

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

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 9th 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.
-

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
Mandatory units				
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
Mandatory units				
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
Optional units				
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
Mandatory synoptic unit				
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 (Data Analysis)	All 5 mandatory units plus: 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 Plus: Unit 21 Synoptic Computing Project
ATHE Level 4 Extended Diploma in Computing (Software Development)	All 5 mandatory units plus: 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 Plus: Unit 21 Synoptic Computing Project
ATHE Level 4 Extended Diploma in Computing (Cyber Security and Networks)	All 5 mandatory units plus: 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 Plus: Unit 21 Synoptic Computing Project

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) – **36 points**.
 Distinction (achieves Learning Outcomes at the standards stated in pass, all merit and all distinction Assessment Criteria) – **45 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) – **54 points**.
 Distinction (achieves Learning Outcomes at the standards stated in pass, all merit and all distinction Assessment Criteria) – **67.5 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 209 points for the qualification:

Unit no.		Unit result	Unit points
1		Pass	45
2		Pass	30
3		Distinction	67.5
4		Pass	30
5		Merit	36
		<i>Total</i>	<i>209 (rounded up)</i>

Marina has achieved 209 points and will be awarded a Pass grade for the qualification as the requirement for a Pass is 180 - 215 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

Unit 1 IT Systems Development: Preparation, Analysis, Design and Problem-solving			
Unit aims	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.		
Unit level	4		
Unit code	Y/650/8502		
GLH	60		
Credit value	15		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
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.	3.1 Carry out an analysis using information gathering techniques to review an existing system. 3.2 Document an existing system using appropriate tools. 3.3 Produce a feasibility report.		LO3 and LO4 3D1 Evaluate the effectiveness of using a range of documentation tools to communicate the results of analysis and design.
4. Can identify, design, and document a possible solution.	4.1 Use the analysis to identify possible solutions to a problem and choose a preferred solution. 4.2 Design the solution using appropriate tools to document the proposal (including functionality and interfaces). 4.3 Describe a further improvement.	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

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
LO1 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. U1 LO1 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. U1 LO1 therefore links directly with U6 LO2 in the Data Analyst pathway, U11 LO1 in the Software Development pathway and U16 LO3 in the Cyber Security Technologist pathway.
LO2 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. U1 LO2 , U10 LO1 and U11 LO3 have strong links with U5 LO4 where learners explore the requirements of professional bodies and professional standards.
LO3 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. U1 LO3 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 U7 LO3 , U11 LO1 and U16 LO1 .
LO4 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 U1 LO4 are used in U3 LO2/LO3 , U6 LO3 , and to support all activity in U11 to U14 and all activity U16 to U20 .
LO5 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 U21 .
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
Problem-solving – 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). Communication - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation & grammar (SPAG) (LO1, LO2, LO3, LO4, LO5). Oral communication, e.g. presenting and choosing appropriate presentation formats (LO5). Working independently - Using own initiative, self-organisation, maintaining motivation/focus, managing tasks (LO1, LO2, LO3, LO4, LO5). Digital Skills – Using appropriate digital devices, handling and judging the reliability of information, problem-solving (eg online research, presenting data) (LO1, LO2, LO3, LO4, LO5).	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, LO5). 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, LO5).

Unit 2 Programming and Scripting	
Unit aims	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. Note: learners will have opportunities to explore other languages in the Advanced Programming unit for the Software Development pathway.
Unit level	4
Unit code	A/650/8503
GLH	40
Credit value	10
Unit grading structure	Pass, Merit and Distinction
Assessment guidance	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. 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: Python Releases for macOS Python.org Python Releases for Windows Python.org Visual Studio Python IDE - Python Development Tools for Windows (microsoft.com) 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.

Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
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.

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

www.coursera.org

www.geeksforgeeks.org/introduction-to-programming-languages/

www.python.org

www.codingground.com/learn-python/

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 principles of computer programming	U2 LO1 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 U8 LO1 , for use in web development U12 LO2/LO3 and which are an underpinning technology for Cyber Security (U18, U19) and as the basis for Cryptography (U20). In addition, learners are introduced to functions which are the building blocks of code which allow Data Analysts to interrogate data, Software Developers to create programs and Cyber Security Technologists to protect data and systems.
LO2 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. U2 LO2 therefore links with U7 LO2, U13 LO1 and U16 LO3 .
LO3 Can develop a computer program to a client brief.	As the learning outcome where programming code is specifically produced, most of U2 LO3 will be developed in Units 11 to 14 in the Software Development pathway, although the style guide (PEP 8) will only be relevant if Python is used as the development language for the extension units.
LO4 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 Data Analyst context, the outputs of analysis should be verified before being shared with users. Computer programs developed by Software Developers should be tested to ensure that they work as expected and have the anticipated functionality. Cyber Security solutions should be tested to ensure that data and systems are secure.
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
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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).
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Unit 3 Data and Database Systems			
Unit aims	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. 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.		
Unit level	4		
Unit code	D/650/8504		
GLH	60		
Credit value	15		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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. 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: https://www.lucidchart.com/ https://miro.com/ https://draw.io/ Equally, learners could draw the diagrams by hand, as long as they are neat and legible.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
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.	2.1 Explain different types of database. 2.2 Describe the different relationship types, join types and types of key. 2.3 Explain normalisation and functional dependency within a database. 2.4 Describe database administration including integrity and security control.	2M1 Assess the integrity constraints within relational models.	
3. Design a database system.	3.1 Design a relational database to meet a specified design brief. 3.2 Apply normalisation to a series of documents to 3NF. 3.3 Use database documentation tools to document a design to meet a design brief. 3.4 Present your design to the client using a suitable format.	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

www.coursera.org

code.tutsplus.com/tutorials/relational-databases-for-dummies--net-30244

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
LO1 Understand what is meant by data	Software Developers and Data Analysts need to have a very strong understanding of data and U3 LO1 examines the basics of data (such as classification, structure and type) in the context of a database. U3 LO1 links to U6 LO1 , and underpins all Software Development units. It is also important to Cyber Security Technicians because the type of data will also influence the technology used to secure it to meet the requirements of Data Protection legislation.
LO2 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 Data Analysts in U6 LO1 when learners consider normalised data (used in relational systems). Software Developers use code to manipulate data systems.
LO3 Design a database system	Using diagramming techniques developed in U1 LO3 , 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	Study 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).	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).

Unit 4 Computer Systems, Networks and Security			
Unit aims	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.		
Unit level	4		
Unit code	F/650/8505		
GLH	50		
Credit value	10		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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.		
Learning outcomes The learner will demonstrate that they:	Assessment criteria The learner can:		
	Pass	Merit	Distinction
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.

3. Understand the risks to computer systems and data.	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.	3M1 Assess the suitability of a range of security processes and the use of encryption to meet specific purposes.	
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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 (SSD)
 - 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, 6th Edition, Wiley

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

Websites

www.skillsyouneed.com

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
LO1 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 U8 LO1 . Use of logic in the coding of selections and loops in all Software Development units and the use of logic to produce diagrams in U16 LO3 and to map partitions in U17 LO2 .
LO2 Understand hardware and software	U4 LO2 links to all pathways as an underpinning technology but has specific links to U17 LO2 in the coverage of operating systems without which computers could not function.
LO3 Understand the risks to computer systems and data	The need to manage risk is also present across all pathways. Considering risk begins in U1 LO3 where one of the purposes of development is to reduce risk. Risk is also the basis for some aspects of legislation (U5 LO1) and it is the reason why organisations develop policies and procedures (U5 LO3). It features in U14 LO3 in relation to web application development, is the rationale for extensive program testing in U15 LO1 and is a founding principle in DevOps. It clearly is also the basis for Cyber Security 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
Problem-solving – 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). Communication - Written communication, e.g. appropriate formats,	Using sources of information – 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). 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).

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).
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Unit 5 Legislation, Regulation, Ethics and Codes of Practice			
Unit aims	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.		
Unit level	4		
Unit code	H/650/8506		
GLH	60		
Credit value	10		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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. 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.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
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

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	
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 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 U5 LO1 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.
LO2 Understand current ethical issues in IT	As with legislation and regulation, ethics is an important aspect of professional behaviour in the industry. Data Analysts should question whether they are using data ethically. Software Developers should consider the wider implications of software they create, for example there is a significant current debate on AI and its applications.
LO3 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.
LO4 Understand the role of professional bodies and industry certification in maintaining professional standards in industry	U5 LO4 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.
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 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
Communication - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation & grammar (SPAG) (LO1, LO2, LO3, LO4). Oral communication, e.g. presenting and	Using source of information – Accessing information, e.g. choosing current, sufficient, relevant and reliable sources (LO1, LO2, LO3, LO4).

choosing appropriate presentation formats (LO5). 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).	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).
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Unit 6 Organisational Data Architecture			
Unit aims	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.		
Unit level	4		
Unit code	K/650/8535		
GLH	40		
Credit value	10		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
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:
 - Cyclical/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

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	
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 the principles of organisational data architecture	This LO links with many other units, for example: U2 LO1 , U11 LO2 , U14 LO1 and U19 LO1 which all explore APIs. Organisational processes discussed in this LO also link with U1 LO3 and U4 LO3 and with the coverage of models, frameworks and methodologies which are scattered across all pathways.
LO2 Understand a common data analysis lifecycle of their choice	U6 LO2 is heavily linked with U1 LO1 as the data lifecycle is a variation of the development lifecycle. It links with the design and development approaches in U11 LO1 and the open standards explored in U16 LO3 .
LO3 Understand a simple entity-relationship model	The interpretation of entity relationship models is fundamental to both U1 , and to all units in the Software Development 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.
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
Problem-solving – 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). Communication - Written communication, e.g. appropriate formats, style and tone, spelling,	Using source of information – Accessing information, e.g. choosing current, sufficient, relevant and reliable sources (LO1, LO2, LO3). Time Management – Breaking down larger activities into manageable stages (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).

