5 LO1</b> indicative content). Learners should also study similar legislation in their own country and discuss why there are operational differences around the world and why legislation is necessary. This topic features in all pathways and across all units as activity should always be regulation and legislation compliant.
<b>LO2</b> Understand current ethical issues in IT	As with legislation and regulation, ethics is an important aspect of professional behaviour in the industry. <b>Data Analysts</b> should question whether they are using data ethically. <b>Software Developers</b> should consider the wider implications of software they create, for example there is a significant current debate on AI and its applications.
<b>LO3</b> Understand the need to create organisational policies and procedures	Policies and procedures are also universally relevant across all pathways. Many organisations will have specific policies about how they handle and store data (to comply with legislation and regulation). They will have policies about levels of access into different areas of software and about how information is transmitted electronically. This should be discussed when opportunities arise in all units in the programs to ensure that learners understand the importance of organisations controlling their own activities.
<b>LO4</b> Understand the role of professional bodies and industry certification in maintaining professional standards in industry	<b>U5 LO4</b> considers the role of professional bodies and lists many organisations that are industry recognised around the world. There are examples for every pathway in the list. If there are similar organisations in the learner's own country, then this would be an opportunity to explore them.
<b>Opportunities for Synoptic Assessment</b>	
Unit 21 provides an opportunity to demonstrate an understanding of the concepts of this unit when learners identify and develop a project idea choosing appropriate tools and techniques to find the solution to a problem, whilst ensuring that their activities are undertaken in the context of sound legal and regulatory principles, are ethical and which demonstrate best professional practice.	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
<b>Communication</b> - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation & grammar (SPAG) (LO1, LO2, LO3, LO4). Oral communication, e.g. presenting and	<b>Using source of information</b> – Accessing information, e.g. choosing current, sufficient, relevant and reliable sources (LO1, LO2, LO3, LO4).

<p>choosing appropriate presentation formats (LO5).</p> <p><b>Working independently</b> - Using own initiative, self-organisation, maintaining motivation/focus, managing tasks (LO1, LO2, LO3, LO4).</p> <p><b>Digital Skills</b> – Using appropriate digital devices, handling and judging the reliability of information, problem-solving (eg online research, presenting data) (LO1, LO2, LO3, LO4).</p>	<p><b>Reading Skills</b> – Identifying different sources of information, reading with a purpose (LO1, LO2, LO3, LO4).</p> <p><b>Thinking Skills</b> – Using critical thinking skills, e.g. reading all information, identifying and interpreting others' positions, arguments and conclusions, weighing up opposing arguments, drawing conclusions (LO1, LO2, LO3, LO4).</p> <p><b>Writing Skills</b> - Understanding the purpose of writing; understanding writing styles and forms; ensuring that written output is suitable for the intended audience (LO1, LO2, LO3, LO4).</p>
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<b>Unit 6 Organisational Data Architecture</b>			
<b>Unit aims</b>	This unit teaches the learners to appreciate the organisational context of data and its importance in modern organisations. It does so by making learners aware of how data is managed, how it is structured, and how data and its analysis impacts the operation of an organisation.		
<b>Unit level</b>	4		
<b>Unit code</b>	K/650/8535		
<b>GLH</b>	40		
<b>Credit value</b>	10		
<b>Unit grading structure</b>	Pass, Merit and Distinction		
<b>Assessment guidance</b>	In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.		
<b>Learning outcomes</b>	<b>Assessment criteria</b>		
The learner will demonstrate that they:	The learner can:		
	<b>Pass</b>	<b>Merit</b>	<b>Distinction</b>
1. Understand the principles of organisational data architecture.	1.1 Explain the importance of data as a business resource. 1.2 Describe the roles played by operational and analytical systems. 1.3 Describe the importance of database locations.	1M1 Compare the development effort and benefits achieved by activities undertaken through an ETL process.	1D1 Evaluate the technical design choices usually employed in operational and analytical systems.
2. Understand a common data analysis lifecycle of their choice.	2.1 Describe each stage and how they follow each other. 2.2 Outline the activities and outcomes of each step.	2M1 Compare the key features of a chosen model with other models.	
3. Understand a simple entity-relationship model.	3.1 Explain the difference between a 'type' and an 'instance'. 3.2 Identify types and their attributes.		3D1 Evaluate the importance of understanding the directions of relationships and how this impacts the

	3.3 Identify relationships between types and their cardinalities, if applicable.		navigability between types.
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## Indicative Content

### 1. Understand the principles of organisational data architecture

- The importance of data as a business resource in addition to traditional business resources such as:
  - Physical
  - financial
  - intellectual
  - human.
- Data generated by business departments:
  - Finance; structured, well defined, reconciled, confidential data.
  - Human resources; structured records, unstructured documents, sensitive data.
  - Customer services; structured sales and customer data, unstructured emails, and voice calls.
  - Senior management/company board; summarised, high level, interpreted data.
- How data is stored and exchanged between departments in an enterprise:
  - Unstructured documents and reports; structured spreadsheets, databases, and APIs.
  - Unprotected email attachments vs protected document sharing, such as SharePoint.
- Master data management; data stored in multiple systems (aka. fragmentation):
  - The golden source of a data item.
- The difference between operational systems and analytical systems:
  - Processing needs in transactional processing; needing to process one record at a time.
  - Bulk/batch processing in analytical systems; needing to process large number of records and write-once-read-many (WORM).
  - Data models; normalised vs flat/tabular.
- Distributed databases; on-premises solutions vs outsourced vs cloud solutions; the impact of non co-location of datasets when performing analysis.

### 2. Understand a common data analysis lifecycle of their choice

- A common data lifecycle model such as CRISP-DM (alternatives include SEMMA, KDD or a custom/industry specific model) – typical stages include:
  - Business Understanding; stakeholder motivations, analysis objectives, requirements description.
  - Data Understanding; listing data sources, considering possible data quality issues.
  - Data Preparation; common data analysis methods described below.
  - Modelling; evaluate, select, and apply modelling techniques, loopback to data preparation, statistical modelling and visualisation techniques are covered in subsequent units.
  - Evaluation; testing the accuracy of the models, collaboration with stakeholders.

- Deployment; presenting them to stakeholders, integrating models into systems/user interfaces.
- Typical characteristics and key features could include:
  - Cyclicity/iterative approach; benefits vs drawback of cyclical models.
  - Does not prescribe tools or methods.
  - Focus on business goals.
  - Industry standard model.
- The requirements of the inputs to each step and to the outputs of each step:
  - Business Understanding; build on prior data analysis, establishes framework/preliminary plan.
  - Data Understanding; build on knowledge of the business, establishes familiarity with the data.
  - Data Preparation; build on data familiarity, establishes well-structured data.
  - Modelling; build on robust data, establishes a set of models.
  - Evaluation; build on models, establishes the most appropriate model(s).
  - Deployment; build on suitable models, realises the business value of the analysis.
- The skills and people involved in each step.

### 3. Understand a simple entity-relationship model

- The popular UML Class Diagram notation:
  - Alternatives such as Barkers, IDEF1X or any other recognised notation, are acceptable.
- The notation and the modelling concepts typically represented by:
  - Entities: type.
  - Relationships: type, cardinality, role descriptions, direction/navigation.
  - Attributes: type, name, value.
- Operation signatures (parameters and return types), operation name.
- The business relationships described by an entity-relationship diagram.

### Suggested Resources

Rasmussen, R., Gulati, H., Joseph, C., Stanier, C. and Umegbolu, O. (2019) Data Analyst: Careers in data analysis, Rasmussen, R. (ed.), BCS Learning and Development.

Parkinson, J. (2022) Introduction to Data Architecture: A foundation covering the key essentials, Holifast Limited

Ben Zahra Anouar (2023) Azure Modern Data Architecture: A Guide to Design and Implement Modern Data Solutions, Self-published

Malaska T. and Seidman, J. (2018) Foundations for Architecting Data Solutions: Managing Successful Data Projects, O'Reilly

### Websites

[www.skillsyouneed.com](http://www.skillsyouneed.com)

[www.coursera.org](http://www.coursera.org)

<https://www.bmc.com/blogs/data-architecture/>

<https://www.cio.com/article/190941/what-is-data-architecture-a-framework-for-managing-data.html>

<https://www.simplilearn.com/what-is-data-architecture-article>

<https://www.snowflake.com/trending/data-architecture-principles>

<https://rivery.io/blog/what-is-data-architecture/>

Supporting information	
<b>Opportunities for Synoptic Teaching and Learning</b>	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	Teaching and learning links to other unit LO/AC
<b>LO1</b> Understand the principles of organisational data architecture	This LO links with many other units, for example: <b>U2 LO1, U11 LO2, U14 LO1</b> and <b>U19 LO1</b> which all explore APIs. Organisational processes discussed in this LO also link with <b>U1 LO3</b> and <b>U4 LO3</b> and with the coverage of models, frameworks and methodologies which are scattered across all pathways.
<b>LO2</b> Understand a common data analysis lifecycle of their choice	<b>U6 LO2</b> is heavily linked with <b>U1 LO1</b> as the data lifecycle is a variation of the development lifecycle. It links with the design and development approaches in <b>U11 LO1</b> and the open standards explored in <b>U16 LO3</b> .
<b>LO3</b> Understand a simple entity-relationship model	The interpretation of entity relationship models is fundamental to both <b>U1</b> , and to all units in the <b>Software Development</b> pathway where data is managed through code. The ERM, often also referred to as an ERD (Entity Relationship Diagram) is one of the most used diagrammatic tools in data management.
<b>Opportunities for Synoptic Assessment</b>	
Unit 21 provides an opportunity to demonstrate an understanding of the concepts of this unit when learners identify and develop a project idea choosing appropriate tools and techniques to find the solution to a problem, whilst demonstrating best professional practice.	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
<p><b>Problem-solving</b> – Understanding the context and importance of data to an organisation (LO1) and knowing how the application of the stages of the data lifecycle provides a framework for data analysis activities (LO2). Being able to interpret ER models is also central to understanding the architecture of data which will allow the analyst to problem solve using data (LO3). Using analytical skills, e.g. research skills, handling information, consulting multiple sources, interpreting and using information (LO1, LO2, LO3).</p> <p><b>Communication</b> - Written communication, e.g. appropriate formats, style and tone, spelling,</p>	<p><b>Using source of information</b> – Accessing information, e.g. choosing current, sufficient, relevant and reliable sources (LO1, LO2, LO3).</p> <p><b>Time Management</b> – Breaking down larger activities into manageable stages (LO2, LO3).</p> <p><b>Reading Skills</b> – Identifying different sources of information, reading with a purpose. (LO1, LO2, LO3).</p> <p><b>Thinking Skills</b> – Using critical thinking skills, e.g. reading all information, identifying and interpreting others' positions, arguments and conclusions, weighing up opposing arguments, drawing conclusions (LO1, LO2, LO3).</p>

punctuation & grammar (SPAG) (LO1, LO2, LO3).

**Working independently** - Using own initiative, self-organisation, maintaining motivation/focus, managing tasks (LO1, LO2, LO3).

**Digital Skills** – Using appropriate digital devices, handling and judging the reliability of information, problem-solving (eg online research, presenting data) (LO1, LO2, LO3).

**Writing Skills** - Understanding the purpose of writing; understanding writing styles and forms; ensuring that written output is suitable for the intended audience (LO1, LO2, LO3).

<b>Unit 7 Methods and Tools for Analysis</b>			
<b>Unit aims</b>	This unit helps learners develop an understanding of the methods used in data analysis and the common tools used to apply those methods. It also helps the learner appreciate the role of data users and requirements analysis.		
<b>Unit level</b>	4		
<b>Unit code</b>	L/650/8536		
<b>GLH</b>	40		
<b>Credit value</b>	10		
<b>Unit grading structure</b>	Pass, Merit and Distinction		
<b>Assessment guidance</b>	In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.		
<b>Learning outcomes</b>	<b>Assessment criteria</b>		
The learner will demonstrate that they:	The learner can:		
	<b>Pass</b>	<b>Merit</b>	<b>Distinction</b>
1. Understand the common methods and tools used in data analysis.	1.1 Explain the purpose of each data analysis method with examples. 1.2 Describe the role of common tools used in analysis.	1M1 Explain the use of visual methods to represent the outcomes of analysis.	
2. Understand the principles of user experience and domain context for data analysis.	2.1 Describe the importance of domain knowledge for effective data analysis.		2D1 Evaluate ways that data analysis can influence users' behaviour.
3. Understand the principal approaches to defining customer requirements for data analysis.	3.1 Explain the process and people involved in requirements gathering. 3.2 Identify and document the requirements for a simple data analysis task.	3M1 Compare different requirement gathering techniques.	3D1 Analyse the difference for requirements gathering in Iterative/Agile vs Waterfall projects.

## Indicative Content

### 1. Understand the common methods and tools used in data analysis

- Common data analysis methods:
  - Data extraction; extraction from production systems or databases, text files, unstructured/semi-structured data; extraction to analytical systems or databases.
  - Manipulation and transformation; removing duplicates and erroneous entries, filtering for defined subsets, converting data types.
  - Merging; horizontal vs vertical merging, unique keys, primary keys, foreign keys, common fields.
- Common tools used in analysis:
  - Formatting; string formatting, e.g. substring, replace, upper case; date formatting, e.g. international date formats; number formatting, e.g. commas vs periods vs spaces, number of decimals, scientific formats.
  - Aggregation; stratification/groups, example functions: sum, average, max, min, first & last value.
  - Visualisation: charts, graphs, diagrams, dashboards.

### 2. Understand the principles of user experience and domain context for data analysis

- User experience principles;
  - results are effective
  - analysis is intuitive and engaging
  - avoidance of jargon
  - avoidance of stereotyping
  - easy to understand
  - flexible to use.
- User experience and domain knowledge relates to both 'Business Understanding' and 'Evaluation' steps in the CRISP-DM model (or similar steps in alternative data analysis lifecycle models).
- Users are often the source of data; appreciating how users generate data.
- Users are often the consumers of data; analysis used to inform or recommend options to users/consumers.
- Importance of domain knowledge in end-user and stakeholder interactions, e.g. requirements gathering and explaining results.

### 3. Understand and apply the principal approaches to defining customer requirements for data analysis

- Investigation techniques:
  - Documentation analysis; learning from past data analysis projects, reviewing past data models.
  - Interviews/questionnaires; selecting the right audience, used for gathering ideas or to compare solution.
  - User observations; engaging with customer representatives, if users are not directly available, e.g. public website users.
  - Stakeholder Workshops; communication, brainstorming.

- Subject Matter Experts; speaking to systems developers, business analysts, enterprise architects, data owners and stewards.
- Building business process models:
  - Relationship between business processes and data entities.
  - Liaising with business analysts and enterprise architects to build reliable process models.
- Prioritising the requirements:
  - Assigning MoSCoV categories, using Kano analysis.
  - Factors that impact priority; benefits, risk, cost, time, compliance.
- Documenting Requirements:
  - Defining and agreeing definitions; requirements document as communication with stakeholders.
  - Ensuring regulatory standards are included, if applicable.
- Agreements and sign-offs:
  - Ensuring senior stakeholders are committed.
  - Agreeing the time, cost, scope, and quality of the data analysis.
  - Enabling subsequent benefits to be measured.
- Traditional linear and gated vs iterative and cyclical (e.g. Agile) requirement gathering:
  - Complete sign-off vs sufficient for next phase (aka. just-in-time requirements).
  - Procedures for changing the requirements; changes coming from the stakeholders vs new insights coming from the analysis process.

### **Suggested Resources**

Rasmussen, R., Gulati, H., Joseph, C., Stanier, C. and Umegbolu, O. (2019) Data Analyst: Careers in data analysis, Rasmussen, R. (ed.), BCS Learning and Development.

AXELOS (2021) Managing Successful Project with PRINCE2, 6<sup>th</sup> Edition, PeopleCert

Girvan, L. and Paul, D. (2017) Agile and Business Analysis, BCS Learning & Development.

Project Management Institute (2015) Business Analysis for Practitioners: A Practice Guide, Project Management Institute

### **Websites**

<https://www.futurelearn.com/courses/foundations-of-project-management>

<https://www.coursera.org/lecture/fundamentals-of-data-analysis/introduction-to-data-requirements-gathering-vNaEM>

<https://www.indeed.com/career-advice/career-development/requirements-gathering>

[https://www.tutorialspoint.com/business\\_analysis/business\\_analysis\\_requirement\\_gathering\\_techniques.htm](https://www.tutorialspoint.com/business_analysis/business_analysis_requirement_gathering_techniques.htm)

<https://www.nngroup.com/articles/definition-user-experience/>

<https://www.usability.gov/what-and-why/user-experience.html>

<https://www.futurelearn.com/courses/digital-skills-user-experience>

Supporting information	
<b>Opportunities for Synoptic Teaching and Learning</b>	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	Teaching and learning links to other unit LO/AC
<b>LO1</b> Understand the common methods and tools used in data analysis.	Although the first part of the indicative content is targeted at <b>Data Analysts</b> and features in <b>U10</b> in relation to data visualisation, the common tools used in analysis such as formatting are also relevant to <b>U2</b> and all of the <b>Software Development</b> units because data that is output by software products should be appropriately formatted.
<b>LO2</b> Understand the principles of user experience and domain context for data analysis.	Users are central to any system, and acknowledging this means that they need to be the focus of any development where user interaction features. <b>U2 LO2</b> is the first time learners come into contact with the concept of the user interface. It is featured in this LO and again in <b>U10 LO1/LO2</b> and <b>LO3</b> . In the <b>Software Development</b> pathway, it is a fundamental consideration in all developments with user interaction, and even forms part of the testing framework in <b>U15</b> . The user experience is also implicit in all units in the <b>Cyber Security</b> pathway even though it does not feature explicitly as a topic.
<b>LO3</b> Understand the principal approaches to defining customer requirements for data analysis.	The principal approaches discussed in this topic bear close relation to those initially identified in <b>U1 LO3</b> where learners are introduced to the three basic components of analysis: information gathering, investigation documentation tools and written reports. Together these help practitioners to define customer needs and set success criteria to measure the success or failure of projects. This links with <b>U1 LO3, U11 LO1</b> and <b>U16 LO1</b> .
<b>Opportunities for Synoptic Assessment</b>	
Unit 21 provides an opportunity to demonstrate an understanding of the concepts of this unit when learners identify and develop a project idea choosing appropriate tools and techniques to find the solution to a problem, whilst demonstrating best professional practice.	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
<b>Working independently-</b> Working independently is the ability to work self-sufficiently on assigned tasks. You might receive direction on your work from a supervisor or a manager, but you can be trusted to accomplish tasks with little or no supervision (LO1, LO2, LO3).	<b>Time Management</b> – Managing time to maximise study and derive a good work-life balance is important. Good time management can ensure that larger study activities are broken down into more manageable bite-size tasks (LO1, LO2, LO3).
<b>Communication Skills</b> - We use communication skills when giving and	<b>Using source of information</b> – Using research, materials and information is an important aspect of effective study. You need to know where to look

receiving different kinds of information. This can be spoken, typed, written, and body language. These skills are important whether you are speaking face-to-face, on the phone, or through social media and emails (LO1, LO2, LO3).

**Problem-solving** - Problem-solving is the process of finding solutions to difficult or complex issues. To solve problems, we use both analytical and critical thinking skills. We use analytical skills to collect and analyse information relevant to the problem. We use critical thinking skills to help us think in an organised and rational way to understand connections between ideas/and/or facts (LO1, LO2, LO3).

**Digital Skills** - Digital Skills are the skills needed to use digital devices, communications applications, and networks to access and manage information (LO1, LO2, LO3).

for information and how to access it (LO1, LO2, LO3).

**Reading Skills** – Sufficiently broad and deep reading must take place to both effectively understand the subject of study and use information to achieve your objectives. There are different reading materials, different purposes to reading and different reading styles (LO1, LO2, LO3).

**Writing Skills** - The purpose of the study activity will determine the way in which something is written. There are a variety of writing styles and forms of writing that you need to understand and practise to study and learn effectively (LO1, LO2, LO3).

**Thinking Skills** – Without a number of key thinking skills, we will not be able to find, read, understand and express our ideas. We use analytical skills to collect and analyse information relevant to the problem. We use critical thinking skills to help us think in an organised and rational way to understand connections between ideas/and/or facts. We apply reflective thinking at the conclusion of a task to ensure we understand our own performance and our feelings towards it (LO2, LO3).

<b>Unit 8 Data Preparation and Quality</b>			
<b>Unit aims</b>	This unit helps learners develop an understanding of basic data extraction, manipulation, combination and common data quality issues. It equips the learners with practical skills needed to perform basic data analysis tasks with SQL and in a spreadsheet.		
<b>Unit level</b>	4		
<b>Unit code</b>	M/650/8537		
<b>GLH</b>	40		
<b>Credit value</b>	10		
<b>Unit grading structure</b>	Pass, Merit and Distinction		
<b>Assessment guidance</b>	<p>In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.</p> <p>To complete this unit learners must have access to a suitable DMBS that allows them to work with SQL commands. This could be MySQL, MariaDB, Oracle. Learners could also use MS Access, but if they do this, they must write the SQL commands rather than using query wizards. Learners will also need spreadsheet software such as MS Excel.</p>		
<b>Learning outcomes</b>	<b>Assessment criteria</b>		
The learner will demonstrate that they:	The learner can:		
	<b>Pass</b>	<b>Merit</b>	<b>Distinction</b>
1. Can undertake basic data extraction and manipulation with SQL queries.	1.1 Carry out simple data extraction using SELECT, WHERE, and FROM clauses. 1.2 Manipulate the product of analysis using ORDER BY and GROUP BY clauses. 1.3 Use six of functions and operators in a data analysis.	1M1 Annotate the code with appropriate comments. 1M2 Explain the role and importance of commenting SQL code.	
2. Understand common approaches to combining data from different sources.	2.1 Explain the need for combining data. 2.2 Describe the difference between horizontal and vertical appending	2M1 Analyse the issues of inconsistency between different datasets and how	

	data and their required conditions.	inconsistencies can be overcome.	
3. Understand quality risks inherent in data and how to mitigate or resolve these.	3.1 Explain the importance of clean data and the potential for data quality issues to be costly. 3.2 Explain how different types of data quality errors can occur.	3M1 Analyse the actions to correct data quality issues and their associated costs.	3D1 Justify the cost of maintaining ongoing data quality monitoring and remediation in the enterprise.

## Indicative Content

### 1. Can undertake basic data extraction and manipulation with SQL queries

- SELECT statement syntax:
  - Star syntax, comma separated columns, DISTINCT.
  - FROM single table
  - Renaming/aliasing columns
- WHERE conditions:
  - Text literals, numeric literals
  - Comparison operators; equal, greater than, greater than or equal, less than, less than or equal, not equal, BETWEEN range, IN list
  - Boolean operators; AND, OR, NOT, use of brackets
- FROM clause; joining tables:
  - ON keyword, INNER join, LEFT join, RIGHT join, OUTER join, FULL join
  - Self joins, cross joins (aka. cartesian joins)
  - Joining multiple tables
- ORDER BY keyword:
  - Comma separated columns.
  - ASC vs DESC
- SQL aggregate functionality:
  - GROUP BY and HAVING clauses syntax.
  - Selected columns must be aggregated or appear in GROUP BY clause
  - Aggregate functions; MIN, MAX, SUM, AVG, COUNT
- Functions and operators (function names and syntax can vary by RDBMS provider):
  - General functions; NVL, NVL2, DECODE, COALESCE, NULLIF
  - Arithmetic operators; add, subtract, multiply, divide and modulo
  - Type conversion; implicit vs explicit, TO\_CHAR, TO\_DATE, TO\_NUMBER
  - String functions; LOWER, UPPER, INITCAP, CONCAT, LENGTH, SUBSTR
  - Date functions; NOW, CURDATE, CURTIME, DATE, EXTRACT, DATE\_ADD, DATE\_SUB, DATEDIFF, DATE\_FORMAT
  - Numeric functions; maths functions, SQRT, PI, SQUARE, ROUND, CEILING, FLOOR, INSTR, LPAD, RPAD, TRIM, REPLACE

- IF function and CASE statements using WHEN, THEN, ELSE, END
- Advanced functions (e.g. RDBMS specific functions); CURRENT\_USER; DATABASE, VERSION
- Comparison functions for NULL (IS NULL and IS NOT NULL)
- Comments in SQL code; double hyphen lines are not executed
- Set operators; UNION, UNION ALL, EXCEPT, INTERSECT
- Subqueries (aka. nested queries):
  - FROM clause, WHERE clause, HAVING clause
  - ANY, ALL, EXISTS conditions
  - Performance of sub-query vs joins

## 2. Understand common approaches to combining data from different sources

- Horizontally appending rows using SQL set operators
- Vertically appending columns using SQL join statement
- Three value logic; TRUE, FALSE and NULL
- Missing values (aka. NULL values) coming from horizontal or from vertical appending
- Inconsistency between different datasets:
  - Aggregation levels, e.g. one dataset cover people while another cover households
  - Groupings; one dataset group age by decade (e.g. 20ies, 30ies etc) while another group by generations (e.g. Boomers, GenX, Millennials etc.)
  - Encodings; one dataset using numerical groups (e.g. 1, 2, 3 etc) while another use alphabetical groups (e.g. A, B, C etc.)
- Non-SQL methods for merging data sources:
  - Combining text files or spreadsheets

## 3. Understand quality risks inherent in data and how to mitigate or resolve these

- Clean data is valuable – ‘dirty’ data is less valuable and/or costly to deal with:
  - Costs: analysis time spend correcting quality, lost opportunity/inability to produce data analysis, reduced accuracy of analysis
  - Monitoring and measuring the quality of the data
  - Comparing with Management Information from Finance or Human Resource etc.
- Data accuracy:
  - Causes of inaccurate data: manual/systematic data entry errors
  - Corrective actions: correction of errors or removal of erroneous records
- Data appropriateness:
  - Causes of inappropriate data: unavailability of correct measures or difficulty in measuring the right values
  - Corrective actions: evaluating suitability of using pseudo-measures
- Data completeness:
  - Causes of incomplete data: data only from some regions, limited customer groups
  - Corrective actions: obtain missing data, consider whether limited data is representative of whole
- Data reliability:
  - Causes of unreliable data: contradictions with authoritative sources or inconsistency with alternative sources
  - Corrective actions: choose alternative sources or correct for systematic discrepancies
- Data timeliness:
  - Issues with old and stale data sets

- Corrective actions: evaluating the appropriateness of the data or seeking newer versions

### **Suggested Resources**

Rasmussen, R., Gulati, H., Joseph, C., Stanier, C. and Umegbolu, O. (2019) Data Analyst: Careers in data analysis, Rasmussen, R. (ed.), BCS Learning and Development

Forta, B. (2022) SQL in 10 Minutes a Day, 5<sup>th</sup> Edition, Sams Publishing

Nield, T. (2016) Getting Started with SQL: A Hands-On Approach for Beginners, O'Reilly

King, T. and Schwarzenbach, J. (2020) Managing Data Quality: A practical guide, BCS Learning and Development

Moses, B., Gavish, L., Vorwerck, M. (2022) Data Quality Fundamentals: A Practitioner's Guide to Building Trustworthy Data Pipelines, O'Reilly

### **Websites**

<https://www.w3schools.com/sql/>

<https://www.codecademy.com/learn/learn-sql>

<https://www.gov.uk/government/news/what-is-data-quality>

<https://www.ibm.com/topics/data-quality>

<https://icedq.com/6-data-quality-dimensions>

<https://www.udemy.com/course/data-management-d/>

Supporting information	
<b>Opportunities for Synoptic Teaching and Learning</b>	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	Teaching and learning links to other unit LO/AC
<b>LO1</b> Undertake basic data extraction and manipulation with SQL queries	The data extraction tools that are demonstrated through studying this topic link directly to the concept of built-in/library functions and user defined functions used across all pathways. They are first introduced in <b>U2 LO1</b> as one of the founding principles of coding, in <b>U7 LO1</b> (aggregation functions), <b>U9 LO3</b> (spreadsheet functions), <b>U12 LO2</b> (language specific functions), <b>U13 LO2</b> (mobile app core language functions), and in the functions and features of operating systems in <b>U17 LO2</b> as part of the security toolkit and in process management, hardware management, and file management.
<b>LO2</b> Understand common approaches to combining data from different sources	Although not specifically included as a sub-topic, what is being described here is the principles of data pipelines which are a method where raw data that has been drawn from a variety of sources is then combined in a meaningful way before being stored. This is first discussed as a concept in <b>U2 LO1</b> and they are considered again in <b>U9 LO1</b> ).
<b>LO3</b> Understand quality risks inherent in data and how to mitigate or resolve these	In addition to the risks to data from theft and destruction, there are significant risks related to the quality of data. This pathway is the only one that examines data quality from an accuracy, appropriateness, completeness, reliability and timeliness perspective. So whilst it does not link directly to other units in other pathways, it is relevant to <b>ATHE Employability Skills Framework, Section 7</b> – handling and judging the reliability of information and therefore is a skill that should be developed across the whole programme.
<b>Opportunities for Synoptic Assessment</b>	
Unit 21 provides an opportunity to demonstrate an understanding of the concepts of this unit when learners identify and develop a project idea choosing appropriate tools and techniques to find the solution to a problem, whilst demonstrating best professional practice.	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
<b>Working independently</b> - Working independently is the ability to work self-sufficiently on assigned tasks. You might receive direction on your work from a supervisor or a manager, but you can be trusted to accomplish tasks with little or no supervision (LO1, LO2, LO3).	<b>Self-organisation</b> - Thinking through your approach to study is important if you are to fully benefit. Being self-organised requires that you think about where you study, when you study, how you will study and with whom you will study (LO3).  <b>Time Management</b> – Managing time to maximise study and derive a good work-life balance is

<p><b>Communication Skills</b> - You use communication skills when giving and receiving different kinds of information. This can be spoken, typed, written, and body language. These skills are important whether you are speaking face-to-face, on the phone, or through social media and emails (LO2, LO3).</p> <p><b>Problem-solving</b> - Problem-solving is the process of finding solutions to difficult or complex issues. To solve problems, we use both analytical and critical thinking skills. We use analytical skills to collect and analyse information relevant to the problem. We use critical thinking skills to help us think in an organised and rational way to understand connections between ideas/and/or facts (LO1, LO2, LO3).</p> <p><b>Digital Skills</b> - Digital Skills are the skills needed to use digital devices, communications applications, and networks to access and manage information (LO1, LO2, LO3).</p>	<p>important. Good time management can ensure that larger study activities are broken down into more manageable bite-size tasks (LO1, LO2, LO3).</p> <p><b>Using source of information</b> – Using research, materials and information is an important aspect of effective study. You need to know where to look for information and how to access it (LO1, LO2, LO3).</p> <p><b>Reading Skills</b> – Sufficiently broad and deep reading must take place to both effectively understand the subject of study and use information to achieve your objectives. There are different reading materials, different purposes to reading and different reading styles (LO1, LO2, LO3).</p> <p><b>Writing Skills</b> - The purpose of the study activity will determine the way in which something is written. There are a variety of writing styles and forms of writing that you need to understand and practise to study and learn effectively (LO2, LO3).</p> <p><b>Thinking Skills</b> – Without a number of key thinking skills, we will not be able to find, read, understand and express our ideas. We use analytical skills to collect and analyse information relevant to the problem. We use critical thinking skills to help us think in an organised and rational way to understand connections between ideas/and/or facts. We apply reflective thinking at the conclusion of a task to ensure we understand our own performance and our feelings towards it (LO2, LO3).</p> <p><b>Digital Skills</b> - Digital Skills are the skills needed to use digital devices, communications applications, and networks to access, create and manage information (LO1).</p>
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<b>Unit 9 Statistics for Analysing Datasets</b>			
<b>Unit aims</b>	This unit helps learners develop an understanding of the statistical principles needed for basic analysis of datasets. It equips the learners with practical skills needed to perform basic data analysis tasks using spreadsheet software.		
<b>Unit level</b>	4		
<b>Unit code</b>	R/650/8538		
<b>GLH</b>	40		
<b>Credit value</b>	10		
<b>Unit grading structure</b>	Pass, Merit and Distinction		
<b>Assessment guidance</b>	<p>In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.</p> <p>To support this unit, learners will need to have access to spreadsheet software such as MS Excel.</p>		
<b>Learning outcomes</b>	<b>Assessment criteria</b>		
The learner will demonstrate that they:	The learner can:		
	<b>Pass</b>	<b>Merit</b>	<b>Distinction</b>
1. Understand the principles of statistics for analysing datasets.	1.1 Describe the causes for variation between observations in a dataset. 1.2 Describe methods to summarise data. 1.3 Explain the characteristics of normal distribution and its role in data analytics. 1.4 Explain what is meant by correlation.	1M1 Explain the issues with the application of interpolation and extrapolation.  1M2 Explain the significance of outliers.	1D1 Evaluate the selection of approach and techniques in the execution of an analysis.
2. Understand the principles of descriptive, predictive and prescriptive analytics.	2.1 Describe appropriate use cases for descriptive, predictive, and prescriptive analytics.		
3. Can carry out simple statistical analysis	3.1 Construct a pivot table.	3M1 Analyse the use of conditional	

using spreadsheet functionality.	3.2 Select and use a range of spreadsheet functions as part of an analysis. 3.3 Explain how lookup functions are used to select data from tables.	statistics summarisation functions.	
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## Indicative Content

### 1. Understand the principles of statistics for analysing datasets

- Data covering entire population vs a sample:
  - Random samples, selection criteria, fair representation in samples
  - Overrepresentations in populations, e.g. analysing all professional rugby players will make results largely non-applicable to women
- Snapshot (aka. cross-sectional) data vs. timeseries data:
  - Timeseries trends; seasonal/cyclical variations, secular trends
- Principles of variations in data:
  - Natural occurring variations vs errors
  - Measurement errors, random errors, systemic errors (aka. bias)
  - Types of bias; selection, reporting, sampling
- The normal distribution:
  - Very common distribution in both continuous and categorical
  - Mean, variation, standard deviation
  - Coverage; 68.3%, 95.4%, 99.7%
- Types of variables:
  - Independent vs dependent variables
  - Categorical, nominal, ordinal, continuous numeric, discrete numeric
- Summarisations:
  - Distributions of categorial variables, frequency tables
  - Min, max, range, deciles, quartiles, interquartile range
- Measuring centrality:
  - Mean and median; sensitivity to skew and outliers
  - Mode; unimodal, multimodal
- Outliers:
  - Investigating and understanding outliers requires business knowledge
  - Removing vs. replacing observations or individual values
- Correlation between variables:
  - “Correlation does not imply causation”
  - Sign; positive, negative and zero correlation
  - Magnitude; -1.0 to +1.0
  - high absolute value means strong correlation
  - Measuring linear relationships
- Interpolation:

- Filling a gap between two points/values
- Extrapolation:
  - Supposing unknown values from a pattern of known values

## 2. Understand the principles of descriptive, predictive and prescriptive analytics

- Descriptive; about the current or historical state:
  - Summary statistics, e.g. regular Management Information reports
- Predictive; about the likely future state:
  - Extrapolations or projections, e.g. accountants' financial forecasts
- Prescriptive; states what should be done now:
  - Recommender models; e.g. product recommendations based on past purchases

## 3. Carry out simple statistical analysis using spreadsheet functionality

- Pivot Tables:
  - Selecting a range with unique headers and insert as new worksheet
  - Dragging fields to columns and rows, filtering columns and rows
  - Value field settings; summarisation options, number formats
  - Sort values, grouping columns and rows
  - Dragging fields to filters; applying filters
  - Show Values As; % of Grand Total, % of Column Total etc.
  - Functions; GETPIVOTDATA
- Date and Time functions:
  - NOW, TODAY, DATE, YEARFRAC
  - DAY, MONTH, YEAR, HOUR, MINUTE, SECOND, TIME
  - Subtracting two dates gives difference in calendar days
- Conditional functions:
  - IF, AND, OR, NOT
- Lookup functions:
  - VLOOKUP, HLOOKUP, MATCH, INDEX, CHOOSE, INDIRECT
- Information functions:
  - ISERR/ISERROR, ISNUMBER
- Statistics summarisation functions:
  - COUNT, COUNTA, COUNTIF, COUNTIFS
  - SUM, SUMIF, SUMIFS, SUMPRODUCT
  - MODE, RANK, AVERAGE, AVERAGEIF, AVERAGEIFS
  - MIN, MINA, MINIF, MAX, MAXA, MAXIF, LARGE, SMALL
- Mathematical functions:
  - ABS, RAND, RANDBETWEEN
  - ROUND, ROUNDUP, ROUNDDOWN, INT, CEILING, FLOOR

### Suggested Resources

Rasmussen, R., Gulati, H., Joseph, C., Stanier, C. and Umegbolu, O. (2019) Data Analyst: Careers in data analysis, Rasmussen, R. (ed.), BCS Learning and Development

Oliver, D. (2021) Statistics for Beginners, Charlie Creative Lab

Borman, D. (2018) Statistics 101: From Data Analysis and Predictive Modeling to Measuring Distribution and Determining Probability, Your Essential Guide to Statistics, Adams Media

McFedries, P. (2022) Excel Data Analysis For Dummies, 5<sup>th</sup> Edition, For Dummies

Linoff, G. S. (2015) Data Analysis Using SQL and Excel, 2<sup>nd</sup> Edition, Wiley

## Websites

<https://www.w3schools.com/statistics/>

<https://www.tutorialspoint.com/statistics/index.htm>

<https://makemeanalyst.com/basic-statistics-for-data-analysis/>

<https://www.coursera.org/learn/excel-basics-data-analysis-ibm>

[https://www.youtube.com/watch?v=qYm1dZ8T\\_DU](https://www.youtube.com/watch?v=qYm1dZ8T_DU)

[https://www.tutorialspoint.com/excel\\_data\\_analysis/index.htm](https://www.tutorialspoint.com/excel_data_analysis/index.htm)

<https://www.analyticsvidhya.com/blog/2021/11/a-comprehensive-guide-on-microsoft-excel-for-data-analysis/>

Supporting information	
<b>Opportunities for Synoptic Teaching and Learning</b>	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	Teaching and learning links to other unit LO/AC
<b>LO1</b> Understand the principles of statistics for analysing datasets	The statistical tools examined in this LO are unique to this pathway, although learners should realise that many of them are essentially functions that will exist in libraries and which learners will be able to use rather than having to recreate them. Functions were first introduced in <b>U2 LO1</b> as one of the founding principles of coding, in <b>U7 LO1</b> (aggregation functions), <b>U8 LO1</b> (SQL functions for data extraction). They will also feature heavily in <b>U10 LO1/LO2</b> and <b>LO3</b> .
<b>LO2</b> Understand the principles of descriptive, predictive and prescriptive analytics	This topic is unique to the data analyst pathway although they are linked directly to organisational policy and procedural development as outlined in <b>U5 LO3</b> .
<b>LO3</b> Carry out simple statistical analysis using spreadsheet functionality	In this LO, learners use the principles of statistics outlined in <b>LO1</b> , selecting and using a range of functions to produce interpreted data.
Opportunities for Synoptic Assessment	
Unit 21 provides an opportunity to demonstrate an understanding of the concepts of this unit when learners identify and develop a project idea choosing appropriate tools and techniques to find the solution to a problem, whilst demonstrating best professional practice.	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
<b>Working independently</b> - Working independently is the ability to work self-	<b>Self-organisation</b> - Thinking through your approach to study is important if you are to fully benefit. Being self-

sufficiently on assigned tasks. You might receive direction on your work from a supervisor or a manager, but you can be trusted to accomplish tasks with little or no supervision (LO1, LO2, LO3).