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).
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Unit 7 Methods and Tools for Analysis			
Unit aims	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.		
Unit level	4		
Unit code	L/650/8536		
GLH	40		
Credit value	10		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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.		
Learning outcomes The learner will demonstrate that they:	Assessment criteria The learner can:		
	Pass	Merit	Distinction
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, 6th 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.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	
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 the common methods and tools used in data analysis.	Although the first part of the indicative content is targeted at Data Analysts and features in U10 in relation to data visualisation, the common tools used in analysis such as formatting are also relevant to U2 and all of the Software Development units because data that is output by software products should be appropriately formatted.
LO2 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. U2 LO2 is the first time learners come into contact with the concept of the user interface. It is featured in this LO and again in U10 LO1/LO2 and LO3 . In the Software Development pathway, it is a fundamental consideration in all developments with user interaction, and even forms part of the testing framework in U15 . The user experience is also implicit in all units in the Cyber Security pathway even though it does not feature explicitly as a topic.
LO3 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 U1 LO3 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 U1 LO3 , U11 LO1 and U16 LO1 .
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
Working independently- 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). Communication Skills - We use communication skills when giving and	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

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).
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Unit 8 Data Preparation and Quality			
Unit aims	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.		
Unit level	4		
Unit code	M/650/8537		
GLH	40		
Credit value	10		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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. 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.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
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, 5th 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	
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 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 U2 LO1 as one of the founding principles of coding, in U7 LO1 (aggregation functions), U9 LO3 (spreadsheet functions), U12 LO2 (language specific functions), U13 LO2 (mobile app core language functions), and in the functions and features of operating systems in U17 LO2 as part of the security toolkit and in process management, hardware management, and file management.
LO2 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 U2 LO1 and they are considered again in U9 LO1 .
LO3 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 ATHE Employability Skills Framework, Section 7 – handling and judging the reliability of information and therefore is a skill that should be developed across the whole programme.
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
Working independently - 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).	Self-organisation - 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). Time Management – Managing time to maximise study and derive a good work-life balance is

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 (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).	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 (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). Digital Skills - Digital Skills are the skills needed to use digital devices, communications applications, and networks to access, create and manage information (LO1).
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Unit 9 Statistics for Analysing Datasets			
Unit aims	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.		
Unit level	4		
Unit code	R/650/8538		
GLH	40		
Credit value	10		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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. To support this unit, learners will need to have access to spreadsheet software such as MS Excel.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
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 categorical 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, 5th Edition, For Dummies

Linoff, G. S. (2015) Data Analysis Using SQL and Excel, 2nd 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.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	
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 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 U2 LO1 as one of the founding principles of coding, in U7 LO1 (aggregation functions), U8 LO1 (SQL functions for data extraction). They will also feature heavily in U10 LO1/LO2 and LO3 .
LO2 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 U5 LO3 .
LO3 Carry out simple statistical analysis using spreadsheet functionality	In this LO, learners use the principles of statistics outlined in LO1 , 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
Working independently - Working independently is the ability to work self-	Self-organisation - 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).
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Unit 10 Analytical Impact through Data Visualisations			
Unit aims	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.		
Unit level	4		
Unit code	T/650/8539		
GLH	40		
Credit value	10		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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. To support this unit, learners will need to have access to spreadsheet software such as MS Excel.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
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.		

3. Can design and construct effective data visualisations.	3.1 Create different types of graphs to represent the outcomes of an analysis. 3.2 Create a dashboard with multiple graphs and data tables. 3.3 Present your dashboard to a client.	3M1 Create a pivot graph based on an underlying dataset. 3M2 Enhance the graph elements in response to client feedback.	3D1 Evaluate the success of your dashboard in communicating clearly and effectively to a range of users.
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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://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	
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 the importance of communicating results in a clear and compelling way	This LO has links to both other units and the ATHE Employability Skills Framework , 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 U21 .
LO2 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.
LO3 Design and construct effective data visualisations	This topic is an extension of LO2 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
Working independently - 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). 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	Self-organisation - 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). 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).

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).
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Unit 11 Advanced Programming			
Unit aims	This unit helps learners build on introductory programming skills and develop professional practice in the discipline. 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.		
Unit level	4		
Unit code	L/650/8545		
GLH	40		
Credit value	10		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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. 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. https://www.uuidtools.com/api/generate/v1		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
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

www.coursera.org

www.freecodecamp.org/news/an-introduction-to-programming-paradigms/

www.geeksforgeeks.org/introduction-of-programming-paradigms/

<https://about.gitlab.com/topics/version-control/>

www.guru99.com/test-driven-development.html

www.docker.com/resources/what-container/

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 Software Design and Development Approaches	Building on U2 this topic introduces new models, frameworks and methodologies. TDD (Test Driven Development) links with U15 , 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 U2 LO2 , U7 LO2 and U13 LO1 (the consideration of the user experience). In this unit this is further developed with an examination of HCI styles and the interaction design process.
LO2 Understand and use Automation Techniques	This LO links with many other units, for example: U2 LO1 , U6 LO1 , U14 LO1 and U19 LO1 which all explore APIs and how they are used in different contexts within all pathways.
LO3 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 (U17 LO3), and although not explicitly referenced is an important facet of Data Analysis 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.
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
Problem-solving – 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). Communication - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation & grammar (SPAG) (LO1, LO2, LO3). 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).	Time management – Identifying and sticking with your objective setting yourself realistic goals (LO3). 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).

Unit 12 Web Design and Programming			
Unit aims	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.		
Unit level	4		
Unit code	R/650/8547		
GLH	40		
Credit value	10		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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. 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.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
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

	2.2 Format content using good standards of CSS to meet UI/UX requirements. 2.3 Create appropriate webpage behaviour using JavaScript to meet interactive UI/UX requirements.		protected from user modification.
3. Can apply the principles of server-side development.	3.1 Demonstrate the use of server-side scripting to process client-side POSTed data. 3.2 Demonstrate the use of server-side scripting to update file assets on the server's local file system.	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

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
LO1 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 (U20 LO1). Many of the concepts here, however, will be developed in U14 . Learners consider web-based APIs which links to U2 LO1 , U11 LO2 , U14 LO1 and U19 LO1 which all explore the application and use of APIs.
LO2 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 U2 . HTML and CSS are unique to website development, but learners will revisit these concepts when they study U14 . There is also a direct link back to the data types as set out in U3 LO1 .

LO3 Can apply the principles of server-side development	Server-side development links more directly to Cyber Security as insecure server-side scripting will be open to cyber attacks (U16 LO2 , U18 LO2 (application of attack methodology frameworks) and U19 LO1 (sources of threat and attack vectors). Basic CRUD operations as defined in this LO are also related to U8 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 (Create new record, Read existing record, Update existing record and Delete existing record). There is also a strong link to U15 LO1 and U14 LO3 when examining hardening a web application against potential threats.
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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

Employability Skills	Study Skills
Problem-solving – Understanding how the principle technologies are used to build, host and access websites (LO1, LO2, LO3). Communication - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation & grammar (SPAG) (LO1, LO2, LO3). 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, using technologies to create publicly accessible websites) (LO1, LO2, LO3).	Time management – Planning helps to organise time around regular activities and other commitments, and helps avoid distraction (LO2, LO3) 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).

Unit 13 Mobile Applications Development			
Unit aims	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.		
Unit level	4		
Unit code	T/650/8548		
GLH	40		
Credit value	10		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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. 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.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
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. simplify 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, 2nd 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/
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
<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
LO1 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 (LO1). This links to U2 LO2 , U7 LO2 and U13 LO1 (the consideration of the user experience). It also builds on the examination of HCI styles and the interaction design process in U11 LO1 .
LO2 Can design and develop mobile apps to meet a client brief	Just as U12 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 U2 , U11 , U12 and which will be built in U14 , using variables, data types, operators, conditions, and loops. And whilst the design approach is the same as in U2 and the remaining units in the Software Development pathway, there are some unique aspects such as the need to develop programs for different commercial pathways. Again, the user is considered (see LO1).
LO3 Can test and publish mobile apps	Linking directly to aspects of U15 , 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
Problem-solving – 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). Communication - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation & grammar (SPAG) (LO1, LO2, LO3). 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).	Time management – Identifying and sticking with the objective or instruction at hand so that you can set yourself regular and realistic goals (LO2, LO3). Using sources 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).