**Communication Skills** - You use communication skills when giving and receiving different kinds of information. This can be spoken, typed, written, and body language. These skills are important whether you are speaking face-to-face, on the phone, or through social media and emails (LO1, LO2).

**Leadership** - Leadership is the skill of motivating a group of people to act towards achieving a common goal. In organisations, this means directing workers and colleagues with a strategy to meet the organisation's needs (LO2).

**Problem-solving** - Problem-solving is the process of finding solutions to difficult or complex issues. To solve problems, we use both analytical and critical thinking skills. We use analytical skills to collect and analyse information relevant to the problem. We use critical thinking skills to help us think in an organised and rational way to understand connections between ideas/and/or facts (LO2, LO3).

organised requires that you think about where you study, when you study, how you will study and with whom you will study (LO1, LO2, LO3)

**Time Management** – Managing time to maximise study and derive a good work-life balance is important. Good time management can ensure that larger study activities are broken down into more manageable bite-size tasks (LO1, LO2, LO3).

**Using source of information** – Using research, materials and information is an important aspect of effective study. You need to know where to look for information and how to access it (LO1, LO2, LO3).

**Reading Skills** – Sufficiently broad and deep reading must take place to both effectively understand the subject of study and use information to achieve your objectives. There are different reading materials, different purposes to reading and different reading styles (LO1, LO2, LO3).

**Writing Skills** - The purpose of the study activity will determine the way in which something is written. There are a variety of writing styles and forms of writing that you need to understand and practise to study and learn effectively (LO1, LO2).

**Thinking Skills** – Without a number of key thinking skills, we will not be able to find, read, understand and express our ideas. We use analytical skills to collect and analyse information relevant to the problem. We use critical thinking skills to help us think in an organised and rational way to understand connections between ideas/and/or facts. We apply reflective thinking at the conclusion of a task to ensure we understand our own performance and our feelings towards it (LO1, LO2, LO3).

<b>Unit 10 Analytical Impact through Data Visualisations</b>			
<b>Unit aims</b>	This unit helps learners develop the skills needed to confidently communicate the results of data analysis. It equips the learners with practical skills in using appropriate graphical representations and visualisations, and with skills in designing and constructing a simple data dashboard.		
<b>Unit level</b>	4		
<b>Unit code</b>	T/650/8539		
<b>GLH</b>	40		
<b>Credit value</b>	10		
<b>Unit grading structure</b>	Pass, Merit and Distinction		
<b>Assessment guidance</b>	<p>In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.</p> <p>To support this unit, learners will need to have access to spreadsheet software such as MS Excel.</p>		
<b>Learning outcomes</b>	<b>Assessment criteria</b>		
The learner will demonstrate that they:	The learner can:		
	<b>Pass</b>	<b>Merit</b>	<b>Distinction</b>
1. Understand the importance of communicating results in a clear and compelling way.	1.1 Explain the importance of subject matter knowledge in effective communication. 1.2 Explain the importance of clarity in effective communication.	1M1 Explain the ways in which visualisations can be misleading, manipulative, or deceptive.	
2. Understand a range of graphical representations and data visualisations that are appropriate for the analysis.	2.1 Compare the appropriateness of using different chart and plot types for continuous vs categorical data variables. 2.2 Compare the appropriateness of using different chart and plot types for timeseries data.		

<p>3. Can design and construct effective data visualisations.</p>	<p>3.1 Create different types of graphs to represent the outcomes of an analysis.</p> <p>3.2 Create a dashboard with multiple graphs and data tables.</p> <p>3.3 Present your dashboard to a client.</p>	<p>3M1 Create a pivot graph based on an underlying dataset.</p> <p>3M2 Enhance the graph elements in response to client feedback.</p>	<p>3D1 Evaluate the success of your dashboard in communicating clearly and effectively to a range of users.</p>
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## Indicative Content

### 1. Understand the importance of communicating results in a clear and compelling way

- The art of communicating vs the science
- Simplifying complex concepts
- Importance of subject matter knowledge and business context understanding in communicating results
- Types of communication styles:
  - Storytelling; oral and written
  - Presentation Skills
  - Social Media Skills
  - Writing a report
- Importance of clarity:
  - Overly complex graphics
  - Too much or irrelevant details
  - Clearly labelled data and charts elements, e.g. axes
  - Using colours appropriately
  - Rounding numbers suitably
- Misleading visualisations:
  - Typical indicators; non-zero or excessive vertical axis, cherry picking, incorrect graph type, misleading colouring
  - Accidental, misleading, deceptive or manipulative
- Listening to feedback and adapting the style

### 2. Understand a range of graphical representations and data visualisations that are appropriate for the analysis

- Appropriate charts for timeseries data vs categorical data vs summary data etc.:
  - Considering axes:
    - Independent vs dependent variables
    - Appropriate min and max values
    - Markers and labels with appropriate number formats
- Charts and graphs:
  - Column or Bar graphs – used for:

- Summary data; vertical vs horizontal; categorical, nominal and ordinal variables
  - Stacked column, 100% stacked column
- Line graphs – used for:
  - Timeseries data
  - Continuous variables
- Pie and doughnut charts – used for:
  - Categorical; nominal and ordinal variables
- Scatter plot – used for:
  - Discrete points / observations
  - Continuous variables
- Bubble chart – used for:
  - 3 dimensional; 3 variables: 2 independent or 2 dependent
  - Categorical variables or continuous variables
- Surface or area chart – used for:
  - 3 dimensional; 3 variables: 2 independent or 2 dependent
  - Continuous variables
- Spider or radar graphs – used for:
  - Categorical variable, and continuous or ordinal variable
- Histograms – used for:
  - Compare to bar charts with summarised data
- Box and Whisker graphs – used for:
  - Investigative charts
- Combo Charts – used for:
  - Separate y-axes

### 3. Design and construct effective data visualisations

- Creating Excel graphs:
  - 2-d column, 3-d column, clustered column, stacked column, 100% stacked column
  - 2-d line, 3-d line, stacked line, 100% stacked line
  - 2-d pie, 3-d pie, doughnut
  - Scatter graph, bubble graph
  - Surface graphs, radar graphs
  - Histogram, Box and Whisker
  - Move chart location and change chart type
- Chart filters:
  - Selecting series and selecting categories
- Excel Graph Elements:
  - Chart quick styles, switch row/column, change chart type
  - Horizontal and vertical axes; text axis, date axis, major and minor tick marks, labels, number formats
  - Formatting data series; line colour, transparency, width etc.
  - Axis titles, chart title; positions, fonts etc.
  - Data labels; label value, label position, number format
  - Data table; borders, legend keys, fonts etc.
  - Gridlines; horizontal and vertical lines, major and minor, colour and width etc.
  - Trend lines; emphasising trend while keeping it simple

- Spark lines:
  - Line diagram, column diagram, win/loss diagram
- Pivot graphs:
  - Based on pivot tables
  - Might be used for data exploration or interactive reports
  - Show/hide field buttons
  - Refreshing data source
- Data Dashboards:
  - Using separate tabs for data
  - Having multiple graphs in one sheet
  - Updating data values and refreshing graphs
- Importance of text and commenting for context and understanding
- Continuously evolve and refine dashboards in collaboration with users

### **Suggested Resources**

Rasmussen, R., Gulati, H., Joseph, C., Stanier, C. and Umegbolu, O. (2019) Data Analyst: Careers in data analysis, Rasmussen, R. (ed.), BCS Learning and Development

Allchin, C. (2021) Communicating with Data: Making Your Case with Data, O'Reilly

Wilke, C. (2019) Fundamentals of Data Visualization: A Primer on Making Informative and Compelling Figures, O'Reilly

Schwabish, J. (2021) Data Visualization in Excel: A Guide for Beginners, Intermediates, and Wonks, A K Peters/CRC Press

Saul, J. M. (2012) Lying, Misleading, & What is Said, Oxford University Press

### **Websites**

<https://www.forbes.com/sites/brentdykes/2016/03/31/data-storytelling-the-essential-data-science-skill-everyone-needs/>

<https://powerbi.microsoft.com/en-us/data-storytelling/>

<https://online.hbs.edu/blog/post/data-storytelling>

<https://www.techtarget.com/searchcio/definition/data-storytelling>

<https://www.javatpoint.com/what-is-data-visualization>

<https://www.analyticsvidhya.com/blog/2021/04/a-complete-beginners-guide-to-data-visualization/>

[https://www.tutorialspoint.com/business\\_writing\\_skills/data\\_visualization.htm](https://www.tutorialspoint.com/business_writing_skills/data_visualization.htm)

<https://multimedia.journalism.berkeley.edu/tutorials/data-visualization-basics/>

<https://www.codecademy.com/catalog/subject/data-visualization>

<https://www.kaggle.com/learn/data-visualization>

<https://venngage.com/blog/misleading-graphs/>

<https://www.statisticshowto.com/probability-and-statistics/descriptive-statistics/misleading-graphs/>

Supporting information	
<b>Opportunities for Synoptic Teaching and Learning</b>	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	Teaching and learning links to other unit LO/AC
<b>LO1</b> Understand the importance of communicating results in a clear and compelling way	This LO has links to both other units and the <b>ATHE Employability Skills Framework</b> , particularly Section 2 – Communication skills and Section 7 – Digital Skills. IT practitioners must be able to communicate information to a variety of audiences. Whether developing solutions for an internal or an external client or producing analytical results for managers, it is essential that learners develop presentation skills that enable them to share their findings confidently and coherently and/or ideas with clients (both technical and non-technical). The skills developed here will support the activity of all pathways and the final Synoptic Project <b>U21</b> .
<b>LO2</b> Understand a range of graphical representations and data visualisations that are appropriate for the analysis	The graphical representations and data visualisations studied in this topic do not link to other pathways but will be building on prior learning. Learners will already be familiar with bar and column charts, pie charts and line graphs, but may well not have come across radar graphs, surface charts, whisker graphs, scatter plots and bubble charts.
<b>LO3</b> Design and construct effective data visualisations	This topic is an extension of <b>LO2</b> as learners apply the theory to produce dashboards.
Opportunities for Synoptic Assessment	
Unit 21 provides an opportunity to demonstrate an understanding of the concepts of this unit when learners identify and develop a project idea choosing appropriate tools and techniques to find the solution to a problem, whilst demonstrating best professional practice.	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
<p><b>Working independently</b> - Working independently is the ability to work self-sufficiently on assigned tasks. You might receive direction on your work from a supervisor or a manager, but you can be trusted to accomplish tasks with little or no supervision (LO1, LO2, LO3).</p> <p><b>Communication Skills</b> - You use communication skills when giving and receiving different kinds of information. This can be spoken, typed, written, and body language. These skills are important whether you are speaking face-to-face, on</p>	<p><b>Self-organisation</b> - Thinking through your approach to study is important if you are to fully benefit. Being self-organised requires that you think about where you study, when you study, how you will study and with whom you will study (LO1, LO2, LO3).</p> <p><b>Time Management</b> – Managing time to maximise study and derive a good work-life balance is important. Good time management can ensure that larger study activities are broken down into more manageable bite-size tasks (LO1, LO2, LO3).</p>

the phone, or through social media and emails (LO1, LO3).

**Negotiation** - Negotiation is the process of discussing something with someone to reach an agreement. In a negotiation, each party tries to persuade the other to agree with their point of view. By negotiating, all involved parties try to avoid arguing but agree to reach some form of compromise (LO1, LO3).

**Problem-solving** - Problem-solving is the process of finding solutions to difficult or complex issues. To solve problems, we use both analytical and critical thinking skills. We use analytical skills to collect and analyse information relevant to the problem. We use critical thinking skills to help us think in an organised and rational way to understand connections between ideas and/or facts (LO1, LO3).

**Using source of information** – Using research, materials and information is an important aspect of effective study. You need to know where to look for information and how to access it (LO1, LO2, LO3).

**Reading Skills** – Sufficiently broad and deep reading must take place to both effectively understand the subject of study and use information to achieve your objectives. There are different reading materials, different purposes to reading and different reading styles (LO1, LO2, LO3).

**Writing Skills** - The purpose of the study activity will determine the way in which something is written. There are a variety of writing styles and forms of writing that you need to understand and practise to study and learn effectively (LO1, LO2, LO3).

**Thinking Skills** – Without a number of key thinking skills, we will not be able to find, read, understand and express our ideas. We use analytical skills to collect and analyse information relevant to the problem. We use critical thinking skills to help us think in an organised and rational way to understand connections between ideas/and/or facts. We apply reflective thinking at the conclusion of a task to ensure we understand our own performance and our feelings towards it (LO1, LO3).

<b>Unit 11 Advanced Programming</b>			
<b>Unit aims</b>	<p>This unit helps learners build on introductory programming skills and develop professional practice in the discipline.</p> <p>It focuses on the software engineering aspect of the discipline, examining coding techniques, design approaches, modern industry practices and popular tooling, platforms and pipelines used to bring code professionally into a Production environment in an agile and industry recognised way.</p>		
<b>Unit level</b>	4		
<b>Unit code</b>	L/650/8545		
<b>GLH</b>	40		
<b>Credit value</b>	10		
<b>Unit grading structure</b>	Pass, Merit and Distinction		
<b>Assessment guidance</b>	<p>In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.</p> <p>You will need to help learners setup a test FTP server with suitable data files as part of the development process. In addition, learners may leverage a GUID for each error log entry using an external API, e.g. <a href="https://www.uuidtools.com/api/generate/v1">https://www.uuidtools.com/api/generate/v1</a></p>		
<b>Learning outcomes</b>	<b>Assessment criteria</b>		
The learner will demonstrate that they:	The learner can:		
	<b>Pass</b>	<b>Merit</b>	<b>Distinction</b>
1. Understand Software Design and Development Approaches.	1.1 Describe the different programming paradigms. 1.2 Solve set problems through designs that pair appropriate algorithms and data structures to achieve efficient processing. 1.3 Demonstrate the use of TDD to solve a set problem successfully. 1.4 Design a user interface which demonstrates the use of recognised design principles.	1M1 Demonstrate the use of a common design pattern as part of a coded solution.	

2. Understand and use Automation Techniques.	2.1 Apply automation techniques in a software project to ease development.	2M1 Demonstrate the use of an API to perform common tasks needed as part of a software project's development.	
3. Can use modern software engineering practice.	3.1 Demonstrate the maintenance of a remote repository containing a project's codebase through the use of version control software. 3.2 Create and deploy a containerised software application.	3M1 Create and deploy a CI/CD pipeline for a software project, including the definition of suitable stages and jobs.	3D1 Evaluate the contribution of Agile techniques, ceremonies, and asset creation on a software project.

## Indicative Content

### 1. Understand Software Design and Development Approaches

- Software designs and functional or technical specifications
- Common programming paradigms:
  - Imperative/Procedural
  - Modular
  - Declarative
  - Functional
  - Object-oriented
- Non-linear data structures relevant to software development, e.g . trees, hash tables/associative arrays/dictionaries etc.
- Common algorithms; searching, sorting; critical sections and race conditions
- Common algorithms; speed/complexity as denoted by Big "O" notation; O0, On, O2 etc.
- Software design approaches and patterns, to identify reusable solutions to commonly occurring problems
- Categories:
  - Creational, e.g. singleton
  - Structural, e.g. decorator
  - Behavioural, e.g. command
- Test Driven Development (TDD) and the Test Pyramid. How the practice is underpinned by unit testing, the importance of automation, appropriate use of test doubles and mocking strategies, reducing a reliance on end-to-end testing
- User interface design rules: Designing universal user interfaces, interfaces that support collaboration, supporting different interaction styles, complex interfaces, Schneiderman's eight golden rules, Nielsen's heuristics

- Interaction: HCI (Human Computer Interaction) styles, the interaction design process, user analysis, evaluating interfaces against requirements

## 2. Understand and use Automation Techniques

- Automation techniques, such as scripting and use of APIs
- What an API is, how to find them and interpret the accompanying documentation to discover available endpoints, request and response formats, authentication etc.

## 3. Use modern software engineering practice

- Version control:
  - Principles of version control: tracking and managing changes made to code and other associated files
  - Types of version control systems: distributed, centralised, lock-based, optimistic
  - Benefits: Quality, acceleration, visibility, streamlining collaboration
  - Software (e.g. Git, Subversion, Mercurial)
  - Common operations, e.g. clone, checkout, commit, push, pull etc.
- Agile techniques, ceremonies, and artefacts:
  - Product owner; product backlog
  - Sprints planning including
  - Taskboard
  - Daily Stand-ups
  - Pair/mob programming techniques and when to use each technique.
  - Formal code reviews
  - Sprint review, sprint retrospective
- CI (Continuous Integration)/CD (Continuous Delivery) pipelines:
  - Stages and Jobs in the pipeline
  - Commercial CI/CD examples, e.g. Jenkins, GitLab, CircleCI
  - “Shifting security to the left”
  - The role of DevOps and DevSecOps
- Containerization:
  - Containers vs. Virtual Machines
  - Containers for Development and Deployment
  - Commercial examples of containers, e.g. Docker, Kubernetes (K8s), AWS EC
  - Cloud native development; Amazon AWS, Google GCP, Microsoft Azure etc.

## Suggested Resources

Dooley John F, 2017 Software Development, Design and Coding: With Patterns, Debugging, Unit Testing and Refactoring, Apress

Gabbrielli Maurizio, et al, 2010 Programming Languages: Principles and Paradigms (Undergraduate Topics in Computer Science), Springer

Lee Graham, 2019 Modern Programming: Object Oriented Programming and Best Practices: Deconstruct object-oriented programming and use it with other programming paradigms to build applications, Packt

Jin Brenda, et al, 2018 Designing Web APIs: Building APIs That Developers Love, O'Reilly

Chan Jack, et al, 2019 Python API Development Fundamentals: Develop a full-stack web application with Python and Flask, Packt

Siddiqui Saleem, 2021 Learning Test-Driven Development: A Polyglot Guide to Writing Uncluttered Code, O'Reilly

Farley Dave, 2021 Continuous Delivery Pipelines: How to Build Better Software Faster

**Websites**

- [www.skillsyouneed.com](http://www.skillsyouneed.com)
- [www.coursera.org](http://www.coursera.org)
- [www.freecodecamp.org/news/an-introduction-to-programming-paradigms/](http://www.freecodecamp.org/news/an-introduction-to-programming-paradigms/)
- [www.geeksforgeeks.org/introduction-of-programming-paradigms/](http://www.geeksforgeeks.org/introduction-of-programming-paradigms/)
- <https://about.gitlab.com/topics/version-control/>
- [www.guru99.com/test-driven-development.html](http://www.guru99.com/test-driven-development.html)
- [www.docker.com/resources/what-container/](http://www.docker.com/resources/what-container/)

Supporting information	
<b>Opportunities for Synoptic Teaching and Learning</b>	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	Teaching and learning links to other unit LO/AC
<b>LO1</b> Understand Software Design and Development Approaches	Building on <b>U2</b> this topic introduces new models, frameworks and methodologies. TDD (Test Driven Development) links with <b>U15</b> , the testing unit itself, and the user interface design rules formalise the approach to the development of interfaces to support different interaction styles. This links to <b>U2 LO2</b> , <b>U7 LO2</b> and <b>U13 LO1</b> (the consideration of the user experience). In this unit this is further developed with an examination of HCI styles and the interaction design process.
<b>LO2</b> Understand and use Automation Techniques	This LO links with many other units, for example: <b>U2 LO1</b> , <b>U6 LO1</b> , <b>U14 LO1</b> and <b>U19 LO1</b> which all explore APIs and how they are used in different contexts within all pathways.
<b>LO3</b> Can use modern software engineering practice	Version control, as outlined in this LO loosely (but importantly), links to the need for security updates to operating systems ( <b>U17 LO3</b> ), and although not explicitly referenced is an important facet of <b>Data Analysis</b> where analysts will often create multiple versions of analytical output achieved by manipulating parameters. The introduction of the Agile framework and methodology is also connected to the methodologies, frameworks and models discussed in the Cyber Security pathway, although again this is implicit rather than explicit. Agile is also an approach that could similarly be used in a large-scale data project.
<b>Opportunities for Synoptic Assessment</b>	
Unit 21 provides an opportunity to demonstrate an understanding of the concepts of this unit when learners identify and develop a project idea choosing appropriate tools and techniques to find the solution to a problem, whilst demonstrating best professional practice.	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
<p><b>Problem-solving</b> – Understanding the application of programming paradigms in software development and meeting the HCI needs of users (LO1). Recognising and developing key modern software engineering behaviours to ensure successful projects (LO3). Using analytical skills, e.g. research skills, handling information, consulting multiple sources, interpreting and using information (LO1, LO2, LO3).</p> <p><b>Communication</b> - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation &amp; grammar (SPAG) (LO1, LO2, LO3). Oral communication, e.g. presenting and choosing appropriate presentation formats (LO3).</p> <p><b>Working independently</b> - Using own initiative, self-organisation, maintaining motivation/focus, managing tasks (LO1, LO2, LO3).</p> <p><b>Digital Skills</b> – Using appropriate digital devices, handling and judging the reliability of information, problem-solving (eg online research, presenting data) (LO1, LO2, LO3).</p>	<p><b>Time management</b> – Identifying and sticking with your objective setting yourself realistic goals (LO3).</p> <p><b>Using source of information</b> – Accessing information, e.g. choosing current, sufficient, relevant and reliable sources (LO1, LO2, LO3).</p> <p><b>Reading Skills</b> – Identifying different sources of information, reading with a purpose (LO1, LO2, LO3).</p> <p><b>Thinking Skills</b> – Using critical thinking skills, e.g. reading all information, identifying and interpreting others' positions, arguments and conclusions, weighing up opposing arguments, drawing conclusions (LO1, LO2, LO3).</p> <p><b>Writing Skills</b> - Understanding the purpose of writing; understanding writing styles and forms; ensuring that written output is suitable for the intended audience (LO1, LO2, LO3).</p>

<b>Unit 12 Web Design and Programming</b>			
<b>Unit aims</b>	This unit helps learners develop the skills needed to confidently design and build a simple interactive website which combines the use of both client-side and server-side components to provide a limited set of functionality for a given client's needs.		
<b>Unit level</b>	4		
<b>Unit code</b>	R/650/8547		
<b>GLH</b>	40		
<b>Credit value</b>	10		
<b>Unit grading structure</b>	Pass, Merit and Distinction		
<b>Assessment guidance</b>	<p>In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.</p> <p>Although HTML, CSS and JavaScript will be required for creating appropriate client-side content, no particular server-side technology tooling is specified for server-side implementation and, as such, this aspect may be selected at the centre's discretion and reflect local industry practice and/or available tooling.</p>		
<b>Learning outcomes</b>	<b>Assessment criteria</b>		
The learner will demonstrate that they:	The learner can:		
	<b>Pass</b>	<b>Merit</b>	<b>Distinction</b>
1. Understand principal technologies and components used to build, host and access websites.	1.1 Describe client-side technologies and components used as part of a bespoke web solution. 1.2 Describe server-side technologies and components used as part of a bespoke web solution. 1.3 Design a simple website using appropriate tools (manual or online).	1M1 Differentiate, using examples, the concepts of content, format and behaviour in a sample web page.	
2. Can apply the principles of client-side development.	2.1 Create content using good HTML standards of coding to meet user needs.	2M1 Validate your client-side HTML and CSS assets using appropriate tools.	2D1 Change your client-side JavaScript to ensure it is obscured and

	<p>2.2 Format content using good standards of CSS to meet UI/UX requirements.</p> <p>2.3 Create appropriate webpage behaviour using JavaScript to meet interactive UI/UX requirements.</p>		protected from user modification.
3. Can apply the principles of server-side development.	<p>3.1 Demonstrate the use of server-side scripting to process client-side POSTed data.</p> <p>3.2 Demonstrate the use of server-side scripting to update file assets on the server's local file system.</p>	3M1 Demonstrate the use of server-side scripting to interact with an SQL or No-SQL database for the purpose of two or more CRUD-style operations.	3D1 Evaluate your website for possible vulnerabilities by malicious users.

## Indicative Content

### 1. Understand principal technologies and components used to build, host and access websites

- Client-side (“front end” user interface and user experience) vs. server-side (“back end”)
- Client-side technologies and components
  - Web Browser Client, e.g. Microsoft Edge, Google Chrome, Apple Safari, Mozilla Firefox etc.
  - HTTP Request; GET, POST methods etc.
  - HTTP Response; HTTP status codes 200, 300, 404, 500 etc.
  - Concept of webpage content vs. format vs. behaviour
    - Role of the W3C
    - Content: HTML5 (Hypertext Markup Language)
    - Format: CSS3 (Cascading Style Sheets)
    - Behaviour: JavaScript
  - Website design; wireframes, concepts of UI (User Interface) and UX (User eXperience) design
  - Website build techniques: WYSIWYG builders, CMS (content management systems) such as WordPress, Joomla etc and traditional “hand”-crafted
- Server-side technologies and components
  - Hosting using Web servers; Apache HTTP, Nginx, Microsoft IIS, LiteSpeed
  - Hosting using Cross-platform JavaScript runtime environment: Node.js
  - Hosting using the cloud, e.g. AWS
  - Domains and DNS (Domain Name Service) registration
  - HTTP (HyperText Transfer Protocol) vs. HTTPS (HTTP Secure)

- Server-side scripting engine/module/environment/run-time, e.g. PHP, ASP .Net, Java etc.
- Relational and non-relational database management systems
  - SQL vs No-SQL; typical use cases, pros and cons
  - SQL (Structured Query Language), e.g. MS SQL, MySQL, MariaDB, PostgreSQL, SQL Lite
  - No-SQL (Not only SQL), e.g. MongoDB, Amazon DynamoDB, Microsoft Azure Cosmos

## 2. Can apply the principles of client-side development

- Content: HTML; open and closing tags, attributes
  - HTML style guide; HTML validators
  - Comments `<!-- -->`
  - Page section tags: `<title>`, `<html>`, `<head>`, `<body>`, `<meta>`
  - Common tags: `<p>`, `<pre>`, `<table>`, `<img>`, `<h1>`, `<h6>`, `<hr/>`, `<div>`, `<span>`, `<a>`, `<list>`, `<ol>`, `<ul>`
  - Data input: `<form>`, `<input>`, `<br/>`, `<select>`, `<option>`, `<textarea>`, `<button>`, name attribute
  - Semantic elements: `<header>`, `<nav>`, `<section>`, `<article>`, `<aside>`, `<footer>`
  - Accessibility: Web Content Accessibility Guidelines (WCAG) 2.1
  - Colours: RGB (red, green, blue), RGBA (red, green, blue, alpha), colour names, HSL (hue, saturation, lightness)
  - Absolute and relative URL (Uniform Resource Locator)
  - HTML Entities and symbols
  - HTML responsiveness
  - IDs and Classes
- Appearance: CSS and styling; elements, properties and values
  - Implementation; inline, internal using `<style>` block and external .CSS file using `<link>` tag
  - Comments `/* */`
  - CSS Validators
  - CSS Box model
  - Common tasks: colour, font, size, border, padding, alignment, margin, display, hidden, z-index etc.
  - Element vs. Class vs ID selector
  - Pseudo-classes, e.g. `<a>` link, visited, hover, active etc.
- Behaviour: JavaScript; `<script>` tag
  - Basic syntax: comments, reserved words, operators, data types, functions etc.
  - Examples: interactive events (onClick, onLoad etc),
  - Simple DOM (Document Object Model) manipulation
  - Basic AJAX/fetch-style operations, e.g. read data from external source to update page after loading in browser
  - JavaScript minification, obfuscation/uglification

## 3. Can apply the principles of server-side development

- Overview of server-side languages, e.g. PHP, Java, ASP.Net, JavaScript, Ruby etc.
- Typical operations:
  - HTML `<form>` data handling and processing via POST http method
  - Loading from/saving to content to local server file
  - Basic database CRUD operations:
    - Create new record (based on `<form>` input)

- Read existing record (based on query)
- Update existing record (based on <form> input)
- Delete existing record (based on query)
- Dangers of server-side scripting, e.g. unsanitised inputs being used as an attack vector, e.g. SQL injection

### Suggested Resources

Myers Dominic, 2020 Front-End Developer, BCS (The Chartered Institute for IT)

Gunarto Hary, 2023 Introduction to Web Design Programming, Self-published

Nieder Robbins Jennifer, 2018 Learning Web Design 5e: A Beginner's Guide to HTML, CSS, JavaScript, and Web Graphics

Frain Ben, 2022 Responsive Web Design with HTML5 and CSS: Build future-proof responsive websites using the latest HTML5 and CSS techniques, 4th Edition, Packt Publishing

McManus Sean, 2023 Web Design in easy steps, 7th Edition, In Easy Steps Limited

### Websites

[www.skillsyouneed.com](http://www.skillsyouneed.com)

[www.coursera.org](http://www.coursera.org)

<https://www.wix.com/blog/2021/05/web-design/>

<https://technerds.com/9-fundamentals-of-a-great-web-design-you-need-to-know/>

<https://webflow.com/blog/web-design-for-beginners>

<https://www.canva.com/learn/20-web-design-principles-follow/>

Supporting information	
Opportunities for Synoptic Teaching and Learning	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	Teaching and learning links to other unit LO/AC
<b>LO1</b> Understand principal technologies and components used to build, host and access websites	Although Cyber Security Technologists should have an understanding of client-side and server-side technologies and components, they will be focused on issues such as the application of security certificates to websites ( <b>U20 LO1</b> ). Many of the concepts here, however, will be developed in <b>U14</b> . Learners consider web-based APIs which links to <b>U2 LO1, U11 LO2, U14 LO1</b> and <b>U19 LO1</b> which all explore the application and use of APIs.
<b>LO2</b> Can apply the principles of client-side development	Client-side development is largely built from three key technologies introduced in this unit for the first time. JavaScript is the first scripting language learners will explore in detail and it uses many of the same basic syntax elements as Python used in <b>U2</b> . HTML and CSS are unique to website development, but learners will revisit these concepts when they study <b>U14</b> . There is also a direct link back to the data types as set out in <b>U3 LO1</b> .

<p><b>LO3</b> Can apply the principles of server-side development</p>	<p>Server-side development links more directly to Cyber Security as insecure server-side scripting will be open to cyber attacks (<b>U16 LO2</b>, <b>U18 LO2</b> (application of attack methodology frameworks) and <b>U19 LO1</b> (sources of threat and attack vectors). Basic CRUD operations as defined in this LO are also related to <b>U8</b> because there would be no data to manipulate using SQL if CRUD principles had not been applied to a database to capture the data in the first place (<b>C</b>reate new record, <b>R</b>ead existing record, <b>U</b>ppdate existing record and <b>D</b>eleate existing record). There is also a strong link to <b>U15 LO1</b> and <b>U14 LO3</b> when examining hardening a web application against potential threats.</p>
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**Opportunities for Synoptic Assessment**

Unit 21 provides an opportunity to demonstrate an understanding of the concepts of this unit when learners identify and develop a project idea choosing appropriate tools and techniques to find the solution to a problem, whilst demonstrating best professional practice.

**Opportunities for Skills Development within this unit**

<b>Employability Skills</b>	<b>Study Skills</b>
<p><b>Problem-solving</b> – Understanding how the principle technologies are used to build, host and access websites (LO1, LO2, LO3).</p> <p><b>Communication</b> - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation &amp; grammar (SPAG) (LO1, LO2, LO3). Oral communication, e.g. presenting and choosing appropriate presentation formats (LO3).</p> <p><b>Working independently</b> - Using own initiative, self-organisation, maintaining motivation/focus, managing tasks (LO1, LO2, LO3).</p> <p><b>Digital Skills</b> – Using appropriate digital devices, handling and judging the reliability of information, problem-solving (eg online research, using technologies to create publicly accessible websites) (LO1, LO2, LO3).</p>	<p><b>Time management</b> – Planning helps to organise time around regular activities and other commitments, and helps avoid distraction (LO2, LO3)</p> <p><b>Using source of information</b> – Accessing information, e.g. choosing current, sufficient, relevant and reliable sources (LO1, LO2, LO3).</p> <p><b>Reading Skills</b> – Identifying different sources of information, reading with a purpose. (LO1, LO2, LO3).</p> <p><b>Thinking Skills</b> – Using critical thinking skills, e.g. reading all information, identifying and interpreting others' positions, arguments and conclusions, weighing up opposing arguments, drawing conclusions (LO1, LO2, LO3).</p> <p><b>Writing Skills</b> - Understanding the purpose of writing; understanding writing styles and forms; ensuring that written output is suitable for the intended audience (LO1, LO2, LO3).</p>

<b>Unit 13 Mobile Applications Development</b>			
<b>Unit aims</b>	This unit helps learners develop the skills needed to confidently design and build simple interactive apps which can be used on common mobile devices, e.g. smartphones, tablets etc.		
<b>Unit level</b>	4		
<b>Unit code</b>	T/650/8548		
<b>GLH</b>	40		
<b>Credit value</b>	10		
<b>Unit grading structure</b>	Pass, Merit and Distinction		
<b>Assessment guidance</b>	<p>In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.</p> <p>As no particular mobile app platform is mandated for use, this aspect may be selected at the centre's discretion and reflect local industry practice, cost factors, and/or available tooling, although Android Studio is a popular example.</p>		
<b>Learning outcomes</b>	<b>Assessment criteria</b>		
The learner will demonstrate that they:	The learner can:		
	<b>Pass</b>	<b>Merit</b>	<b>Distinction</b>
1. Understand the user experience.	1.1 Describe the commercial drivers for mobile apps. 1.2 Describe the three different forms of mobile app implementation. 1.3 Describe different commercial platforms and their common feature sets. 1.4 Explain the different accessibility adaptations that should be catered for.	1M1 Compare the strengths and weaknesses of different forms of mobile app implementation.	

2. Can design and develop mobile apps to meet a client brief.	2.1 Prototype a mobile application for a client brief using appropriate platform guidelines. 2.2 Create a mobile application using a recommended development environment and tools.	2M1 Demonstrate the accurate measurement of sensor information on a mobile device.	2D1 Evaluate user gestures on a mobile device programmatically to affect mobile app behaviour.
3. Can test and publish mobile apps.	3.1 Demonstrate the successful debugging and testing of a mobile app.	3M1 Deploy a mobile application using appropriate methods.	