Unit 14 The Principles of Full-Stack Development			
Unit aims	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. 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.		
Unit level	4		
Unit code	Y/650/8549		
GLH	40		
Credit value	10		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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. 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.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
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 Nodejs
- 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

www.coursera.org

owasp.org/Top10/

www.geeksforgeeks.org/what-is-full-stack-development/

www.freecodecamp.org/news/what-is-a-fullstack-developer/

www.codecademy.com/resources/blog/how-to-become-a-full-stack-developer/

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 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 U12 . Learners consider web-based APIs which links to U2 LO1, U11 LO2, U12 LO1 and U19 LO1 which all explore the application and use of APIs.
LO2 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 U11 LO3 .
LO3 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 (U16 LO2, U18 LO2 (application of attack methodology frameworks) and U19 LO1 (sources of threat and attack vectors).
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
Problem-solving – 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). Communication - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation & grammar (SPAG) (LO1, LO2, LO3). 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).	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).

Unit 15 Software Testing Frameworks and Methodologies			
Unit aims	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. 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.		
Unit level	4		
Unit code	F/650/8550		
GLH	40		
Credit value	10		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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. 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.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
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

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

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

www.coursera.org

www.codecademy.com/resources/blog/what-is-software-testing/

www.ibm.com/topics/software-testing

usersnap.com/blog/software-testing-basics/

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 Software Testing Frameworks and Methodologies	As suggested in U1 , computing projects rely heavily on models, frameworks and methodologies to give structure to activities. When U1 LO1 discusses a concept of a lifecycle as a model or framework it has a testing phase which is explored in more detail in U15 LO1 . 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 U6 LO2 in the Data Analyst pathway, U11 LO1 in the Software Development pathway and U16 LO3 in the Cyber Security Technologist pathway where approaches are examined, and where testing is a feature.
LO2 Can implement a TDD process successfully	Test Driven Development (TDD) is first introduced in U11 LO1 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 U6 LO2 in the Data Analyst pathway, U11 LO1 in the Software Development pathway and U16 LO3 in the Cyber Security Technologist pathway.
LO3 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 U6 LO2 in the Data Analyst pathway, U11 LO1 in the Software Development pathway and U16 LO3 in the Cyber Security Technologist pathway.
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
Problem-solving – 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).	Using source of information – Accessing information, e.g. choosing current, sufficient, relevant and reliable sources to support investigation (LO1, LO2, LO3). Reading Skills – 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).
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Unit 16 Principles of Networks			
Unit aims	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.		
Unit level	4		
Unit code	H/650/8551		
GLH	40		
Credit value	10		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
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, 6th Edition, Wiley

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

Websites

www.skillsyouneed.com

www.coursera.org

www.geeksforgeeks.org/computer-network-tutorials/

www.techtarget.com/searchnetworking/feature/12-common-network-protocols-and-their-functions-explained

www.computer-networking.info/1st/cnp3.pdf

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 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 U4 LO2 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 U14 .
LO2 Understand risks to data and its mitigation	As suggested in U4 LO3 the need to manage risk is also present across all pathways. Considering risk begins in U1 LO3 where one of the purposes of development is identified as the reduction of risk. Risk is also the basis for some aspects of legislation (U5 LO1) and it the reason why organisations develop policies and procedures (U5 LO3). It features in U14 LO3 in relation to web application development, is the rationale for extensive program testing in U15 LO1 and is a founding principle in DevOps. It clearly is also the basis for Cyber Security as a whole which seeks to protect data and systems from a range of risks. There are also clear links with U18 LO1/LO2 where penetration is introduced as a method of securing data before other risks and mitigations are developed. Risks are also examined in U19 LO1/LO2 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 U5 LO1/LO3 because it focuses on documented standards and considers how they are used to build flexible and resilient networks.
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
Digital Skills - Using digital devices, creating information, handling and judging the reliability of information, problem solving, applying relevant numerical skills to organise data (LO1, LO2, LO3).	Using sources of information - Accessing information, e.g. choosing current, sufficient, relevant and reliable sources (LO1, LO2, LO3).

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).
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Unit 17 Concepts and Features of Operating Systems			
Unit aims	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.		
Unit level	4		
Unit code	J/650/8552		
GLH	40		
Credit value	10		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
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.

3. Understand security functions and associated security features.	3.1 Explain how user accounts and permissions are used to ensure security. 3.2 Explain how read/write/execute attributes are used to manage access to processes and files. 3.3 Explain why it is important to ensure that the OS is kept up to date.	3M1 Analyse the difference between user mode and kernel mode and explain how it is used to ensure system security.	
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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, 6th 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	
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 the concept of Operating Systems (OS)	The concept of operating systems immediately links to U4 LO1 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 U13 LO2 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 U4 LO2 as part of the software topic as without an operating system the computer is simply a collection of hardware. It also links heavily to U14 LO1 because the full-stack developer needs an understanding of operating systems as a fundamental part of the software stack. In addition, building on U4 LO2 further this topic explores
LO3 Understand security functions and associated security features	Building on U4 LO3 '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.
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
Problem-solving – 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, 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	Using sources 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).

of information, problem-solving (e.g., online research, presenting data) (LO1, LO2, LO3).	
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Unit 18 Cyber Security Concepts			
Unit aims	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.		
Unit level	4		
Unit code	L/650/8554		
GLH	40		
Credit value	10		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
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.		

3. Understand client security requirements to derive security objectives.	3.1 Examine security requirements. 3.2 Outline standards and regulations that apply to cyber space. 3.3 Recommend security objectives.	3M1 Create a playbook based on a known vulnerability.	3D1 Develop a case study on a recent data breach that is relevant to a given scenario.
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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://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	
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 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 U15 – Software Testing Frameworks and Methodologies - in the Software Development pathway. The final topic, in particular the threats from cyber-attacks, link to U16 LO2 , and U19 LO1 (sources of threat and attack vectors) and also build on U4 LO3 .
LO2 Understand risks and how to respond to cyber incidents	Incident response is largely a pathway specific topic, although it also builds on U4 LO3 and indicative content in U16 LO2 , and U19 LO1 , not forgetting U15 from the Software Development 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 U1 LO1 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 U6 LO2 in the Data Analyst pathway, U11 LO1 in the Software Development pathway and U16 LO3 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
Digital skills - Using digital devices, creating information, handling and judging the reliability of information, problem solving, applying relevant numerical skills to organise data (LO1, LO2, LO3). 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,	Using sources of information - Accessing information, e.g. choosing current, sufficient, relevant and reliable sources (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).

consulting multiple sources, categorising information (LO1, LO2, LO3).	Writing Skills – Understanding the purpose of writing; understanding writing styles and forms (LO1, LO2, LO3).
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Unit 19 Security Architectures			
Unit aims	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.		
Unit level	4		
Unit code	R/650/8556		
GLH	40		
Credit value	10		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
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, 2nd 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	
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 how the security environment of an organisation affects its response to security	This topic links to U4 LO3 where learners explore the risks to computer systems and data and also to U18 LO2 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 U5 LO3 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 U18 LO2 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 U4 LO1/LO2 and LO3 from the technician perspective, which is less relevant to the other pathways.
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

Problem Solving – 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, 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).	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).
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Unit 20 Cryptography			
Unit aims	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.		
Unit level	4		
Unit code	A/650/8559		
GLH	40		
Credit value	10		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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. 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.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
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 Software Development 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 U4 LO3 , this topic has close links with U11 LO1 where hash tables are introduced, and U11 LO2 where automation is used as part of authentication. At a very basic level, this also builds on the arithmetic operations introduced in U2 LO1 (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
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Digital Skills - Using digital devices, creating information, handling and judging the reliability of information, problem solving, applying relevant numerical skills to organise data (LO1, LO2, LO3) 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).	Using sources of information - Accessing information, e.g. choosing current, sufficient, relevant and reliable sources (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).
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Unit 21 Synoptic Computing Project			
Unit aims	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.		
Unit level	4		
Unit code	H/650/8560		
GLH	40		
Credit value	10		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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. 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. This is the synoptic unit for the qualification and should be delivered as the final unit for learners in their qualification.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
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

www.coursera.org

www.projectmanager.com/guides/it-project-management

asana.com/resources/it-project-management

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
LO1 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.
LO2 Use appropriate tools to design a solution and plan its implementation and testing	
LO3 Demonstrate an understanding of professional best practice	
Therefore, this unit demonstrates a learner's personal development, which is evidenced through the successful completion of the project. It will show that they understand the theory and are able to apply the theory in a meaningful way.	
Opportunities for Synoptic Assessment	
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.	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
Problem-solving – 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). Communication - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation & grammar (SPAG) (LO1, LO2, LO3). 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).	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).