## Indicative Content

### 1. Understand the user experience

- Commercial Drivers: How the user experience sits at the heart of modern development practices in terms of strategies to understand diverse user needs, accessibility and how to drive adoption
- Implementation of mobile applications
  - Three types:
    - Native application
    - Mobile web-based applications
    - Hybrid mobile application
- Different commercial platforms: Apple iOS, Google Android
  - User perspectives:
    - Hardware platform; different models (“device fragmentation”) and specifications (screen sizes etc)
    - Hardware features, e.g. camera, sensors (accelerometer, gyroscope, digital compass, proximity sensor etc.)
    - Memory and storage, e.g. iOS and Android versions/revisions
    - Compatibility issues
- User accessibility
  - Published platform guidelines (iOS “Human Interface Guidelines”, Android etc.)
  - Considering adaptations, and accommodating users with:
    - Cognitive impairments, e.g. make data entry easier
    - Visual impairments, e.g. screen/font size, colour contrast
    - Auditory impairments, e.g. don’t rely on audio-only cues/feedback
    - Mobility impairments, e.g. simple gestures, increase tap target zones
  - Accessibility goals:
    - Perceivable information

- Operable interface
- Understandable information and functionality
- Robust, including interaction by user agents, e.g. assistive screen readers etc.

## 2. Can design and develop mobile apps to meet a client brief

- Prototyping; on paper (templates etc), online and offline prototyping and wireframe tools
- Different commercial platforms: Apple iOS, Google Android
  - Development perspectives:
    - Development tools, e.g. Xcode, Android Studio, Eclipse, IntelliJ Idea etc.
    - Programming language(s), e.g. Swift for iOS, Java or Kotlin for Android
    - Security limitations; Apple iOS is a “closed” ecosystem
    - Development and testing environments
    - Deployment options
    - User demographics
- Codeless App Development platforms
- Mobile App essential concerns
  - Design features
  - Functionality
  - UI (User interface)
  - UX (User eXperience)
- Mobile app core language
  - basics (variables, data types, operators, constructs – if statements, loops etc, lists and arrays etc)
  - functions, classes, methods, properties, and objects
  - layouts; responsive vs. exact-size
  - UI components/widgets
  - responding to events; event handlers
  - navigation
  - static images
  - sounds
  - capturing gestures
  - interacting with onboard sensors

## 3. Can test and publish mobile apps

- Testing
  - Via Physical devices
  - Via Emulators and virtual devices, e.g. AVD (Android Virtual Device)
  - Physical devices vs. emulated devices
  - Typical test types: unit test, integration, functional
  - Simulating a range of devices for compatibility:
    - Via Automated testing tools
    - Check various form factors, connectivity types e.g. wi-fi vs 4G, OS versions etc.
- Publishing
  - Apple App store for iOS mobile apps
  - Google Play store for Android apps
  - Sideload, e.g. for Android apps without using Google Play

## Suggested Resources

Forrester Alex, et al., 2023 How to Build Android Apps with Kotlin: A practical guide to developing, testing and publishing your first Android apps, 2<sup>nd</sup> Edition, Packt

Callaghan Michael, 2020 Developing a Mobile Application UI with Ionic and React: How to Build Your First Mobile Application with Common Web Technologies: 2 (Ionic and React: Idea to App Store)

Thornton Edward, 2021 Coding Projects in Flutter: A Hands-On, Project-Based Introduction to Mobile App Development

Whitaker Rob, 2020 Developing Inclusive Mobile Apps: Building Accessible Apps for iOS and Android, Apress

## Websites

[www.accessibilitychecker.org/guides/mobile-apps-accessibility/](http://www.accessibilitychecker.org/guides/mobile-apps-accessibility/)

[www.gov.uk/guidance/make-your-website-or-app-accessible-and-publish-an-accessibility-statement](http://www.gov.uk/guidance/make-your-website-or-app-accessible-and-publish-an-accessibility-statement)

[www.gov.uk/guidance/guidance-and-tools-for-digital-accessibility](http://www.gov.uk/guidance/guidance-and-tools-for-digital-accessibility)

<https://developer.apple.com/design/human-interface-guidelines/>

<https://m2.material.io/design/introduction>

Supporting information	
Opportunities for Synoptic Teaching and Learning	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	Teaching and learning links to other unit LO/AC
<b>LO1</b> Understand the user experience	Whilst most of the topics in this LO are unique to the software pathway and to this unit in particular, there are links with other units – for example through a study of user accessibility ( <b>LO1</b> ). This links to <b>U2 LO2, U7 LO2</b> and <b>U13 LO1</b> (the consideration of the user experience). It also builds on the examination of HCI styles and the interaction design process in <b>U11 LO1</b> .
<b>LO2</b> Can design and develop mobile apps to meet a client brief	Just as <b>U12</b> introduced a new scripting language (Java), this unit introduces the mobile app core language basics and reminds learners that mobile apps are built on the same constructs as programs built in <b>U2, U11, U12</b> and which will be built in <b>U14</b> , using variables, data types, operators, conditions, and loops. And whilst the design approach is the same as in <b>U2</b> and the remaining units in the <b>Software Development</b> pathway, there are some unique aspects such as the need to develop programs for different commercial pathways. Again, the user is considered (see LO1).
<b>LO3</b> Can test and publish mobile apps	Linking directly to aspects of <b>U15</b> , this topic has the additional expectation that code must be tested for different types of devices either using physical devices or emulators.
Opportunities for Synoptic Assessment	

Unit 21 provides an opportunity to demonstrate an understanding of the concepts of this unit when learners identify and develop a project idea choosing appropriate tools and techniques to find the solution to a problem, whilst demonstrating best professional practice.

### Opportunities for Skills Development within this unit

Employability Skills	Study Skills
<p><b>Problem-solving</b> – Ability to apply different techniques to mobile application contexts, ensuring that the applications meet user needs (LO1) and developing key behaviours to ensure successful development projects for commercial clients (LO2). Using analytical skills, e.g. research skills, handling information, consulting multiple sources, interpreting and using information (LO1, LO2, LO3).</p> <p><b>Communication</b> - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation &amp; grammar (SPAG) (LO1, LO2, LO3). Oral communication, e.g. presenting and choosing appropriate presentation formats (LO3).</p> <p><b>Working independently</b> - Using own initiative, self-organisation, maintaining motivation/focus, managing tasks (LO1, LO2, LO3).</p> <p><b>Digital Skills</b> – Using appropriate digital devices, handling and judging the reliability of information, problem-solving (eg online research, presenting data) (LO1, LO2, LO3).</p>	<p><b>Time management</b> – Identifying and sticking with the objective or instruction at hand so that you can set yourself regular and realistic goals (LO2, LO3).</p> <p><b>Using sources of information</b> – Accessing information, e.g. choosing current, sufficient, relevant and reliable sources (LO1, LO2, LO3).</p> <p><b>Reading Skills</b> – Identifying different sources of information, reading with a purpose. (LO1, LO2, LO3).</p> <p><b>Thinking Skills</b> – Using critical thinking skills, e.g. reading all information, identifying and interpreting others’ positions, arguments and conclusions, weighing up opposing arguments, drawing conclusions (LO1, LO2, LO3).</p> <p><b>Writing Skills</b> - Understanding the purpose of writing; understanding writing styles and forms; ensuring that written output is suitable for the intended audience (LO1, LO2, LO3).</p>

<b>Unit 14 The Principles of Full-Stack Development</b>			
<b>Unit aims</b>	<p>This unit helps learners develop the skills needed to confidently use full-stack development technologies and tooling to build secure web-based applications that meet a client brief, including the creation of traditional CRUD-implemented APIs.</p> <p>Emphasis is placed on modern architectural approaches, favouring modern SOA-style applications, coupled with suitable protection against common vulnerabilities and threats. Testing methods are then applied to ensure that solutions are both functionally sound and suitably hardened for the modern security-focused landscape.</p>		
<b>Unit level</b>	4		
<b>Unit code</b>	Y/650/8549		
<b>GLH</b>	40		
<b>Credit value</b>	10		
<b>Unit grading structure</b>	Pass, Merit and Distinction		
<b>Assessment guidance</b>	<p>In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.</p> <p>There is no need to implement this in a Production environment, i.e. on a “live” external, public-facing website; a development server and environment are acceptable for creating, documenting, and testing learner’s work, e.g. client/server full stack development environment and tools. You may need to help learners to set this up if necessary.</p>		
<b>Learning outcomes</b>	<b>Assessment criteria</b>		
The learner will demonstrate that they:	The learner can:		
	<b>Pass</b>	<b>Merit</b>	<b>Distinction</b>
1. Understand principles of full-stack development.	1.1 Describe the common components of a full-stack solution. 1.2 Explain the key differences between different commercial-grade full-stack solutions. 1.3 Explain the functional operation of a web-based API.	1M1 Describe the advantages that cloud-based solutions using SOA have over traditionally hosted monolithic solutions.	
2. Can design and implement a web application using full-	2.1 Design a web-based application using a full-stack	2M1 Justify the use of full-stack technologies	

stack technologies to fulfil a client brief.	solution to meet a client brief. 2.2 Implement a web-based application using a full-stack solution to meet a client brief.	used in a solution.	
3. Can apply best practice when hardening a web application against potential threats.	3.1 Describe common vulnerabilities and threats to web-based applications. 3.2 Identify and apply code and configuration based protective actions to secure a web-based application. 3.3 Test your web-based application to ensure common threats and vulnerabilities have been identified and neutralised.	3M1 Justify your decisions to harden the web-based application.	3D1 Evaluate your full-stack solution against the original client brief and industry best practice.

## Indicative Content

### 1. Understand principles of full-stack development

- Frontend vs. Backend
- Common components
  - Database Management System (DBMS)
  - Scripting Languages (client and server)
  - Operating System
  - Web Server
  - Backend and Frontend frameworks etc.
- Commercial web stack examples
  - Overviews of LAMP, WAMP, MERN, MEAN, Ruby on Rails etc
  - Underpinning technologies, e.g. for MERN: MongoDB, Express.js, React.js and Node.js
- SOA (Service Oriented Architecture) vs monolithic website architecture
  - Traditional hosted solutions; “on-prem” or shared hosting services
  - Scalable cloud-based solutions; Amazon Web Services (AWS), Google Cloud Platform (GCP), Microsoft Azure etc.
  - Pros and cons of cloud-based solutions using SOA
- Web-based APIs
  - Examples of Web-based APIs; commercial and non-commercial
  - API Requests and Responses
  - Use of HTTP status codes in API responses (200, 404 etc)

- Formats, e.g. JSON (JavaScript Object Notation), XML (eXtensible Markup Language)
- RESTful services; CRUD (Create, Read, Update, Delete) operation mappings

## 2. Can design and implement a web application using full-stack technologies to fulfil a client brief

- Web framework elements:
  - MVC (Model View Controller) architectural pattern
  - ORM (Object-Relational Mapping)
  - Web page Templates
  - Routing (HTTP methods/verbs, e.g. GET, POST, DELETE etc)
- Environments: Development, Staging, Production
- CI/CD (Continuous Integration/Continuous Delivery) pipelines

## 3. Can apply best practice when hardening a web application against potential threats

- Common vulnerabilities and threats
  - Client-side:
    - XSS (Cross-site Scripting)
    - CSRF (Cross-site Request Forgery)
  - Server-side:
    - SQL (Structured Query Language) injection attacks
    - Directory Traversal
    - Broken Access Control
    - Poor Security Misconfiguration
- Sources of best practice for mitigating potential web application security risks
  - OWASP (Open Web Application Security Project) Top 10 Web Application Security Risks
  - NCSC (National Cyber Security Centre)
- Coding techniques
  - Data sanitisation of user input
  - CSRF token
- Configuration
  - Configuration types, e.g. cfg files etc.
  - Web server options, e.g. protocols (HTTP/HTTPS), ports (80, 443), disable directory browsing etc.
  - Logging activity and regular Monitoring
- Testing
  - Static application security testing (SAST)
  - Dynamic application security testing (DAST)
  - Common testing: Unit testing, Integration testing etc.
  - “Pen” (penetration) testing; techniques, goals, constraints and reporting

### Suggested Resources

Ahmed Riaz, 2021 Full-stack Web Development for Beginners: Learn Ecommerce Web Development Using HTML, CSS3, Bootstrap, Javascript, MySQL and PHP, Self-published

Zammetti Frank, 2022 Modern Full-Stack Development: Using TypeScript, React, Node.js, Webpack, Python, Django, and Docker, Apress

Northwood Chris, 2018 The Full-stack Developer: Your Essential Guide to the Everyday Skills Expected of a Modern Full-stack Web Developer, Apress

Mohan Gayathri, 2022 Full-stack Testing: A Practical Guide for Delivering High Quality Software, O'Reilly Media

## Websites

[www.skillsyouneed.com](http://www.skillsyouneed.com)

[www.coursera.org](http://www.coursera.org)

[owasp.org/Top10/](http://owasp.org/Top10/)

[www.geeksforgeeks.org/what-is-full-stack-development/](http://www.geeksforgeeks.org/what-is-full-stack-development/)

[www.freecodecamp.org/news/what-is-a-fullstack-developer/](http://www.freecodecamp.org/news/what-is-a-fullstack-developer/)

[www.codecademy.com/resources/blog/how-to-become-a-full-stack-developer/](http://www.codecademy.com/resources/blog/how-to-become-a-full-stack-developer/)

Supporting information	
<b>Opportunities for Synoptic Teaching and Learning</b>	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	Teaching and learning links to other unit LO/AC
<b>LO1</b> Understand principles of full-stack development	Whilst web developers typically focus on websites, a full-stack developer is responsible for the whole software stack building solutions which include front and backend, but also software, databases and other applications that form part of the solution. In addition, the full-stack developer makes sure that all of the components work together and that the solutions are both reliable and secure. They tend to be experienced in web server administration and server operating systems. Many of the concepts here, build on those developed in <b>U12</b> . Learners consider web-based APIs which links to <b>U2 LO1, U11 LO2, U12 LO1</b> and <b>U19 LO1</b> which all explore the application and use of APIs.
<b>LO2</b> Can design and implement a web application using full-stack technologies to fulfil a client brief	In addition to new technologies introduced in this unit for the first time, there are connections to CI/CD pipeline concept introduced in <b>U11 LO3</b> .
<b>LO3</b> Can apply best practice when hardening a web application against potential threats	Applying best practice to harden web applications against threats and risks links to the U16, U17, U18 and U19 in the Cyber Security pathway. In particular, the threats from cyber-attacks ( <b>U16 LO2, U18 LO2</b> (application of attack methodology frameworks) and <b>U19 LO1</b> (sources of threat and attack vectors).
<b>Opportunities for Synoptic Assessment</b>	
Unit 21 provides an opportunity to demonstrate an understanding of the concepts of this unit when learners identify and develop a project idea choosing appropriate tools and techniques to find the solution to a problem, whilst demonstrating best professional practice.	
<b>Opportunities for Skills Development within this unit</b>	

Employability Skills	Study Skills
<p><b>Problem-solving</b> – Understanding the range of technologies that could be used in a full-stack development (LO1) and being able to design and implement web applications using technologies to meet client needs (LO2). Developing key behaviours by applying best practice when hardening web applications against potential threats (LO3).</p> <p><b>Communication</b> - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation &amp; grammar (SPAG) (LO1, LO2, LO3). Oral communication, e.g. presenting and choosing appropriate presentation formats (LO3).</p> <p><b>Working independently</b> - Using own initiative, self-organisation, maintaining motivation/focus, managing tasks (LO1, LO2, LO3).</p> <p><b>Digital Skills</b> – Using appropriate digital devices, handling and judging the reliability of information, problem-solving (eg online research, presenting data) (LO1, LO2, LO3).</p>	<p><b>Using source of information</b> – Accessing information, e.g. choosing current, sufficient, relevant and reliable sources (LO1, LO2, LO3).</p> <p><b>Reading Skills</b> – Identifying different sources of information, reading with a purpose. (LO1, LO2, LO3).</p> <p><b>Thinking Skills</b> – Using critical thinking skills, e.g. reading all information, identifying and interpreting others' positions, arguments and conclusions, weighing up opposing arguments, drawing conclusions (LO1, LO2, LO3).</p> <p><b>Writing Skills</b> - Understanding the purpose of writing; understanding writing styles and forms; ensuring that written output is suitable for the intended audience (LO1, LO2, LO3).</p>

<b>Unit 15 Software Testing Frameworks and Methodologies</b>			
<b>Unit aims</b>	<p>This unit helps learners develop the skills needed to test a software application for functional and non-functional outcomes using tools and timings appropriate for a project's selected software development life cycle.</p> <p>Additionally, focus is placed on modern software engineering practices such as test-driven development (TDD) and behaviour driven development (BDD) to provide extra industry awareness.</p>		
<b>Unit level</b>	4		
<b>Unit code</b>	F/650/8550		
<b>GLH</b>	40		
<b>Credit value</b>	10		
<b>Unit grading structure</b>	Pass, Merit and Distinction		
<b>Assessment guidance</b>	<p>In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.</p> <p>For this unit, learners will be creating test plans for code already provided. A unit testing framework in Python such as unittest or pytest are suggested, or similar. You may need to help learners set this up.</p>		
<b>Learning outcomes</b>	<b>Assessment criteria</b>		
The learner will demonstrate that they:	The learner can:		
	<b>Pass</b>	<b>Merit</b>	<b>Distinction</b>
1. Understand Software Testing Frameworks and Methodologies.	1.1 Identify the objectives of testing and describe how testing is implemented in different software development lifecycles. 1.2 Describe the different objectives of TDD and BDD. 1.3 Explain why independent testers may prove beneficial to a software project's success.	1M1 Compare functional and non-functional testing, including the various types of test performed.	
2. Can implement a TDD process successfully.	2.1 Describe the key aspects of TDD.	2M1 Create and execute a TDD plan for a given software application.	2D1 Evaluate the given software application and the robustness of

	<p>2.2 Explain black box and white box testing.</p> <p>2.3 Describe different types of functional testing and their associated objectives.</p>		<p>the executed TDD plan to identify errors, defects and failures.</p>
<p>3. Can implement a BDD process successfully.</p>	<p>3.1 Describe the key aspects of BDD.</p> <p>3.2 Describe the key aspects of a domain-specific language (DSL) using suitable examples.</p>	<p>3M1 Create and execute a BDD plan for a given software application.</p>	<p>3D1 Evaluate the given software application and the robustness of the executed BDD plan to identify unexpected behaviours, performance levels and outcomes.</p>

## Indicative Content

### 1. Understand Software Testing Frameworks and Methodologies

- Objectives of testing
  - Prevent and identify errors, defects, and failures
  - Evaluate the quality of the software product build; Quality Assurance (QA)
  - Reduce associated risks, e.g. data loss, inaccurate results, reputational damage etc.
  - Verify the end-user and stakeholder requirements have been satisfied
  - Build stakeholder confidence in software product
- Software testing implementation as part of chosen Software Development Life Cycle (SDLC)
  - Waterfall vs. V-Model vs. Agile differences
- Impact of human psychology on testing
  - Tester vs. Software Engineer mindset; cognitive bias
  - Internal vs. Independent testers – pros and cons, e.g. objectivity, political neutrality, lack of insider knowledge, potential delays, sense of responsibility etc.
- Functional vs Non-functional testing
  - Functional: documented functional requirements and specifications; results and conformity
  - Non-functional: behaviour, expectations of the end-user and stakeholders
- Functional testing: approaches, black box (functionality) vs. white box (internal structures and operation); manual vs. automated testing, test frameworks and tooling, e.g. Selenium, Cypress, Gherkin, Cucumber etc. Types: unit, smoke, integration, regression etc.
- Test levels: Component testing, integration testing, system testing, acceptance testing
- Non-functional testing
  - Goals: speed/efficiency, stability, reliability, secure and scalable
  - Types: performance, load, stress, volume, security etc.
- Software testing frameworks and methodologies
  - Test Driven Development (TDD)

- Behaviour Driven Development (BDD); collaboration of software engineers, management teams, quality assurance testers and customers.
- Pros and cons of using TDD and BDD; Pros: fewer defects and bugs, improved quality of code, improved maintainability, and improved reusability; Cons: increased development time

## 2. Can implement a TDD process successfully

- How to write an automated test case based on requirement
  - TDD framework and syntax
  - Concept and types of assertions
- How to run all test cases
- Developing program code to satisfy a test case
- Re-run the test case to ensure that it passed satisfactorily
- Refactoring code to improve readability, reusability and maintenance

## 3. Can implement a BDD process successfully

- Comparing behaviour (what happens) to what we expect to see if BDD test succeeds
- Open-source testing frameworks, e.g. Cucumber
- How to write behaviour using domain-specific language (DSL)
  - Features
  - Scenarios
  - Typical DSL Keywords: Given, When, And, Then etc.
- Formalised parsers for BDD, e.g. Gherkin
- Integration with automated frameworks such as Selenium, Cypress etc.

## Suggested Resources

Hambling Brian, et al., 2019 Software Testing: An ISTQB-BCS Certified Tester Foundation guide - 4th edition, BCS (The Chartered Institute for IT)

Panagiotis Leloudas, 2023 Introduction to Software Testing: A Practical Guide to Testing, Design, Automation, and Execution, Apress

Mohan Gayathri, 2022 Full Stack Testing: A Practical Guide for Delivering High Quality Software, O'Reilly Media

Aniche Mauricio, 2022 Effective Software Testing: A Developer's Guide, Manning Publications

Kaner Cem, et al., 2002 Lessons Learned in Software Testing: A Context-Driven Approach, Wiley

## Websites

[www.skillsyouneed.com](http://www.skillsyouneed.com)

[www.coursera.org](http://www.coursera.org)

[www.codecademy.com/resources/blog/what-is-software-testing/](http://www.codecademy.com/resources/blog/what-is-software-testing/)

[www.ibm.com/topics/software-testing](http://www.ibm.com/topics/software-testing)

[usersnap.com/blog/software-testing-basics/](http://usersnap.com/blog/software-testing-basics/)

Supporting information	
<b>Opportunities for Synoptic Teaching and Learning</b>	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	Teaching and learning links to other unit LO/AC
<b>LO1</b> Understand Software Testing Frameworks and Methodologies	As suggested in <b>U1</b> , computing projects rely heavily on models, frameworks and methodologies to give structure to activities. When <b>U1 LO1</b> discusses a concept of a lifecycle as a model or framework it has a testing phase which is explored in more detail in <b>U15 LO1</b> . The theory in this topic also compares the TDD and BDD frameworks and looks at the positives and negatives of these. Because this explores models, frameworks and methodologies, this topic links directly with <b>U6 LO2</b> in the Data Analyst pathway, <b>U11 LO1</b> in the Software Development pathway and <b>U16 LO3</b> in the Cyber Security Technologist pathway where approaches are examined, and where testing is a feature.
<b>LO2</b> Can implement a TDD process successfully	Test Driven Development (TDD) is first introduced in <b>U11 LO1</b> as a development methodology. In this unit it is explored further and learners study how to apply the framework to development just as they did in units such as <b>U6 LO2</b> in the Data Analyst pathway, <b>U11 LO1</b> in the Software Development pathway and <b>U16 LO3</b> in the Cyber Security Technologist pathway.
<b>LO3</b> Can implement a BDD process successfully	Behaviour Driven Development (BDD) is introduced here for the first time and again it has conceptual links to other methodologies, frameworks and models in units such as <b>U6 LO2</b> in the Data Analyst pathway, <b>U11 LO1</b> in the Software Development pathway and <b>U16 LO3</b> in the Cyber Security Technologist pathway.
<b>Opportunities for Synoptic Assessment</b>	
Unit 21 provides an opportunity to demonstrate an understanding of the concepts of this unit when learners identify and develop a project idea choosing appropriate tools and techniques to find the solution to a problem, whilst demonstrating best professional practice.	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
<b>Problem-solving</b> – Understanding the need for structured processes and developing key behaviours to ensure successful projects (e.g. being able to apply a range of testing approaches as appropriate to the context) (LO1). Being able to implement processes successfully (LO2, LO3).	<b>Using source of information</b> – Accessing information, e.g. choosing current, sufficient, relevant and reliable sources to support investigation (LO1, LO2, LO3).  <b>Reading Skills</b> – Identifying different sources of information, reading with a purpose. (LO1, LO2, LO3).

**Communication** - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation & grammar (SPAG) (LO1, LO2, LO3).

**Working independently** - Using own initiative, self-organisation, maintaining motivation/focus, managing tasks (LO1, LO2, LO3).

**Digital Skills** – Using appropriate digital devices, handling and judging the reliability of information, problem-solving (eg online research, presenting data) (LO1, LO2, LO3).

**Thinking Skills** – Using critical thinking skills, e.g. reading all information, identifying and interpreting others' positions, arguments and conclusions, weighing up opposing arguments, drawing conclusions (LO1, LO2, LO3).

**Writing Skills** - Understanding the purpose of writing; understanding writing styles and forms; ensuring that written output is suitable for the intended audience. (LO1, LO2, LO3).

<b>Unit 16 Principles of Networks</b>			
<b>Unit aims</b>	This unit has three primary focuses. Firstly, it explores the concepts and technologies that enable networks to communicate and meet the needs of the user. Secondly, it explores the threat to data and methods of protection. Finally, it explores methods of network design, flexibility and creating resilience based on open standards.		
<b>Unit level</b>	4		
<b>Unit code</b>	H/650/8551		
<b>GLH</b>	40		
<b>Credit value</b>	10		
<b>Unit grading structure</b>	Pass, Merit and Distinction		
<b>Assessment guidance</b>	In order to achieve this unit, learners must produce a report which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.		
<b>Learning outcomes</b>	<b>Assessment criteria</b>		
The learner will demonstrate that they:	The learner can:		
	<b>Pass</b>	<b>Merit</b>	<b>Distinction</b>
1. Understand network technologies and the needs of the user.	1.1 Explain networking concepts including installing, configuration and troubleshooting. 1.2 Describe routing technologies and networking devices including wireless and cloud connectivity. 1.3 Design a hardware and software solution to meet specific purposes.		
2. Understand risks to data and its mitigation.	2.1 Compare a range of attack techniques. 2.2 Explain the nature of security incidents with examples. 2.3 Identify and explain a range of security processes and their importance.	2M1 Assess the suitability of a range of network security devices for a given scenario.	
3. Understand open standards to design and can integrate	3.1 Design network infrastructure,	3M1 Assess the requirements of the open	3D1 Evaluate your design by explaining the

flexibility and resilience into a network.	cabling and wireless solutions, WAN links. 3.2 Explain how the open standards provided are applied.	standards and how they contribute to the design of a flexible and resilient network.	choices you have made in the selection of your proposed hardware and software.  3D2 Evaluate how a network for a client achieves resilience and flexibility meeting the needs of the client.
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## Indicative Content

### 1. Understand network technologies and the needs of the user

- Open Systems Interconnection 7-layer Model, TCP/IP model
  - Explain protocols ports and devices at their appropriate layer
  - Purpose and use of protocols and ports
- Concepts of routing and switching
- Configuration of IP address and network system components
- Network and wireless topologies and configurations to meet the needs of the user
- Cloud services and Models, system migration and hybrid solutions
- Hardware and software that provide network services
  - DHCP, DNS, NTP etc.
- Network device application, configuration and design
- Virtualization and network storage technologies
- Monitoring and scanning of performance, logs and event management, patch management vulnerability scanning
- Network troubleshooting, problem identification, establishing a cause, creating a plan of action
- Virtualization, cloud services
- Scanning, monitoring and patching processes
  - SNMP, SIEM, log review, patch roll back

### 2. Understand risks to data and its mitigation

- Risks: Computer threats, Digital crime, Privacy, Security, Impact of e-everything (e.g. e-marketing, e-banking)
- The concept of attack surfaces and attack vectors
- Attack techniques: main types of common attack techniques; also the role of human behaviour, including the significance of the 'insider threat'. Including: how attack techniques combine with motive and opportunity to become a threat. Techniques and strategies to defend against attack techniques and mitigate hazards

- Security tools and techniques: A range of modern security tools and techniques - e.g. threat modelling, vulnerability scanning and dependency checking, with a general awareness of penetration testing - in order to deal with threats and attack vectors within code and across the cyber domain

### **3. Understand open standards to design and can integrate flexibility and resilience into a network**

- Open standards provided by the IETF, ISO, BSEN, IRTF, IEEE and the IAB, including the functions of IANA
- Operations and infrastructure design
  - Documentation, SOP's Change management, work instructions, asset register, policies and best practice (ITIL)
  - Logical v Physical diagrams, rack diagrams, wiring and port location
- Cabling solutions
  - Media types and standards
- Business continuity and disaster recovery

#### **Suggested Resources**

Thornton G., Jones C., 2023, Computer and Network Technology, BCS Level 4 Certificate in IT study guide, BCS (The Chartered Institute for IT)

Hodson C.J., 2019, Cyber Risk Management: Prioritize Threats, Identify Vulnerabilities and Apply Controls, Kogan Page

Englander I., Wong W., 2021, The Architecture of Computer Hardware, Systems Software, and Networking: An Information Technology Approach, 6<sup>th</sup> Edition, Wiley

Mind Tools, 2023, Logic in Computer Science for Everyone: A Practical Guide with Real-World Scenarios, Independently Published

#### **Websites**

[www.skillsyouneed.com](http://www.skillsyouneed.com)

[www.coursera.org](http://www.coursera.org)

[www.geeksforgeeks.org/computer-network-tutorials/](http://www.geeksforgeeks.org/computer-network-tutorials/)

[www.techtarget.com/searchnetworking/feature/12-common-network-protocols-and-their-functions-explained](http://www.techtarget.com/searchnetworking/feature/12-common-network-protocols-and-their-functions-explained)

[www.computer-networking.info/1st/cnp3.pdf](http://www.computer-networking.info/1st/cnp3.pdf)

Supporting information	
<b>Opportunities for Synoptic Teaching and Learning</b>	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	Teaching and learning links to other units LO/AC
LO1 Understand network technologies and the needs of the user	The network technologies introduced in this unit and in this topic are a development of the concepts first introduced in <b>U4 LO2</b> where learners explored the principles of networks at a basic level. They were asked to cover 3 operating systems and it has been left to the teacher to decide which ones to focus on. Network technologies are also relevant to the full-stack developer as suggested in <b>U14</b> .
LO2 Understand risks to data and its mitigation	As suggested in <b>U4 LO3</b> the need to manage risk is also present across all pathways. Considering risk begins in <b>U1 LO3</b> where one of the purposes of development is identified as the reduction of risk. Risk is also the basis for some aspects of legislation ( <b>U5 LO1</b> ) and it the reason why organisations develop policies and procedures ( <b>U5 LO3</b> ). It features in <b>U14 LO3</b> in relation to web application development, is the rationale for extensive program testing in <b>U15 LO1</b> and is a founding principle in DevOps. It clearly is also the basis for <b>Cyber Security</b> as a whole which seeks to protect data and systems from a range of risks. There are also clear links with <b>U18 LO1/LO2</b> where penetration is introduced as a method of securing data before other risks and mitigations are developed. Risks are also examined in <b>U19 LO1/LO2</b> where a range of vulnerabilities and response factors are discussed, in addition to some common frameworks from different parts of the world and for different contexts such as Cloud that are designed to mitigate risk.
LO3 Understand open standards to design and can integrate flexibility and resilience into a network	This topic links to <b>U5 LO1/LO3</b> because it focuses on documented standards and considers how they are used to build flexible and resilient networks.
<b>Opportunities for Synoptic Assessment</b>	
Unit 21 provides an opportunity to demonstrate an understanding of the concepts of this unit when learners identify and develop a project idea choosing appropriate tools and techniques to find the solution to a problem, whilst demonstrating best professional practice.	
<b>Opportunities for Skills Development within this unit</b>	
Employability Skills	Study Skills
<b>Digital Skills</b> - Using digital devices, creating information, handling and judging the reliability of information, problem solving, applying relevant numerical skills to organise data ( <b>LO1, LO2, LO3</b> ).	<b>Using sources of information</b> - Accessing information, e.g. choosing current, sufficient, relevant and reliable sources ( <b>LO1, LO2, LO3</b> ).

**Working Independently** - Using own initiative, self-organisation, maintaining motivation/focus, managing tasks (**LO1, LO2, LO3**).

**Problem-solving** - Using analytical skills, e.g. research skills, handling information, consulting multiple sources, categorising information (**LO1, LO2, LO3**).

**Reading Skills** – Identifying different reading materials, reading with a purpose, understanding reading styles (**LO1, LO2, LO3**).

**Thinking Skills** - Using critical thinking skills, e.g. reading all information, identifying and interpreting others' positions, arguments and conclusions, weighing up opposing arguments, drawing conclusions (**LO1, LO2, LO3**).

**Writing Skills** – Understanding the purpose of writing; understanding writing styles and forms (**LO1, LO2, LO3**).

<b>Unit 17 Concepts and Features of Operating Systems</b>			
<b>Unit aims</b>	This unit helps learners understand the concepts, main functions and features of different Operating Systems (OS). It identifies their security functions and associated security features.		
<b>Unit level</b>	4		
<b>Unit code</b>	J/650/8552		
<b>GLH</b>	40		
<b>Credit value</b>	10		
<b>Unit grading structure</b>	Pass, Merit and Distinction		
<b>Assessment guidance</b>	In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.		
<b>Learning outcomes</b>	<b>Assessment criteria</b>		
The learner will demonstrate that they:	The learner can:		
	<b>Pass</b>	<b>Merit</b>	<b>Distinction</b>
1. Understand the concept of Operating Systems (OS).	1.1 Explain the purpose of an operating system. 1.2 Identify the common types of operating systems. 1.3 Explain how the operating system is loaded when the computer is turned on.		
2. Understand the main functions and features of different Operating Systems (OS).	2.1 Identify the main OS functions. 2.2 Explain how the OS allocates resources to run programs. 2.3 Explain how the OS supports multiple users.	2M1 Explain the operating system processes used when a user copies a file from one location to another.	2D1 Evaluate how timesharing techniques are used to allocate the use of the CPU to enable the OS and at least three separate user processes A, B and C to run at the same time.

<p>3. Understand security functions and associated security features.</p>	<p>3.1 Explain how user accounts and permissions are used to ensure security.</p> <p>3.2 Explain how read/write/execute attributes are used to manage access to processes and files.</p> <p>3.3 Explain why it is important to ensure that the OS is kept up to date.</p>	<p>3M1 Analyse the difference between user mode and kernel mode and explain how it is used to ensure system security.</p>	
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## Indicative Content

### 1. Understand the concept of Operating Systems (OS)

- What is an operating system?
  - A collection or suite of programs that manages and controls the computer.
  - A platform for launching applications
  - An interface between the user and the computer hardware
  - A system to ensure consistency across a range of devices
- Common operating systems
  - Computer Operating Systems
    - Microsoft Windows
    - MacOS (used to be called OSX)
    - Linux
    - BSD
  - Mobile Operating Systems
    - iOS
    - Android
  - Embedded operating systems
- Bootstrap
  - POST
  - MBR, UEFI
  - Bootloader, e.g., GRUB
  - Load and run the OS

### 2. Understand the main functions and features of different Operating Systems (OS)

- All general operating systems perform a range of key functions
  - process management
  - hardware management
  - file management

- user interface management (GUI or command line)
- Process management
  - Programs, instructions and processes
  - Threads, multithreading and hyperthreading
  - CPU and memory allocation
    - Scheduler
    - Hardware interrupts, IRQ allocation, clock interrupts
  - Scheduling algorithms
    - First come, first served (FCFS)
    - Round Robin
    - Priority based
  - Process Memory Management
    - Call stack, heap, text, kernel code, uninitialized data, initialised data
      - Local variables, stack pointers, stack overflow
      - Heap space allocation, process system call requests (allocate, deallocate)
      - Process user IDs, file descriptors, environment, current and root directory
      - Kernel code and user code
      - Privilege levels (OS and app processes)
    - Process memory translation tables
    - Virtual memory, page swapping
  - Process lifecycle states – created, waiting, running, blocked, terminated
  - Inter Process Communication (IPC) – files, pipes, sockets, signals, shared memory
- Hardware management
  - Device drivers - generic or bespoke
  - Device drivers - included in the operating system or installed for each new device
- File management
  - Tasks on files, e.g.: create, save, copy, move, delete
  - File management systems, virtual file structure, root directory
  - Mapping logical partitions, directories and files against physical location, e.g.:
    - Windows allocates each partition a letter C: D: etc
    - Linux has Root / and every other directory (and partition) is a subdirectory
- User interface management (GUI or command line)
  - Communication with the hardware
  - Simplified virtual machine giving access to logical devices
  - Three main types of interfaces
    - Graphic user interface (GUI)
    - Command line interface (CLI)
    - Mobile User Interface (MUI)
  - Graphical User Interface
    - Desktop view and use WIMP (windows, icons, menus and pointer)
    - Ease of use and processing power requirement.
    - Windows and MacOS GUIs
    - Linux GUI choices, e.g., Gnome, KDE, LXQT, XFCE, etc.
  - Command Line Interface
    - Text-based, user commands.