ATHE qualification specification for:

ATHE Level 5 Diploma in Computing

610/3714/X

ATHE Level 5 Extended Diploma in Computing

610/3715/1

Pathways:

ATHE Level 5 Extended Diploma in Computing (Data Technologist)
ATHE Level 5 Extended Diploma in Computing (Software Engineer)
ATHE Level 5 Extended Diploma in Computing (NetDevOps Engineer)

Specification Version 1.0 Valid from February 2024

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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

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 5 in this Specification

This document provides key information on the following ATHE Level 5 Computing qualifications:

- ATHE Level 5 Diploma in Computing
- ATHE Level 5 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 5 Diploma in Computing	610/3714/X
ATHE Level 5 Extended Diploma in Computing	610/3715/1

Regulation Dates

These qualifications are regulated from February 2024 and their operational start dates in centres is February 2024.

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 5 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 5 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 4, the Diploma qualification provides essential Level 5 learning in the main, underpinning Computing management areas: IT project management, professional development and business communication, new technologies and information systems. For learners seeking to develop their occupational skills in Computing, this provides the initial step for learners to then progress to specific technical pathway developments in data technology (Data Technologist), software engineering (Software Engineer) and NetDevOps (NetDevOps Engineer) or to construct their own qualification outcome based upon academic/professional requirements.

In the absence of Level 5 standards for these areas, each of the pathways builds logically on the Level 4 current UK IfATE standards for the following occupational roles: Data Analyst, Software Developer and Cyber Security Technologist. You can view the details of these roles by visiting the IfATE website: [Home / Institute for Apprenticeships and Technical Education](#)

Additionally, each of the pathways at Level 5 links to the industry recognised 'Bodies of Knowledge' (BoKs), ie Data Management Body of Knowledge (DMBoK), Software Engineering Body of Knowledge (SWEBoK) and Cyber Body of Knowledge (CYBoK). In this way, learners taking a specific pathway can be assured that their learning and achievement is fully relevant to computing industry expectations for these industry roles.

Equally, the breadth of coverage within the qualification's 17 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 range of Computing skill areas, eg Advanced Database Practice, Client and Server Technologies and Penetration Testing and Ethical Hacking.

The qualifications have a synoptic focus. Unit 17 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 5 Diploma in Computing

Aims of the Qualification

The Level 5 Diploma in Computing (60-credit) offers learners a short but relatively extensive introduction to Level 5 computer management themes and issues. As an outcome, the Level 5 Diploma offers learners a common management foundation from which to explore the advanced technical skills and knowledge of each pathway and chosen optional unit.

Introduction to the ATHE Level 5 Extended Diploma in Computing

Aims of the Qualification

The Level 5 Extended Diploma in Computing (120-credit) builds on the Computing foundation offered by the Diploma and offers learners access to both pathway learning for role-based occupational development, or broader and diverse opportunities for more academic and professional learning development. The Extended Diploma offers a blended learning approach with the core, generic computer management units offering a context for the study of the optional technical units.

Unit 17'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 5. 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:

- prior study in computing or related subjects at level 4 or above a level 4 qualification, for example, an ATHE Level 4 Diploma/Extended Diploma in Computing
- 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 5. 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 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 6/7 ATHE qualification such as the ATHE Level 7 Extended Diploma in Computing Technologies
- the final year of degree programmes at universities supporting the ATHE progression route (see HE Progression Routes on the ATHE website)

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 5 are:

Knowledge descriptor (the holder....)

- Has practical, theoretical or technological knowledge and understanding of a subject or field of work to find ways forward in broadly defined, complex contexts.
- Can analyse, interpret and evaluate relevant information, concepts and ideas.
- Is aware of the nature and scope of the area of study or work.
- Understands different perspectives, approaches or schools of thought and the reasoning behind them

Skills descriptor (the holder can....)

- Determine, adapt and use appropriate methods, cognitive and practical skills to address broadly defined, complex problems.
- Use relevant research or development to inform actions.
- Evaluate actions, methods and results.

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 5 Diploma in Computing

ATHE Level 5 Diploma in Computing is a 60-credit qualification.

Rules of combination

Learners must achieve all 4 units.

The Total Qualification Time is 600 Hours

The Total Guided Learning Hours is 240

The Total Credit value is 60

Unit code	Unit Title	Level	Credit	GLH
Mandatory units				
F/651/0150	Unit 1 Computing Projects for Digital Transformation	5	15	60
H/651/0151	Unit 2 Professional Development and Business Communication	5	15	60
J/651/0152	Unit 3 Innovative Technologies and Connected Devices	5	15	60
K/651/0153	Unit 4 Information Systems	5	15	60

ATHE Level 5 Extended Diploma in Computing

ATHE Level 5 Extended Diploma in Computing is a 120-credit qualification.

Rules of combination

For learners not following a specific pathway, they must achieve the 4 mandatory units, any 3 optional units and Unit 17 Advanced Project.

Where learners wish to follow a specific pathway, then the unit requirements for each of these is detailed below (see 'Qualification pathways').

The Total Qualification Time is 1200 Hours

The Total Guided Learning Hours is 480

The Total Credit value is 120

Unit Codes	Unit Title	Level	Credit	GLH
Mandatory units				
F/651/0150	Unit 1 Computing Projects for Digital Transformation	5	15	60
H/651/0151	Unit 2 Professional Development and Business Communication	5	15	60
J/651/0152	Unit 3 Innovative Technologies and Connected Devices	5	15	60
K/651/0153	Unit 4 Information Systems	5	15	60
Optional units				
L/651/0154	Unit 5 Advanced Database Practice	5	15	60
M/651/0155	Unit 6 Programming for Data Engineering	5	15	60
R/651/0156	Unit 7 Implementing Data Flows and Data Warehouses	5	15	60
T/651/0157	Unit 8 Data Analytics and Machine Learning	5	15	60
Y/651/0158	Unit 9 Advanced Programming	5	15	60
A/651/0159	Unit 10 Client and Server Technologies	5	15	60
H/651/0160	Unit 11 Virtualisation and Cloud Computing	5	15	60
J/651/0161	Unit 12 Cloud Native Solutions	5	15	60
K/651/0162	Unit 13 Penetration Testing and Ethical Hacking	5	15	60
L/651/0163	Unit 14 Digital Forensics	5	15	60
M/651/0164	Unit 15 Network Developer and IT Operations (NetDevOps)	5	15	60
R/651/0165	Unit 16 Network and Cloud Design and Configuration	5	15	60
Mandatory synoptic unit				
T/651/0166	Unit 17 Advanced Project	5	15	60

Qualification pathways

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

Pathway title	Unit requirements
ATHE Level 5 Extended Diploma in Computing (Data Technologist)	All 4 mandatory units plus 3 units from:

	Unit 5 Advanced Database Practice Unit 6 Programming for Data Engineering Unit 7 Implementing Data Flows and Data Warehouses Unit 8 Data Analytics and Machine Learning Plus, the mandatory synoptic unit: Unit 17 Advanced Project
ATHE Level 5 Extended Diploma in Computing (Software Engineer)	All 4 mandatory units plus 3 units from: Unit 9 Advanced Programming Unit 10 Client and Server Technologies Unit 11 Virtualisation and Cloud Computing Unit 12 Cloud Native Solutions Unit 13 Penetration Testing and Ethical Hacking Plus, the mandatory synoptic unit: Unit 17 Advanced Project
ATHE Level 5 Extended Diploma in Computing (NetDevOps Engineer)	All 4 mandatory units plus 3 units from: Unit 13 Penetration Testing and Ethical Hacking Unit 14 Digital Forensics Unit 15 Network Developer and IT Operations (NetDevOps) Unit 16 Network and Cloud Design and Configuration Plus, the mandatory synoptic unit: Unit 17 Advanced Project

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 5 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 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 5 Diploma in Computing (60 credits)

Pass 180 - 215

Merit 216 - 269

Distinction 270

ATHE Level 5 Extended Diploma in Computing (120 credits)

Pass 360 - 431

Merit 432 - 539

Distinction 540

Example grading for Level 5 Diploma in Computing

Example 1

Marina has achieved a total of 210 points for the qualification:

Unit no.	Unit result	Unit points
1	Pass	45
2	Pass	45
3	Distinction	75
4	Pass	45
<i>Total</i>		<i>210</i>

Marina has achieved 210 points and will be awarded a Pass grade for the qualification as the requirement for a Pass is 180 - 215 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 some units, 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
LO2 + LO3

3D1 Evaluate how the identification and mitigation of risk increases the likelihood of success in a digital transformation.