- Powerful and don't require a lot of processing power
- Mobile User Interface
  - Smartphones and tablets
  - Single-user operating systems (iOS, Android)
  - Similar to GUIs but respond to touch

### 3. Understand security functions and associated security features

- User accounts
- User privileges and access rights to be able to perform tasks.
- Security groups - Users can belong to multiple groups
- File and Directory permissions – rwx rwx rwx
- Auditing and keeping a log of file edits, deleted files, creation of files etc.
- Security updates to the operating system
- System calls (Syscalls)
  - Program modes – User mode and Kernel mode
  - Context switching
  - Alleviation of context switch in modern operating systems
  - Syscall categories
    - Process control e.g.: create, load, execute, wait, signal, allocate and free memory, terminate, etc.
    - File manipulation e.g.: – create, open, read, write, close, delete
    - Device management e.g.: request device, release device, read, write, logical attachment and detachment
    - Information maintenance e.g., time and data, file attributes, device attributes
    - Communication e.g.: networking sockets, kernel signals, errors, Inter Process Communication (IPC)

### Suggested Resources

Thornton G., Jones C., 2023, Computer and Network Technology, BCS Level 4 Certificate in IT study guide, BCS (The Chartered Institute for IT)

Englander I., Wong W., 2021, The Architecture of Computer Hardware, Systems Software, and Networking: An Information Technology Approach, 6<sup>th</sup> Edition, Wiley

Andrew S. Tanenbaum, Herbert Bos, 2015, Modern Operating Systems, Pearson  
William Stallings, 2018, Operating Systems: Internals and Design Principles, Pearson

### Websites

<https://www.britannica.com/technology/operating-system>

<https://www.geeksforgeeks.org/operating-systems/>

<https://www.bbc.co.uk/bitesize/guides/zkrr97h/revision/6>

<https://www.youtube.com/@nesoacademy>

<https://www.youtube.com/@briantwill>

<https://www.youtube.com/@theurbanpenguin>

Supporting information	
<b>Opportunities for Synoptic Teaching and Learning</b>	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	Teaching and learning links to other unit LO/AC
LO1 Understand the concept of Operating Systems (OS)	The concept of operating systems immediately links to <b>U4 LO1</b> where learners consider stored programs, although the different types of common operating systems are not introduced at that stage. However, it also links directly to <b>U13 LO2</b> where software development learners come into contact with the Apple iOS and Google Android and where an understanding of these platforms is essential for the development of mobile apps.
LO2 Understand the main functions and features of different Operating Systems (OS)	The obvious link here is with <b>U4 LO2</b> as part of the software topic as without an operating system the computer is simply a collection of hardware. It also links heavily to <b>U14 LO1</b> because the full-stack developer needs an understanding of operating systems as a fundamental part of the software stack. In addition, building on <b>U4 LO2</b> further this topic explores
LO3 Understand security functions and associated security features	Building on <b>U4 LO3</b> 's discussion of security processes, this topic really develops the technician by examining rights, privileges, auditing and security updating from a technical support perspective, rather than form a coding one.
<b>Opportunities for Synoptic Assessment</b>	
Unit 21 provides an opportunity to demonstrate an understanding of the concepts of this unit when learners identify and develop a project idea choosing appropriate tools and techniques to find the solution to a problem, whilst demonstrating best professional practice.	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
<p><b>Problem-solving</b> – Using analytical skills, e.g., research skills, handling information, consulting multiple sources, interpreting and using information (LO1, LO2, LO3,).</p> <p><b>Communication</b> - Written communication, e.g., appropriate formats, style and tone, spelling, punctuation &amp; grammar (SPAG) (LO1, LO2, LO3).</p> <p><b>Working independently</b> - Using own initiative, self-organisation, maintaining motivation/focus, managing tasks (LO1, LO2, LO3).</p> <p><b>Digital Skills</b> – Using appropriate digital devices, handling and judging the reliability</p>	<p><b>Using sources of information</b> – Accessing information, e.g., choosing current, sufficient, relevant and reliable sources (LO1, LO2, LO3).</p> <p><b>Reading Skills</b> – Identifying different sources of information, reading with a purpose (LO1, LO2, LO3).</p> <p><b>Thinking Skills</b> – Using critical thinking skills, e.g., reading all information, identifying and interpreting others' positions, arguments and conclusions, weighing up opposing arguments, drawing conclusions (LO1, LO2, LO3).</p> <p><b>Writing Skills</b> - Understanding the purpose of writing; understanding writing styles and forms; ensuring that written output is suitable for the intended audience (LO1, LO2, LO3).</p>

of information, problem-solving (e.g., online research, presenting data) (LO1, LO2, LO3).	
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<b>Unit 18 Cyber Security Concepts</b>			
<b>Unit aims</b>	This unit helps learners understand cyber security concepts. They will understand the cyber security risks to systems, data, and assets. They will develop skills to act when detecting a cyber security event and carry out appropriate activities to contain and recover due to a cyber security incident. The learner will understand the methods used to implement appropriate security of critical services.		
<b>Unit level</b>	4		
<b>Unit code</b>	L/650/8554		
<b>GLH</b>	40		
<b>Credit value</b>	10		
<b>Unit grading structure</b>	Pass, Merit and Distinction		
<b>Assessment guidance</b>	In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.		
<b>Learning outcomes</b>	<b>Assessment criteria</b>		
The learner will demonstrate that they:	The learner can:		
	<b>Pass</b>	<b>Merit</b>	<b>Distinction</b>
1. Understand cyber security concepts.	1.1 Explain how cyber security assurance concepts are applied and why it matters. 1.2 Outline the tools used by cyber security teams. 1.3 Differentiate between threat intelligence and threat hunting concepts.	1M1 Analyse malicious activity using the appropriate tools and techniques.	
2. Understand risks and how to respond to cyber incidents.	2.1 Explain how attack methodology frameworks are applied. 2.2 Describe the incident management lifecycle. 2.3 Describe how vulnerability assessments are measured.		

<p>3. Understand client security requirements to derive security objectives.</p>	<p>3.1 Examine security requirements. 3.2 Outline standards and regulations that apply to cyber space. 3.3 Recommend security objectives.</p>	<p>3M1 Create a playbook based on a known vulnerability.</p>	<p>3D1 Develop a case study on a recent data breach that is relevant to a given scenario.</p>
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## Indicative Content

### 1. Understand cyber security concepts

- Cyber security concepts and why cyber security matters to business and society:
  - Loss of data required to undertake business processes
  - Diminished reputation (lack of client engagement, no longer recommended by current clients)
  - Financial penalties for non-compliance with legislation (data protection, misuse of computers)
  - Reduced profits (loss of financial details, paying to gain access to data being held by third party, fraud)
  - Increased overheads (hardware, specialist support)
  - Denial of services (access to websites, ability to place orders, access to data stored on networks)
- Security assurance concepts and how assurance may be achieved in practice including penetration testing and extrinsic assurance methods:
  - Tools used in Cyber Security e.g., Kali, Parrot OS, Backbox. Horizon scanning including use of recognised sources of threat intelligence and vulnerabilities
- The difference between threat intelligence and threat hunting; threat intelligence is the data that has been collected and analysed by automatic security systems; this is then used in threat hunting to start looking for the 'potential bad actor' on the network; this hunt can in itself identify new threats or a false positive
- The significance of identified trends in cyber security threats and how to deal with attack techniques:
  - Zero-day hazards
  - Ransomware
  - Phishing
  - Supply chain attacks
  - Social engineering

### 2. Understand risks and how to respond to cyber incidents

- Risk assessment and audit methodologies and approaches to risk treatment:
  - fault tree analysis
  - failure mode effect critical analysis (FMECA)
  - Central Computer and Telecommunications Agency (CCTA) risk analysis and management methodologies

- Approaches to identifying the vulnerabilities in organisations and security management systems:
  - Network monitoring
  - Penetration testing
  - Permission management - Access control (mandatory access control (MAC)), discretionary access control (DAC), attribute-based access control (ABAC), role-based access control (RBAC))
- The role of the risk owner in contrast with other stakeholders
- Cyber incident response and management processes/the incident management lifecycle:
  - Threat identification
  - Security of information
  - Detection of intrusions and attacks
  - Response to intrusion and attacks
  - Rebuild and recover
- Evidence collection/preservation requirements to support incident investigation

### 3. Understand client security requirements to derive security objectives

- Analyse employer or customer requirements to derive security objectives
- Proposed security objectives/measures in the context with reasoned justification
- Applying lifecycle and service management practices to an established standard e.g., Information Technology Infrastructure Library (ITIL), National Institute of Standards and Technology (NIST), the Cybersecurity Framework's five functions.
- Cyber Security response playbook: this is a plan that sets out the steps that will need to be taken in the event of a security incident

### Suggested Resources

Patu V. and Yamamoto, 2013, How to develop Security Case by combining real life security experiences (evidence) with D-Case, Procedia Computer Science Vol 22 pages 954-959

Charles J. Brooks, Christopher Grow, Philip A. Craig, Donald Short, Cybersecurity Essentials, Wiley 2018

Raef Meeuwisse, Cybersecurity for Beginners, Kogan Page Publishers, 2018

P.W. Singer and Allan Friedman, Cybersecurity and Cyberwar: What Everyone Needs to Know, Oxford University Press, 2014

### Websites

[www.nist.gov/cyberframework](http://www.nist.gov/cyberframework)

<http://csrc.nist.gov/>

<https://www.bcs.org/articles-opinion-and-research/the-biggest-cyber-attacks-of-2022/https://www.ncsc.gov.uk/section/keep-up-to-date/threat-reports?q=&defaultTypes=report&sort=date%2Bdesc>

<https://www.nist.gov/itl/smallbusinesscyber/cybersecurity-basics/case-study-series>

Supporting information	
<b>Opportunities for Synoptic Teaching and Learning</b>	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	Teaching and learning links to other units LO/AC
LO1 Understand cyber security concepts	The sub-topics in this LO are specific to the cyber pathway and therefore have few links to other units. Having said that, the testing component does link to <b>U15</b> – Software Testing Frameworks and Methodologies - in the <b>Software Development</b> pathway. The final topic, in particular the threats from cyber-attacks, link to <b>U16 LO2</b> , and <b>U19 LO1</b> (sources of threat and attack vectors) and also build on <b>U4 LO3</b> .
LO2 Understand risks and how to respond to cyber incidents	Incident response is largely a pathway specific topic, although it also builds on <b>U4 LO3</b> and indicative content in <b>U16 LO2</b> , and <b>U19 LO1</b> , not forgetting <b>U15</b> from the <b>Software Development</b> pathway.
LO3 Understand client security requirements to derive security objectives	Because this final LO focuses on a security project for a client, all of the models, framework and methodologies links are relevant here. First introduced in <b>U1 LO1</b> where it focused on the concept of a lifecycle as a model or framework, it will again use the lifecycle concept to manage the project. It also links with <b>U6 LO2</b> in the Data Analyst pathway, <b>U11 LO1</b> in the Software Development pathway and <b>U16 LO3</b> in the Cyber Security Technologist pathway. The choice of methodology is not specified and therefore learners will need to choose an appropriate model based on the context.
Opportunities for Synoptic Assessment	
Unit 21 provides an opportunity to demonstrate an understanding of the concepts of this unit when learners identify and develop a project idea choosing appropriate tools and techniques to find the solution to a problem, whilst demonstrating best professional practice.	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
<p><b>Digital skills</b> - Using digital devices, creating information, handling and judging the reliability of information, problem solving, applying relevant numerical skills to organise data (LO1, LO2, LO3).</p> <p><b>Working Independently</b> - Using own initiative, self-organisation, maintaining motivation/focus, managing tasks (LO1, LO2, LO3).</p> <p><b>Problem-solving</b> - Using analytical skills, e.g. research skills, handling information,</p>	<p><b>Using sources of information</b> - Accessing information, e.g. choosing current, sufficient, relevant and reliable sources (LO1, LO2, LO3).</p> <p><b>Reading Skills</b> – Identifying different reading materials, reading with a purpose, understanding reading styles (LO1, LO2, LO3).</p> <p><b>Thinking Skills</b> - Using critical thinking skills, e.g. reading all information, identifying and interpreting others' positions, arguments and conclusions, weighing up opposing arguments, drawing conclusions (LO1, LO2, LO3).</p>

consulting multiple sources, categorising information (LO1, LO2, LO3).

**Writing Skills** – Understanding the purpose of writing; understanding writing styles and forms (LO1, LO2, LO3).

<b>Unit 19 Security Architectures</b>			
<b>Unit aims</b>	This unit helps learners understand common security architectures and methodologies. It makes them aware of reputable security architectures that incorporate hardware and software components, and sources of architecture patterns and guidance. It explains the role of hardware and software security controls in the implementation of cyber security frameworks.		
<b>Unit level</b>	4		
<b>Unit code</b>	R/650/8556		
<b>GLH</b>	40		
<b>Credit value</b>	10		
<b>Unit grading structure</b>	Pass, Merit and Distinction		
<b>Assessment guidance</b>	In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.		
<b>Learning outcomes</b>	<b>Assessment criteria</b>		
The learner will demonstrate that they:	The learner can:		
	<b>Pass</b>	<b>Merit</b>	<b>Distinction</b>
1. Understand how the security environment of an organisation affects its response to security.	1.1 Identify areas where an organisation could be targeted. 1.2 Identify and explain common threat and attack techniques. 1.3 Explain how the security environment of an organisation affects its response.	1M1 Analyse how defending information assets and related systems is asymmetric.	
2. Understand how well-designed security architectures can provide an inclusive approach to cyber security.	2.1 Explain the key objectives of IT Service Management frameworks. 2.2 Explain the objectives of control, programme, and risk frameworks.	2M1 Analyse why an organisation might initially choose to develop a control framework.	2D1 Evaluate how a control framework, such as CIS-CSC, maps into a programme framework such as ISO/IEC 27001.
3. Understand how hardware and software can be deployed in a secure architecture.	3.1 Explain the implementation of hardware and software as part of a structured security architecture.		

	3.2 Explain how software powered services can help an organisation to comply with its chosen cyber security architecture.		
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## Indicative Content

### 1. Understand how the security environment of an organisation affects its response to security

- **Security environment**
  - Why? Why would it be targeted by a hostile actor?
  - Where? Where are the weak points?
  - How? How will the attack be done?
  - Asymmetry of attack and defence - because every risk needs to be treated whilst attackers only need to exploit one weakness
- **Why - Information assets**
  - Strategy
  - Intellectual property
  - Trade secrets
  - Training materials
  - Marketing Media
  - Customer lists
- **Where - Attack surfaces and attack vectors**
  - Attack surfaces, physical, digital, people
  - Attack vectors, how they work and where they are successful
  - Insider threats - negligent, malicious or untrained employees, unmanaged 3rd parties
- **How - Common vulnerabilities**
  - Misconfigurations
  - Untrained staff
  - Unsecure APIs
  - Unpatched software
  - Zero-day vulnerabilities
  - Weak access control
  - Stolen credentials
- **Response factors**
  - What is the potential impact?
  - Does the organisation have the skills to put cyber security in place?
  - How much is it willing/able to spend?
  - Are the staff trained to avoid cyber hazards?
  - Are policies in place?

- Has the organisation a multi-layered approach to security?

## 2. Understand how well-designed security architectures can provide an inclusive approach to cyber security

- **Common ITSM frameworks**

- **International**

- ISO 27000 series
  - ISO/IEC 27001 – Information Security Management System (ISMS) – recognised around the world
  - ISO/IEC 27002 – Code of Practice for information security controls
  - ISO/IEC 27031 - framework of methods and processes for developing an organisation's ICT readiness for business continuity
  - ISO/IEC 27032 – a risk management framework
  - ISO/IEC 27701 – Privacy Information Management Systems (PIMS)
- ISO 22301 - designed to protect an organisation from potential disruption
- ISO 31000 – International standard for risk management practices
- ITIL – focus on Information Technology Service Management – 5 core activities
- COBIT – Control Objectives for Information and Related Technology - ISACA
- TOGAF - The Open Group Architecture Framework,
- SABSA - Sherwood Applied Business Security Architecture
- OSA - Open Security Architecture
- PAS 555- holistic framework can apply to any organisation
- CIS-CSC

- **United States**

- National Institute of Standards and Technology (NIST) Risk Management Framework (RMF)
- NIST Cybersecurity Framework (CSF)

- **UK**

- MCSS – Minimum Cyber Security Standard (mandatory for UK Government departments)
- Cyber Essentials – Used by many businesses, 5 key areas

- **Sector-specific**

- PCI DSS – Payment Card Industry Data Security Standard

- **Cloud**

- Cloud Security Alliance (CSA) Cloud Controls Matrix (CCM) – mapped to standards and legislation, designed to maximise information security for users of Cloud technologies.