For certain units, namely, Unit 17 Advanced 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

Unit 1 Computing Projects for Digital Transformation			
Unit aims	This unit enables learners to begin to think about how digital transformation may benefit their organisation, their job role, or the day-to-day activities within their organisation or their team. This understanding should be pathway neutral as learners at Level 5 will be expected to understand and contribute to plans for a digital transformation, regardless of their role.		
Unit level	5		
Unit code	F/651/0150		
GLH	60		
Credit value	15		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	There are no special software requirements to support the delivery or assessment of this unit. Learners should, however, have access to the internet. You could find a range of local and global examples of how digital transformation has benefitted organisations and individuals. 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. For a Merit, all pass and all merit criteria must be met. For a Distinction, all pass, all merit and all distinction criteria must be met.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
1. Understand opportunities and drivers for digital transformation	1.1 Identify and explain a range of opportunities for digital transformation 1.2 Give examples of how digital transformation can enable organisations to reduce their carbon footprint 1.3 Explain the benefits of digital transformation to a non-technical audience	1M1 Recommend digital assets to support a digital transformation	1D1 Evaluate your choice of digital assets to support a digital transformation

2. Understand risks associated with digital transformation	2.1 Identify and explain the skills needed to support a digital transformation 2.2 Explain the costs associated with digital transformation 2.3 Explain why staff can be resistant to change	2M1 Analyse the importance of realistic timescales in the implementation of a digital transformation	3D1 Evaluate how the identification and mitigation of risk increases the likelihood of success in a digital transformation
3. Understand how risks associated with digital transformation are mitigated	3.1 Explain the role that communication plays in managing how staff perceive change resulting from digital transformation 3.2 Explain the importance of ROI (return on investment) and why ROI might not be immediate 3.3 Describe how data will need to be prepared to accommodate digital transformation	3M1 Analyse how a range of risks associated with digital transformation can be mitigated	

Indicative Content

1 Understand opportunities and drivers for digital transformation

- Opportunities for digital transformation
 - Automation
 - e.g., industrial machinery, home automation, vehicle automation and logistics, programmed kitchen appliances and consumer electronics, agricultural processes such as automated ploughing, irrigation systems and harvesting
 - Development of products
 - e.g., technology used in design, prototyping, simulation
 - Accessing new markets and customers
 - e.g., building or re-energising a brand
 - Taking advantage of emerging technologies
 - e.g., having an awareness of emerging technologies and their capabilities and how these could be used by organisations
 - Futureproofing (upskilling staff and developing a staff base that is ready for the future demands of the organisation)
 - Leveraging connected technologies
 - e.g., automated social media posting, personalised marketing, using assistive devices to generate sales (such as re-ordering reminders)
 - Modernising IT infrastructure

- e.g. what are the benefits of modernisation such as scalability, responsiveness, greater capacity
- Modernising operational practices
 - e.g. simplification, improved workflow, improved capabilities (the ability to do more)
- Digitising documentation
 - e.g., better storage, better organisation, improved access, more availability for analysis to support decision making
- Improvement in the customer experience
 - e.g., more responsive to customer needs, use of chatbots, remote patient or customer management, online help
- Re-engagement of staff
 - e.g., improved communication and information sharing, better collaboration across teams, provides wider access to resources, potential for remote working, better work-life balance, developing a digital culture that is recognised and appreciated
- Becoming greener
 - e.g., embracing sustainability, reduction of carbon footprint, better relationships with local community
- Accessibility to education and training
 - e.g., more efficient access to education and training (access to remote learning and training), greater choice of training and educational programmes
- Enhanced collaboration with external partners
 - e.g., easier access to meetings without excessive travel
- Drivers for digital transformation
 - Regulatory compliance and ethical responsibility
 - e.g., using technology to help organisations meet legislative requirements and demonstrate ethical responsibility
 - Cost reduction
 - e.g., this does not necessarily mean reducing staff, it could be using satellite technologies to find better delivery routes, online meetings to avoid attending in person
 - Improved efficiency
 - e.g., improved workflow, creating an organisation that can respond to continuous change, reduction in process bottlenecks
 - Meeting evolving customer expectations
 - e.g., responsiveness, accountability, agility
 - Obsolescence of existing technology
 - e.g., technology for which parts are no longer available, software is no longer supported or updated (causing an operational and security risk)
 - To drive innovation
 - e.g., support initiatives for growth, access to data for research and development
 - Greater access to a wider talent pool
 - e.g., using digital technologies to enable a wider pool of skills and abilities to be available for work (such as carers and those who are housebound), being able to outsource to reduce costs by employing less expensive labour.
 - Maintain competitiveness
 - e.g., having access to more information about competitors and their activities

2 Understand risks associated with digital transformation

- Lack of appropriate skills in existing workforce to support a digital transformation
 - technical skills
 - people management skills
 - project management
- Costs
 - initial outlay for hardware and software upgrades
 - hidden costs (such as the costs of training, downtime when staff are being trained)
 - ongoing maintenance costs
 - ongoing support costs
 - ROI (return on investment)
 - costs of software licenses
 - managing cost increases caused by scope creep
- Lack of real understanding about the technologies being implemented
 - what the technology can do
 - what the technology cannot do
 - over-promising what digital transformation can offer
 - lack of appreciation about the extent of change and what will really be impacted
- Risks to staff
 - staff burnout due to
 - expectation that staff can manage more work
 - expectation that staff can work more quickly
 - staff can feel that there is a greater expectation that they are accessible 24/7
 - isolation during long periods where they are working from home
- Staff fear of change and resistance to change
 - fears, including job loss, requirements to do more work or to work more quickly
 - assumption that staff will buy in to transformation
 - staff who lack understanding
- Managing large volumes of digital data
 - many organisations work with multiple systems which often means data duplication
 - data may need to be cleaned and prepared
 - data may need to be kept within certain locations due to security concerns or legislation
- Timescales
 - digital transformation should be carefully planned
 - underestimating the impact from the changeover from one way of working to another
 - adopting new technologies without sufficient testing
 - high volumes of users
 - wireless capacity (number of connected users)
 - underestimating problems that could emerge during transformation
 - costs over-running
 - scope creep
- New cyber security risks
 - the introduction of new digital assets that need to be risk assessed and managed before being added to the existing infrastructure
- Disaster recovery
 - updated policies for disaster management to reflect digital transformation
 - updated policies for business recovery to reflect digital transformation

3 Understand how risks associated with digital transformation are mitigated

- Managing change and the risks associated with digital transformation
 - Upskilling

- providing necessary training
 - buying in expertise (which increases costs)
- Costs
 - finding project capital
 - creating a budget for operational and support costs
 - calculating ROI (return on investment)
- Lack of real understanding about the technologies being implemented
 - be clear about what will and will not be possible after digital transformation
 - share the facts with staff so that they feel informed
 - ask staff to contribute to the estimates of how the transformation will impact on their ability to work
 - keep staff informed about how the transformation will affect them
- Risks to staff
 - create operational policies and set out expectations of staff
 - ensure that remote staff have regular contact with their manager and team
- Staff fear of change and resistance to change
 - assumption that staff will buy in to transformation
 - staff who lack understanding of technology
- Managing large volumes of digital data
 - many organisations work with multiple systems which often means data duplication
 - data may need to be cleaned and prepared (e.g. removal of duplicated data, data may need to be reorganised)
 - requirements in relation to data sovereignty should be observed
- Timescales
 - should be realistic
 - should be agreed with staff
 - should be shared with all stakeholders
- New cyber security risks
 - cyber specialists should be involved in the selection and preparation of technologies
- Importance of taking stakeholders with you on a digital transformation journey

Suggested Resources

Lardi, K., 2022, The Human Side of Digital Business Transformation, Wiley

Weiss, A., 2022, The Practical Guide to Digital Transformation: Quickly Master the Essentials with Tips, Case Studies and Actionable Advice, Kogan Page

Porter, M.E., et al., 2021, HBR's 10 Must Reads on Leading Digital Transformation (with bonus article "How Apple Is Organized for Innovation" by Joel M. Podolny and Morten T. Hansen), Harvard Business Review Press

Rogers, D., 2023, The Digital Transformation Roadmap: Rebuild Your Organization for Continuous Change, Columbia University Press

Websites

www.skillsyouneed.com

www.coursera.org

[Digital Transformation: What is it? 10 Successful Big Brand Examples](#)

[What is digital transformation?](#) (IBM)

[What is digital transformation?](#) (McKinsey & Company)

[The Essential Components of Digital Transformation](#)

[13 Benefits of Digital Transformation to Inspire You](#)

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 opportunities and drivers for digital transformation.	It is clear that to understand how new and emerging technologies can be used in digital transformation, it is essential to understand not only what these technologies and connected devices are, but also how they impact on organisations, individuals, the IT sector and society as a whole. This is examined in U3 LO1 , U3 LO2 , and U3 LO3 . It is also likely that developments in information systems (links with U4 LO1 , U4 LO2 , U4 LO3) and the growth and developments in AI and machine learning and the ability of organisations to run enhanced data analytics (Data pathway U8 LO1 , U8 LO2 , U8 LO3) will also drive digital transformation as outlined in this unit.
LO2 Understand risks associated with digital transformation.	Barriers to communication are one of the key risks associated with digital transformation. If a practitioner cannot successfully take customers and users on their journey, then the transformation may fail. For this reason, practitioners should understand the importance of communication at the right level to suit the target audience and know how to overcome any communication barriers to sure that users as customers are supported. U1 LO2 and U1 LO3 therefore link directly with U2 LO4 .
LO3 Understand how risks associated with digital transformation are mitigated.	
Opportunities for Synoptic Assessment	
Some of the Distinction criteria require knowledge from one or more of the LOs. In this unit, AC 3D1 includes assessment across LO2 and LO3 .	
In addition, Unit 17 Advanced Project provides an opportunity for learners to demonstrate an understanding of the concepts of this unit when learners use the skills learned in both the core and their chosen 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 units.	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
Problem-solving – Understanding how and why digital transformation benefits an organisation, a team or an individual in their job role (LO1). Learners will also need to identify risks associated with a digital transformation in a given context (LO2), and explain how to overcome the risks by suggesting suitable mitigations (LO3). Communication - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation & grammar (SPAG) (LO1, LO2, LO3). Oral communication, e.g. presenting and choosing appropriate presentation formats (LO1). 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 to support argument, presenting data) (LO1, LO2, LO3).	Using sources 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).

Unit 2 Professional Development and Business Communication			
Unit aims	This unit builds on the professional practice content first introduced in Level 4's Unit 21 (Synoptic Project and Professional Best Practice) where learners considered team behaviours that contribute to effective working, written and oral communication and wider considerations such as ethical practice and an understanding of relevant legislation. Because the IT industry is fast moving, practitioners should understand that working in this sector will necessitate continuous professional development (CPD), often including the updating of technical skills as well as the development of professional skills as practitioners are promoted.		
Unit level	5		
Unit code	H/651/0151		
GLH	60		
Credit value	15		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	There are no special software requirements to support the delivery or assessment of this unit. Learners should, however, have access to the internet. Learners should be encouraged to watch professional development videos on streaming services such as YouTube that relate to their preferred pathway. 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. For a Merit, all pass and all merit criteria must be met. For a Distinction, all pass, all merit and all distinction criteria must be met.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
1. Understand the role of Continuous Professional Development (CPD) in the professional development of IT practitioners	1.1 Explain the purpose and importance of CPD 1.2 Describe the types of CPD and a range of typical activities that contribute to CPD 1.3 Explain the importance of formally recording CPD activity		

2. Understand the factors that contribute to different types of communication and the reputational impact of good business communication	2.1 Explain a range of factors that contribute to successful business communication 2.2 Explain how the way you communicate impacts on how others perceive you, your department and your organisation 2.3 Describe, with examples, how organisations should use different communication channels	2M1 Analyse the importance of understanding the reputational impact of different communication methods	2D1 Justify a chosen approach to business communication in a given context
3. Understand how to communicate at a level that is appropriate to the target audience, particularly with senior management	3.1 Describe the importance of identifying and understanding a target audience 3.2 Explain how you could better prepare to facilitate good communication 3.3 Explain why SLAs are necessary to manage expectations within organisations	3M1 Differentiate between the differing needs of internal and external audiences	4D1 Evaluate the success of a business communication and identify CPD tasks you could undertake to improve your business communication
4. Understand how barriers to communication can be overcome to support users as customers	4.1 Explain barriers to communication 4.2 Describe how barriers to communication can be overcome	4M1 Analyse how fear of change becomes a barrier to communication	

Indicative Content

1 Understand the role of Continuous Professional Development (CPD) in the professional development of IT practitioners

- Purpose of CPD (e.g. short, medium and long term career planning)
- Types of CPD (e.g. structured activity, formal unstructured activity, informal unstructured activity, reflective practice)
- Activities that contribute to CPD (e.g. certificated courses, in-house training, job shadowing, workshops and seminars, online learning, networking events and conferences)
- CPD process (e.g. performance review: analysing personal contributions over period being reviewed, identifying job and personal goals, target setting)
- Formally recording CPD (e.g. CPD log, copies of certificates, feedback from informal training)
- Importance of CPD (e.g. preparing to meet the needs of the organisation, meeting the needs and aspirations of the practitioner)

2 Understand the factors that contribute to different types of communication and the reputational impact of good business communication

- Types of communication (e.g. verbal, written)
- Factors that contribute to business communication (e.g. body language, facial expressions, tone of voice, use of technical jargon, use of listening skills, use of appropriate images: awareness of image copyright)
- Reputational impact (e.g. understanding that in a business context practitioners are representing themselves, their departments, and their organisations)
- Appropriate use of communication channels (e.g. social media, email, verbal communication channels like Microsoft Teams, presentations, written reports)
- Public and private communication channels (e.g. when to use)

3 Understand how to communicate at a level that is appropriate to the target audience, particularly with senior management

- Types of target audience (e.g. technical, non-technical)
- Internal audience (e.g. colleagues, subordinates, senior managers)
- The importance of understanding internal users of IT services as customers (e.g. why it is necessary to have SLAs (Service Level Agreements) and why it is necessary to set and manage expectations)
- External audience (e.g. customers, suppliers, stakeholders, business partners)
- Target audience differentiators (e.g. lifestyle, attitudes and beliefs, gender, ethnicity, culture or sub-culture, specific age-groups, needs and motivations, aspirations, location, economic group, seniority (particularly in a business context), level of education, occupation, technical proficiency)
- Importance of understanding different audiences so that you speak their language, not IT e.g.
 - to enable you to find common ground between you and your audience
 - to enable you to adapt your message to suit their needs
 - to enable your audience to engage
 - to avoid the potential for miscommunication
 - to help you build a business relationship
- How to understand your audience:
 - Spend time trying to get to know your audience (e.g. with customers – what do they usually buy and how often, whether they are buying from your competitors and what your competitors offer; with senior managers – understand their role within the

organisation and the needs of their area of responsibility; with subordinates – know how the message you are sharing will impact them and their day to day activities)

4 Understand how barriers to communication can be overcome to support users as customers

- Technical (e.g. having no understanding of computing, IT or individual technologies and relevant terminology, having no understanding of the time that may be needed to investigate and correct faults in systems and devices or time needed to develop a solution)
 - How to overcome: use simple language, avoid using technical terminology and try to only explain the key points that customers need to know, be realistic about time needed to develop systems or solutions, or to investigate and correct faults.
- Physical (e.g. distance, time zones, technical issues, noise and other distractions)
 - How to overcome: leverage technology, be prepared to be flexible, plan ahead and find a suitable time, test technology in advance, find a quiet environment
- Language (e.g. different languages, specialised language and technical jargon, regional dialects, colloquialisms)
 - How to overcome: use simple language, where possible avoid jargon, limit the amount of information being shared, be unambiguous, spend as much time listening as talking
- Culture (e.g. social customs, cultural norms and values, values and belief systems, stereotypes)
 - How to overcome: learn about other cultures, ask questions if unsure, demonstrate respect, be positive
- Physiological (e.g. physical disability that prevents travel, visual impairment, hearing impairment, dyslexia)
 - How to overcome: where practitioners are aware of a physiological challenge they should make suitable adjustments, organisations should also help employees make adjustments
- Psychological (e.g. fear of change creates a psychological barrier, due to: personal insecurity, lack of trust in management, assumption that change will be bad, fear of job loss, fear of loss of control, previous experience of change)
 - How to overcome:
 - share the nature of change, timescales and the expected benefits
 - give an audience time to absorb the information and ask questions
 - demonstrate emotional intelligence, do not assume everyone will be on your page

Suggested Resources

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

Heller, Daniel, 2020, Building a Career in Software Development: A comprehensive Guide to Success in the Software Industry, Apress

Edited by Rasmussen, Rune, 2019, Data Analyst: Careers in Data Analysis, BCS (The Chartered Institute for IT)

Barker, Jessica, 2020, Confident Cyber Security: How to Get Started in Cyber Security and Futureproof Your Career (Kogan Page)

Pontus, M.J., 2021, Management for Beginners: The Ultimate Guide for First Time Managers, Self-published

Websites

www.lucidchart.com/blog/communicate-with-senior-management

www.prnewsonline.com/water-cooler/2015/02/27/10-tips-for-smart-communications-with-upper-management

www.grammarly.com/business/learn/types-of-business-communication/

www.highspeedtraining.co.uk/hub/what-is-cpd/

www.makingbusinessmatter.co.uk/barriers-to-effective-communication/

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 the role of Continuous Professional Development (CPD) in the professional development of IT practitioners	All of the units in all of the pathways contribute towards CPD as the learners (and then learners as employees) come across new technologies, approaches, methodologies and technologies when in the world of work. There is a good opportunity here as part of teaching this outcome to ask learners to consider why academic/vocational computing/IT qualifications and professional qualifications and certificates are updated regularly. You should also explain the importance of documenting CPD activities to ensure that evidence is available for formal personal reviews. All units/LOs.
LO2 Understand the factors that contribute to different types of communication and the reputational impact of good business communication	Summaries of numerical data and data visualisations as laid out in the Data pathway U6 LO3 are regularly used to communicate information. In this unit, the importance of accurate data is stressed because of the potential reputational impact of misinformation.
LO3 Understand how to communicate at a level that is appropriate to the target audience, particularly with senior management	As stated above, summaries of numerical data and data visualisations as laid out in the Data pathway U6 LO3 are regularly used to communicate information. In this unit, the importance of accurate data is stressed because of the potential reputational impact of misinformation. This LO is equally important in relation to the Cyber pathway U14 LO3 , where learners have to consider why it is necessary to have professional guidelines and demonstrate best practice, particularly in the preparation of data and information as digital forensic evidence.
LO4 Understand how barriers to communication can be overcome to support users as customers	Communication as a barrier to digital transformation as outlined in U1 LO2 and U1 LO3 , is the most important risk in relation to any IT related activity in all pathways. Practitioners should develop negotiation techniques and strategies to overcome any negative or uncooperative attitudes demonstrated by stakeholders in a project, transition or transformation activity, or even in day-to-day interactions with non-technical users.
Opportunities for Synoptic Assessment	
Some of the Distinction criteria require knowledge from one or more of the LOs. In this unit, AC 4D1 includes assessment across LO3 and LO4 .	
In addition, Unit 17 Advanced Project provides an opportunity for learners to demonstrate an understanding of the concepts of this unit when learners use the skills learned in both the core and their chosen 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 units.	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
Problem-solving – Understanding why continuous professional development is essential for the IT practitioner in their job role (LO1). Learners must understand that their demonstrated behaviour impacts on how their organisation, their department and how they themselves are perceived (LO2). Communication - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation & grammar (SPAG) (LO1, LO2, LO3, LO4). Oral communication, e.g. presenting and choosing appropriate presentation formats (LO1). 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 to support argument, presenting data) (LO1, LO2, LO3, LO4).	Using sources 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).