- **Framework categories**

- **Control frameworks**

- NIST 800-53 – a comprehensive set of 18 control families
- CIS-CSC – 20 control families split into Basic, Foundational and Organisational groups

- **Programme frameworks**

- ISO 27001 – recognised worldwide

- NIST CSF –simpler model, easier to get started, more of a technical focus using core, tiers, profiles
- **Risk frameworks**
  - ISO 27005 – defines a systematic approach to manage risks for an organisation
  - FAIR – Factor Analysis of Informational Risk – use as complement with other frameworks
  - NIST SP 800-39, NIST SP 800-37, NIST SP 800-30

### 3. Understand how hardware and software can be deployed in a secure architecture

- **Hardware**
  - Firewalls
  - Email Security gateways
  - Unified threat management systems
  - Intrusion prevention systems/Intrusion detection systems
    - Network-based
    - Host-based
    - Wireless intrusion
    - Network behaviour-based
- **Software**
  - Firewalls
  - VPNs
  - Antivirus
  - Policies
  - Processes
- **Software Powered Services, e.g.:**
  - SolarWinds
  - Secpod SanerNow
  - ManageEngine Vulnerability Manager Plus
  - Jira Service management
  - Fresh service
  - Zendesk Suite
  - Atera

#### Suggested Resources

Thornton G., Jones C., 2023, Computer and Network Technology, BCS Level 4 Certificate in IT study guide, BCS (The Chartered Institute for IT)

Joseph Steinberg, 2022, Cyber Security for Dummies, 2<sup>nd</sup> Edition, Wiley

Tim Rains, 2023, Cybersecurity Threats, Malware Trends, and Strategies, Packt Publishing

Paul Tyrone Thomas, 2023, Navigating the NIST Cyber Security Framework, P T Thomas

Larry Clinton, 2022, Cybersecurity for Business: Organization-Wide Strategies to Ensure Cyber Risk Is Not Just an IT Issue, Kogan Page

## Websites

<https://www.iso.org/standard/27001>

<https://csrc.nist.gov/>

<https://www.isaca.org/resources/cobit>

<https://www.pcisecuritystandards.org/glossary/pci-dss/>

<https://www.peoplecert.org/products/ITIL-4>

<https://www.geeksforgeeks.org/osi-security-architecture/>

<https://www.threatintelligence.com/blog/security-architecture>

Supporting information	
<b>Opportunities for Synoptic Teaching and Learning</b>	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	Teaching and learning links to other unit LO/AC
LO1 Understand how the security environment of an organisation affects its response to security	This topic links to <b>U4 LO3</b> where learners explore the risks to computer systems and data and also to <b>U18 LO2</b> where they consider incident response and the management process. However, this topic is more proactive than reactive because it expects technical staff to understand where vulnerabilities exist and where attacks can come from with a view to pre-emptive action.
LO2 Understand how well-designed security architectures can provide an inclusive approach to cyber security	The international frameworks such as ITIL and the ISO suite link directly to <b>U5 LO3</b> where professional standards are explored. There are many to explore and the learner should also examine any relevant frameworks from their own country or region.
LO3 Understand how hardware and software can be deployed in a secure architecture	This topic links primarily to <b>U18 LO2</b> where approaches to identifying the vulnerabilities in organisations and security management systems are discussed, but, as with many of the units in this pathway, this builds on the content of <b>U4 LO1/LO2</b> and <b>LO3</b> from the technician perspective, which is less relevant to the other pathways.
<b>Opportunities for Synoptic Assessment</b>	
Unit 21 provides an opportunity to demonstrate an understanding of the concepts of this unit when learners identify and develop a project idea choosing appropriate tools and techniques to find the solution to a problem, whilst demonstrating best professional practice.	
<b>Opportunities for Skills Development within this unit</b>	
Employability Skills	Study Skills

<p><b>Problem Solving</b> – Using analytical skills, e.g. research skills, handling information, consulting multiple sources, interpreting and using information (LO1, LO2, LO3).</p> <p><b>Communication</b> - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation &amp; grammar (SPAG) (LO1, LO2, LO3).</p> <p><b>Working independently</b> - Using own initiative, self-organisation, maintaining motivation/focus, managing tasks (LO1, LO2, LO3).</p> <p><b>Digital Skills</b> – Using appropriate digital devices, handling and judging the reliability of information, problem-solving (eg online research, presenting data) (LO1, LO2, LO3).</p>	<p><b>Using source of information</b> – Accessing information, e.g. choosing current, sufficient, relevant and reliable sources (LO1, LO2, LO3).</p> <p><b>Reading Skills</b> – Identifying different sources of information, reading with a purpose. (LO1, LO2, LO3).</p> <p><b>Thinking Skills</b> – Using critical thinking skills, e.g. reading all information, identifying and interpreting others' positions, arguments and conclusions, weighing up opposing arguments, drawing conclusions (LO1, LO2, LO3).</p> <p><b>Writing Skills</b> - Understanding the purpose of writing; understanding writing styles and forms; ensuring that written output is suitable for the intended audience (LO1, LO2, LO3).</p>
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<b>Unit 20 Cryptography</b>			
<b>Unit aims</b>	This unit will provide an understanding of the evolution of cryptography, how modern cryptography is applied within computer systems, and how this impacts on contemporary society. The learner will understand the concepts and features of cryptography and be able to apply encryption methods for a given scenario.		
<b>Unit level</b>	4		
<b>Unit code</b>	A/650/8559		
<b>GLH</b>	40		
<b>Credit value</b>	10		
<b>Unit grading structure</b>	Pass, Merit and Distinction		
<b>Assessment guidance</b>	<p>In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.</p> <p>To support this unit, learners will need to create a self-certificated SSL cert on a server e.g. Linux or Windows Server. You may need to assist with or demonstrate this.</p>		
<b>Learning outcomes</b>	<b>Assessment criteria</b>		
The learner will demonstrate that they:	The learner can:		
	<b>Pass</b>	<b>Merit</b>	<b>Distinction</b>
1. Understand terminology and the historical evolution of cryptography.	1.1 Explain terminology used in cryptography. 1.2 Describe the evolution of encryption methods.	1M1 Analyse the evolution of simple substitution methods to public/private key encryption.	
2. Understand the arithmetic used in current, common cryptography techniques and their features.	2.1 Describe the main cryptographic techniques that are currently in use. 2.2 Explain the features associated with cryptographic techniques. 2.3 Explain modular arithmetic as a basis for cryptography.	2M1 Calculate the arithmetic used for a given cryptographic method.	

3. Understand the application of modern encryption methods.	3.1 Explain the concepts of symmetric and asymmetric encryption. 3.2 Explain the use of a public key infrastructure. 3.3 Explain how modern encryptions can be applied.	3M1 Create a local work instruction on an encryption method and outline how its security should be tested.	3D1 Expand the local work instruction by including guidance on a cryptographic solution for a given scenario.
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## Indicative Content

### 1. Understand terminology and the historical evolution of cryptography

- The basic terminology and history of cryptography:
  - Historic Ciphers and cryptanalysis (Shift, Substitution, Vigenere, Stream, Lorenz)
  - Obfuscation
  - Pseudo-random number generators
  - Number only used once (Nonce)
  - Perfect forward secrecy
  - Security through obscurity
  - Collision
  - Steganography
  - Diffusion
  - Implementation of secure algorithms using programming or script e.g. Apply a security certificate to a website (HTTP to HTTPS)

### 2. Understand the arithmetic used in current, common cryptography techniques and their characteristics

- Common cryptography techniques in use and their features:
  - Perfectly secret encryption
  - Message authentication
  - Hashes and collision resistant Hash functions
  - Block cyphers v stream cyphers, benefits, and negatives
  - Digital Signature Schemes
  - Cryptosystems (Random Oracle Model, OAEP)
  - Quantum encryption, Quantum key distribution
  - Support of Confidentiality, Integrity, Authentication and non-repudiation
- Modular arithmetic
  - Congruence modulo
  - Equivalence relations
  - Quotient remainder theorem
  - Modular addition, subtraction, and multiplication
  - Modular exponentiation
  - Euclidean algorithm

### 3. Understand the application of modern encryption methods

- Private-key (symmetric) encryption:
  - AES (Advanced Encryption Standard)
  - DES (Data Encryption Standard)
  - IDEA (International Data Encryption Algorithm)
  - Blowfish (Drop-in replacement for DES or IDEA)
  - RC4 (Rivest Cipher 4)
  - RC5 (Rivest Cipher 5)
  - RC6 (Rivest Cipher 6)
- Public-Key (asymmetric) encryption and key negotiation:
  - RSA (Ron Rivest, Adi Shamir, and Leonard Adleman)
  - DSA (Digital Signature Algorithm)
  - ECC (Elliptic Curve Cryptography)
  - Diffie-Hellman
  - El Gamal
- The importance of effective key management and the main techniques used:
  - Key management and key life cycle, Certificate Authorities, registration authorities, certificate management systems – generation, distribution and deployment, certificate policies, certificate revocation. X.509 certificates
  - Legal and regulatory, Wassenaar Arrangement, Digital Rights Management
  - Export issues specific to the use of cryptography
  - Privacy versus disclosure:
    - Forced disclosure of encryption keys
- Cryptographic applications in the modern world:
  - Banking sector (Payment applications like card transactions)
    - Chip and Pin
    - Online transactions
  - Random number generation
  - Validation of sender's message
    - WhatsApp
    - Telegram
    - Facebook
    - Cell phones
    - VPN
  - Digital signatures
  - Confidentiality of data
    - Disk encryption
    - File encryption
  - Authenticity using digital signatures
  - Integrity of information exchange
  - Non-repudiation
- A local work instruction is a detail step by step guide of how to carry out a procedure to meet a given aim.

## Suggested Resources

Alexander D'Agapeyeff, 2006, Codes and Ciphers - A History of Cryptography, Read Books Ltd

Keith Martin, 2020, Cryptography: The Key to Digital Security, How It Works, and Why It Matters, Norton & Co.

James Kraft, Lawrence Washington, 2023, An Introduction to Number Theory with Cryptography, CRC Press

## Websites

<https://www.khanacademy.org/computing/computer-science/cryptography>

<https://csrc.nist.gov/Topics/Security-and-Privacy/cryptography>

<https://brilliant.org/courses/basic-number-theory/>

Supporting information	
Opportunities for Synoptic Teaching and Learning	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	Teaching and learning links to other unit LO/AC
LO1 Understand terminology and the historical evolution of cryptography	This unit and topic is highly specialist and although you could make connections between this and the <b>Software Development</b> pathway, there is not enough specific relevant content in the pathway to make explicit links.
LO2 Understand the arithmetic used in current, common cryptography techniques and their features	Building on concepts learned in <b>U4 LO3</b> , this topic has close links with <b>U11 LO1</b> where hash tables are introduced, and <b>U11 LO2</b> where automation is used as part of authentication. At a very basic level, this also builds on the arithmetic operations introduced in <b>U2 LO1</b> (programming language constructs).
LO3 Understand the application of modern encryption methods	The final LO in this unit is also highly subject specialist although cryptography as a concept is a fundamental part of cyber security, as it exists to mitigate risk.
Opportunities for Synoptic Assessment	
Unit 21 provides an opportunity to demonstrate an understanding of the concepts of this unit when learners identify and develop a project idea choosing appropriate tools and techniques to find the solution to a problem, whilst demonstrating best professional practice.	
Opportunities for Skills Development within this unit	
Employability Skills	Study Skills

<p><b>Digital Skills</b> - Using digital devices, creating information, handling and judging the reliability of information, problem solving, applying relevant numerical skills to organise data (LO1, LO2, LO3)</p> <p><b>Working Independently</b> - Using own initiative, self-organisation, maintaining motivation/focus, managing tasks (LO1, LO2, LO3)</p> <p><b>Problem-solving</b> - Using analytical skills, e.g. research skills, handling information, consulting multiple sources, categorising information (LO1, LO2, LO3).</p>	<p><b>Using sources of information</b> - Accessing information, e.g. choosing current, sufficient, relevant and reliable sources (LO1, LO2, LO3).</p> <p><b>Reading Skills</b> – Identifying different reading materials, reading with a purpose, understanding reading styles (LO1, LO2, LO3).</p> <p><b>Thinking Skills</b> - Using critical thinking skills, e.g. reading all information, identifying and interpreting others' positions, arguments and conclusions, weighing up opposing arguments, drawing conclusions (LO1, LO2, LO3).</p> <p><b>Writing Skills</b> – Understanding the purpose of writing; understanding writing styles and forms (LO1, LO2, LO3).</p>
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<b>Unit 21 Synoptic Computing Project</b>			
<b>Unit aims</b>	This unit is designed to enable learners from any pathway to resolve a business problem or show how a business opportunity could be pursued using appropriate tools and technologies. The project should be a suitable match to their study pathway and should make use of the knowledge and skills gained when studying the Diploma and Extended Diploma programmes.		
<b>Unit level</b>	4		
<b>Unit code</b>	H/650/8560		
<b>GLH</b>	40		
<b>Credit value</b>	10		
<b>Unit grading structure</b>	Pass, Merit and Distinction		
<b>Assessment guidance</b>	<p>In order to achieve this unit, learners must produce work which demonstrates achievement of the learning outcomes at the standards provided by the assessment criteria. To achieve a merit or distinction grade, the learners must demonstrate that they have achieved all the criteria set for these grades.</p> <p>Learners may implement and test the solution if they choose to as they may feel it will help with the evaluation. However, this unit's purpose is to allow learners to demonstrate that they can draw together the technical knowledge and learned skills needed to design a solution for their pathway, not deliver one.</p> <p>This is the synoptic unit for the qualification and should be delivered as the final unit for learners in their qualification.</p>		
<b>Learning outcomes</b>	<b>Assessment criteria</b>		
The learner will demonstrate that they:	The learner can:		
	<b>Pass</b>	<b>Merit</b>	<b>Distinction</b>
1. Can identify and investigate a business problem or opportunity that could benefit from a computing solution.	1.1 Identify and define a problem or opportunity that would benefit from a computing solution, defining its scope and its key stakeholders. 1.2 Explain why solutions should meet the needs of project stakeholders. 1.3 Define a series of metrics that will be used to measure the	1M1 Justify your choice of metrics that will be used to measure success.	

	success of the project.		3D1 Evaluate your approach to the project and explain how you demonstrated best practice.
2. Can use appropriate tools to design a solution and plan its implementation and testing.	2.1 Use a range of tools to design a potential solution to the problem or opportunity. 2.2 Document a plan to implement the solution. 2.3 Explain the testing strategies that will be used to test the solution.	2M1 Justify your choice of design tools in the context of this project.	
3. Can demonstrate an understanding of professional best practice.	3.1 Explain the skills and behaviours that would be needed in a team context to ensure effective working. 3.2 Communicate your project proposal, design, implementation and testing plan to an audience. 3.3 Explain any ethical or legislative considerations in relation to your solution.	3M1 Justify your choice of communications methods, demonstrating an understanding of the target audience.	

**Indicative Content**

**1. Can identify and investigate a business problem or opportunity that could benefit from a computing solution**

- Type of problem or opportunity: e.g.
  - data analysis, data visualisation, big data
  - software development, web development, mobile app development
  - network implementation or configuration, cyber security consultation, business security risk assessment
- Project stakeholders: e.g.

- internal: users, teams, departments, business owners, directors, employees, shareholders
- external: external client or customer and their users, suppliers, the public, government, local community
- Metrics to measure the success of the project: e.g.
  - business outcomes (gross profit margin)
  - Key Performance Indicators (KPIs)
  - customer satisfaction
  - efficiency (improvement in processing times, resource utilisation)
  - return on investment (ROI)
  - stakeholder satisfaction

## **2. Can use appropriate tools to design a solution and plan its implementation and testing**

- Design tools: e.g.
  - text (e.g. reports, presentation slides)
  - tables of information
  - diagrams (e.g. DFDs, ERDs, flowcharts, wireframes, network diagrams, technical schematics, cyber security network diagrams, cyber attack diagrams, data analysis flowcharts, business data flow diagrams)
- Identify suitable timelines and use planning tools: e.g.
  - Gantt charts
  - Pert charts
  - Critical path diagrams
  - proposed work breakdowns
  - timelines
  - schedules
  - tables of information
- Testing strategies: e.g.
  - functional testing
  - non-functional testing
  - user testing
  - compliance testing

## **3. Can demonstrate an understanding of professional best practice**

- Skills and behaviours for working effectively as a part of a team
  - understanding your role
  - making appropriate contributions
  - supporting peers
  - being flexible
  - having a positive attitude
  - having personal accountability
  - showing commitment to the team activity
- Communication methods for different audiences:
  - technical audience
  - non-technical audience
  - written
  - oral
- Professional practice best behaviours:

- spell checking documents using available software
- proof reading outputs to eradicate context errors
- writing clearly and with purpose
- creation of reports with page numbers and a contents page
- demonstrating interest in the project when communicating with an audience
- taking personal responsibility for the completion of tasks
- speaking with confidence
- making good use of communications technologies
- Wider considerations:
  - ethical practice
  - acknowledgement of relevant legislation e.g. DPA 2018 (or local alternatives)

### Suggested Resources

Hughes Bob, 2019 Project Management for IT-Related Projects: 3rd Edition, BCS (The Chartered Institute for IT)

Phillips Joseph, 2010 IT Project Management: On Track from Start to Finish 3rd Edition, McGraw-Hill Education

Rosell M, 2023 Data Analyst's Step-by-Step Project Planner: A comprehensive Guide for Success, Self-published

Fishpool B and Fishpool M, 2020 Software Development in Practice, BCS (The Chartered Institute for IT)

Hodson Christopher J, 2019 Cyber Risk Management: Prioritize Threats, Identify Vulnerabilities and Apply Controls, Kogan Page

Szymanski Thomas, 2021 Migration of Network Infrastructure: Project Management Experience, Lulu.com

### Websites

[www.skillsyouneed.com](http://www.skillsyouneed.com)

[www.coursera.org](http://www.coursera.org)

[www.projectmanager.com/guides/it-project-management](http://www.projectmanager.com/guides/it-project-management)

[asana.com/resources/it-project-management](http://asana.com/resources/it-project-management)

[www.fool.com/the-ascent/small-business/project-management/articles/it-project-management/](http://www.fool.com/the-ascent/small-business/project-management/articles/it-project-management/)

Supporting information	
Opportunities for Synoptic Teaching and Learning	
Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.	
Learning Outcome	Teaching and learning links to other unit LO/AC
<b>LO1</b> Identify and investigate a business problem or opportunity that could	The unit allows learners to draw on all of the knowledge learned, and skills developed in both the core programme and their chosen learning pathway.

benefit from a computing solution	Learners will be expected to draw appropriately on methodologies, tools and techniques, testing strategies and security concepts, applying their skills and acquired knowledge to find a solution to an IT problem that complements their chosen pathway.
<b>LO2</b> Use appropriate tools to design a solution and plan its implementation and testing	
<b>LO3</b> Demonstrate an understanding of professional best practice	
<b>Opportunities for Synoptic Assessment</b>	
This is the synoptic unit which allows learners to draw knowledge and skills from all units they have studied in a single synoptic project. In addition, criterion 3D1 enables learners to evaluate their application of skills and knowledge against the project as a whole.	

<b>Opportunities for Skills Development within this unit</b>	
<b>Employability Skills</b>	<b>Study Skills</b>
<p><b>Problem-solving</b> – Understanding the need for structured processes (LO1) and developing key behaviours to ensure successful projects (LO3). Using analytical skills, e.g. research skills, handling information, consulting multiple sources, interpreting and using information (LO1, LO2, LO3).</p> <p><b>Communication</b> - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation &amp; grammar (SPAG) (LO1, LO2, LO3). Oral communication, e.g. presenting and choosing appropriate presentation formats (LO3).</p> <p><b>Working independently</b> - Using own initiative, self-organisation, maintaining motivation/focus, managing tasks (LO1, LO2, LO3).</p> <p><b>Digital Skills</b> – Using appropriate digital devices, handling and judging the reliability of information, problem-solving (eg online research, presenting data) (LO1, LO2, LO3).</p>	<p><b>Using source of information</b> – Accessing information, e.g. choosing current, sufficient, relevant and reliable sources (LO1, LO2, LO3).</p> <p><b>Reading Skills</b> – Identifying different sources of information, reading with a purpose. (LO1, LO2, LO3).</p> <p><b>Thinking Skills</b> – Using critical thinking skills, e.g. reading all information, identifying and interpreting others' positions, arguments and conclusions, weighing up opposing arguments, drawing conclusions (LO1, LO2, LO3).</p> <p><b>Writing Skills</b> - Understanding the purpose of writing; understanding writing styles and forms; ensuring that written output is suitable for the intended audience (LO1, LO2, LO3).</p>