Unit 3 Innovative Technologies and Connected Devices			
Unit aims	This unit aims to equip you with an understanding of innovative technologies like AI, IoT, Blockchain, AR, VR, and the world of connected devices. You will explore their applications, understand their working principles, and learn about their implementation and ethical challenges. This knowledge and skill set will prepare you to navigate the ever-evolving digital landscape.		
Unit level	5		
Unit code	J/651/0152		
GLH	60		
Credit value	15		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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. For a Merit, all pass and all merit criteria must be met. For a Distinction, all pass, all merit and all distinction criteria must be met.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
1. Understand innovative developments in technology	1.1 Define innovative technologies and their importance in today's digital world 1.2 Explore various innovative technologies such as Artificial Intelligence (AI), Internet of Things (IoT), Blockchain, Augmented Reality (AR), Virtual Reality (VR), etc 1.3 Discuss the applications and implications of these technologies in different sectors	1M1 Analyse a range of innovative developments in technology and make recommendations to address particular scenarios	
2. Understand the impact of technological innovations on the computer industry	2.1 Explain impacts of technological innovation on the way computer systems are used and supported	2M1 Choose a recommendation made in 1M1 and assess the pros and cons of the recommendation	2D1 Reflect on the ethical argument that possessing the ability to use technology to carry out an action

	2.2 Describe ethical issues relating to technological innovation in computing 2.3 Describe the impact of legislation on technological innovation in computing		always means we should use it
3. Understand the impact of technological innovations on society	3.1 Describe the impact of innovations in technology on society 3.2 Explain ethical issues relating to the use of technological innovation in society 3.3 Describe the impact of legislation on technological innovation in society	3M1 Analyse innovative technologies and connected devices in a range of scenarios and recommend an ethical course of action	3D1 Evaluate the impact on society of a chosen scenario

Indicative Content

1 Understand innovative developments in technology

- Identify current developments
 - Virtual Reality and Augmented Reality
 - Quantum Computing
 - Artificial Intelligence
 - Chat GPT
 - Surveillance, smart cities, etc.
 - Smartphones, 5G and beyond
 - Big data
 - Blockchain
 - Cloud
 - Ubiquitous computing
 - Wearables
 - IoT – smart homes
 - ‘Smart’ cars – software updates
 - Driverless cars
 - Streaming music and films
 - ‘Smart’ utility meters
 - Crypto currencies
 - Facial recognition
- Identify environments that utilise innovative technologies
 - Government
 - Business
 - Social media
 - Education, knowledge society
 - Health
 - Health & Safety

- Finance
- Entertainment
- Security
- Assess the dependency of environments on future developments
 - Sustainability – increased recycling of equipment
 - Energy use – equipment growth needs energy
 - Data security, data sovereignty

2 Understand the impact of technological innovations on the computer industry

- Impacts of technological innovation on the way computer systems are used and supported
 - Increased dependency on large datacentres
 - Increased data storage requirement
 - Increased bandwidth to the user
 - Increased use of wireless network connectivity
 - Increased security concerns
 - Increased need for staff training and continuous development
- Ethical issues relating to technological innovation in computing
 - Does the ability to do something justify doing it?
 - When new technology creates new capabilities, do existing ethics still apply?
 - Use of personal data
 - Security versus privacy
 - Smartphones 24/7 calling home – reporting location, etc.
- Impact of legislation on technological innovation in computing
 - US Patriot Act 2001
 - UK Online Privacy Bill 2023
 - GDPR
 - IPR and copyright

3 Understand the impact of technological innovations on society

- Pros and cons of adopting technological innovations
 - Increased dependency on large datacentres
 - Increased data storage requirements
 - Increased use of wireless network
 - Increased security concerns
 - Increased need for staff training and CPD
 - Pros for business and staff (e.g.)
 - Faster decision making
 - Better productivity
 - Better access to learning
 - Automation of repetitive tasks
 - Better work-life balance
 - Streamlining communication
 - Overcoming geographical barriers
 - Access to wider talent pool
 - Improves global understanding
 - Convenience
 - Cons for businesses and staff (e.g.)
 - Social isolation

- Set up costs
- Loss of skills
- Privacy
- Expectation of staff being available 24/7
- Reduction in interpersonal skills if everything is text based
- Risk of a sedentary lifestyle
- Being remotely monitored (affecting morale)
- Analyse the impact of innovations in technology on society
 - Behavioural changes
 - Working from home
 - Online banking, online commerce, pay by phone
 - Personal data online – Facebook, X, et al
 - Dependence on using apps, e.g. ChatGPT
 - Smart homes
 - Alarms, locks, appliances, utility meters, etc.
 - Dynamic energy tariffs
 - Alexa, Hive, etc. monitoring occupant behaviour and activities
 - Smart cities
 - Traffic management, smart roads, clean air zones, CCTV vehicle tracking, instant fines
 - Population flow monitoring, phone GPS, CCTV facial recognition, no-smoking zones, instant fines
 - Improved services or erosion of civil liberties?
 - Smart city apps
- Evaluate ethical issues relating to the use of technological innovation in society
 - Monitoring social media – is it justified?
 - Employers monitoring staff activities
 - Police monitoring for personal views
 - Artificial intelligence / algorithms monitoring and filtering all online activity
 - Privacy of personal information online, e.g. medical records, criminal record, credit rating, etc.
 - How much information is really necessary for the purpose?
 - Who does the data belong to?
 - Who should have access to the data?
 - Who is responsible for data security and accuracy?
 - Surveillance
 - CCTV vehicle tracking, instant fines
 - CCTV facial recognition, instant fines
 - Improved services or erosion of civil liberties?
 - ‘Smart’ cars – subscription services, software updates, self-driving – who is responsible if an update goes wrong?
- Energy use and carbon footprint
 - Greater user demand for more and more, faster and faster, online services drives IT energy use up
 - Where are the savings made to reduce energy use?
 - Where are the savings made to reduce the carbon footprint?
 - Are the savings real or do ethics become subject to cognitive dissonance?

- Evaluate the impact of legislation on technological innovation in society
 - UK Online Safety Bill – safety or censorship
 - Low Emission Zones
 - Clean air zones

Suggested Resources

Steff Reuben et al., (2022), Emerging Technologies and International Security: Machines, the State, the War (Routledge Studies in Conflict, Security and Technology), Routledge Press

Pink, Sarah, (2022), Emerging Technologies / Life at the Edge of the Future, Routledge Press

Kampakis, Stylianos et al., (2022), Business Models in Emerging Technologies: Data Science, AI, and Blockchain, Business Expert Press

Amami, Mokhtar, (2021), Emerging Technologies and Supply Chain Digitalization, Self Publication

Khan Fawad, A., and Anderson, Jason M., (2021), Digital Transformation using Emerging Technologies: A CxO's Guide to Transform your Organisation, Self Publication

Websites

Internet of Things

<https://www.ibm.com/topics/internet-of-things>

<https://www.weforum.org/agenda/2021/03/what-is-the-internet-of-things/>

<https://aws.amazon.com/what-is/iot/>

<https://www.mckinsey.com/featured-insights/mckinsey-explainers/what-is-the-internet-of-things>

<https://www.intel.com/content/www/us/en/tech-tips-and-tricks/virtual-reality-vs-augmented-reality.html>

<https://edu.gcfglobal.org/en/thenow/understanding-virtual-reality-and-augmented-reality/1/>

<https://aws.amazon.com/what-is/blockchain/>

<https://www.forbes.com/advisor/investing/cryptocurrency/what-is-cryptocurrency/>

SmartCities

<https://www.smartcitiesworld.net/>

<https://www.aboutsmartcities.com/>

<https://www.youtube.com/watch?v=HBMIQZeXMiA&pp=ygUac21hcnQgY2l0aWVzIG9mIHRob2ZSBmdXR1cmU%3D>

<https://www.youtube.com/watch?v=d1DndVz9dAs>

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 innovative developments in technology	All learning outcomes in this unit underpin the notion of computing projects for digital transformation as set out in U1 LO1 . Practitioners in any IT role in industry should be aware of emerging trends and new technologies or new ways that existing technologies are being used. When working in more senior IT roles learners will be expected not only to know what is coming, but also they will need to be able to articulate to senior managers and stakeholders how these developments can be leveraged to improve operational efficiency, contribute to cost savings, respond to changing legislation or regulation, and/or take advantage of new opportunities.
LO2 Understand the impact of technological innovations on the computer industry	
LO3 Understand the impact of technological innovations on society	
Opportunities for Synoptic Assessment	
Unit 17 Advanced Project provides an opportunity for learners to demonstrate an understanding of the concepts of this unit when learners use the skills learned in both the core and their chosen 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 units.	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
Problem-solving – Using appropriate different sources of information to develop a balanced view (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 – Judging the reliability of information, problem-solving, presenting data (LO1, LO2, LO3).	Using sources of information – Accessing information, e.g. choosing different sources of information to enable developing a balanced view (LO1, LO2, LO3). Reading Skills – Identifying different sources of information (LO1, LO2, LO3). Thinking Skills – Using critical thinking skills, e.g. reading all information, identifying and interpreting 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).

Unit 4 Information Systems			
Unit aims	When working in industry, IT practitioners must be able to see the bigger picture, drawing on all of their knowledge and previous experiences to find the best and most viable solutions to the problem. This is particularly important when working with non-technical managers who may not understand the technologies that they need to be able to perform their role. Practitioners must be able to share their knowledge and understanding in an appropriate way to promote the use of data and information systems to support modern business and enterprise. This unit enables learners to examine a wide range of information systems that they will find in industry.		
Unit level	5		
Unit code	K/651/0153		
GLH	60		
Credit value	15		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	No specialist resources are needed to deliver and assess this unit. 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. For a Merit, all pass and all merit criteria must be met. For a Distinction, all pass, all merit and all distinction criteria must be met.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
1. Understand different types of information systems that are used in an organisation	1.1 Explain different types of information system with examples of their application 1.2 Describe the components of an information system 1.3 Explain the characteristics of information systems	1M1 Choose and recommend an information system in a business context	1D1 Justify your choice of information systems in a business context
2. Understand the principal uses, advantages and disadvantages of	2.1 Explain the principal uses of information systems 2.2 Describe the advantages of		

information systems	information systems and how they can be used by organisations 2.3 Describe the reasons why information systems can fail		3D1 Evaluate the importance of testing different scenarios by changing variables within projection models
3. Understand how organisations use information systems to support strategic and operational decisions	3.1 Examine, with examples, how information systems are used to support strategic decisions 3.2 Examine, with examples, how information systems are used to support operational decisions 3.3 Present your arguments to a non-technical audience	3M1 Analyse the key benefits of information systems in how they are used to support strategic and operational decision making, ensuring that data is used ethically and within regulatory and legislative constraints	

Indicative Content

1 Understand different types of information systems that are used in an organisation

- Types of information systems:
 - Expert Systems (ES) (e.g. used in health, science, engineering)
 - Knowledge Systems (KS) (e.g. helpdesk and support systems)
 - Knowledge Work Systems (KWS) (e.g. Computer Aided Design (CAD), Virtual Reality (VR))
 - Transaction Processing Systems (TPS) (e.g. payroll, booking, stock control, point of sale (POS), supply chain management, automated ordering)
 - Management information (MIS) (e.g. Human Resource (HR), budgeting, sales management, customer relationship management systems (CRM), crime and fraud detection, terrorism detection using Artificial Intelligence (AI))
 - Decision support (DSS) (e.g. financial planning systems, logistics and transportation systems)
 - Executive support systems (ESS) (drawing data from DSS and MIS systems)
 - Online Analytical Processing (OLAP) (e.g. used in marketing, forecasting, process management)
 - Office Automation Systems (OAS) (e.g. word processing, email)
 - Process control (PCS) (e.g. used in water purification, desalination plants, sewage management, food manufacturing and processing, chemical processing and refining, vehicle manufacturing, nuclear power)

- Components of information systems:
 - Sources of data
 - Databases
 - Data Warehouses
 - Hardware (input and output devices)
 - Software
 - Networks
 - Human resources
 - Defined policies and procedures
- Characteristics of information systems:
 - Collecting data
 - Processing data
 - Storing data
 - Distributing information

2 Understand the principal uses, advantages and disadvantages of information systems

- Principle uses of information systems:
 - Automate operational processes
 - Production of information that is reliable and up to date
 - Manage internal data
 - Organise data
 - Manage change
 - Control organisational activities
- Advantages of information systems
 - Reduction in time taken to achieve routine tasks
 - Reduced labour costs
 - Finding ways to realise competitive advantage
 - Finding ways to make optimal use of organisational resources
 - Production of real time data
 - Reduction of errors
 - Faster response
 - Greater variety of ways to present information
- Disadvantages of information systems
 - Poor initial design
 - Incorrect setup (GIGO principles – Garbage In, Garbage Out)
 - Systems can fail (e.g. data loss, processing errors, hardware failure, software fault, power outages, disaster including sabotage, natural disaster, user error due to poor training)

3. Understand how organisations use information systems to support strategic and operational decisions

- Applications of information systems – strategic
 - Analysis of trends
 - Analysis of competitors
 - Carry out cost-benefit analysis
 - Financial forecasting

- Set and manage future budgets
- Reduction of costs
- Create competitive advantage
- Create new products
- Improve products
- Improve services
- Establish future goals and aspirations
- Planning improvements
- Key benefits of information systems in supporting strategic decision making:
 - having the right information to support long-term decision making
 - having the ability to test different scenarios by changing variables within projection models
- Applications of information systems – operational
 - Day to day management of staff
 - Day to day management of resources
 - Production planning
 - Logistics planning
 - Providing e-learning/training
 - Booking management
 - Communication (e.g. video conferencing, Teams channels, remote working)
 - Key benefits of information systems in supporting operational decision making:
 - faster responses
 - better customer service
 - better control of resources
- Identifying business objectives and aligning a data strategy to support objectives (e.g. data in the right format, unbiased data, sufficient data)
- Identifying long-term strategic objectives and planning a data strategy to support objectives
- Ensuring that data is used in a way that is ethical and is within relevant regulatory and legislative constraints

Suggested Resources

Benyon-Davies, Paul, (2019), Business Information Systems, Red Globe Press

Stair, Ralph et al., (2020), Principles of Business Information Systems, Cengage Learning EMEA

Cadle, James, (2014), Developing Information Systems: Practical guidance for IT

Peppard, Joe et al., (2016), The Strategic Management of Information Systems: Building a Digital Strategy

Laudon, Kenneth and Jane, (2021), Management Information Systems: Managing the Digital Firm

Websites

<https://opentextbook.site/informationssystem2019/chapter/chapter-1-what-is-an-information-system-information-systems-introduction/>

<https://www.britannica.com/topic/information-system>
www.umn.ac.id/en/information-system-applications-in-daily-life/
<https://au.indeed.com/career-advice/career-development/examples-of-information-management-systems>

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 different types of information systems that are used in an organisation	From a generic perspective, Unit 4 has a direct link with U1 LO1 as the underpinning concept for understanding opportunities and drivers for digital transformation.
LO2 Understand the principal uses, advantages and disadvantages of information systems	In addition, this unit is particularly relevant for the Data pathway where there are strong links with U5 LO1 advanced relational database concepts, and with U7 LO1 data flows and warehouses, U7 LO2 data extraction/capture, transformation and loading, U7 LO3 multidimensional modelling and OLAP.
LO3 Understand how organisations use information systems to support strategic and operational decisions	Learners should understand however that this does not mean that information systems do not link with the Software and Cyber pathways. The Software pathway will develop these systems and the Cyber pathway will distribute and secure them.
Opportunities for Synoptic Assessment	
Unit 17 Advanced Project provides an opportunity for learners to demonstrate an understanding of the concepts of this unit when learners use the skills learned in both the core and their chosen 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 units.	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
Problem-solving – Whether working in a technical role, development or data role, practitioners must understand the concept of information systems and how different information systems are built on the same principles but with completely different applications. The practitioner must be able to select and justify the use of specific information systems to solve a problem (LO1, LO2, LO3). Communication - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation &	Using sources 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).

grammar (SPAG) (LO1, LO2, LO3). Oral communication, e.g. presenting and choosing appropriate presentation formats. 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 to support argument, 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).
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Unit 5 Advanced Database Practice			
Unit aims	This unit will teach the learners relational theory concepts such as normalisation, foreign keys, ensuring consistency, three value logic, indexes for efficiency, database optimisation etc. As an advanced course, it will presume that the learners have some familiarity with basic SQL extraction and manipulation techniques, such as those taught in L4 Unit 8. It will teach how to create various database objects and their benefits, e.g. tables, dynamic/materialised views, triggers, stored procedures, user defined functions etc.		
Unit level	5		
Unit code	L/651/0154		
GLH	60		
Credit value	15		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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. For a Merit, all pass and all merit criteria must be met. For a Distinction, all pass, all merit and all distinction criteria must be met.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
1. Understand advanced relational database concepts	1.1 Discuss how SQL implements relational set theory and the relational model 1.2 Explain why the SQL standard is not Turing Complete and the consequences 1.3 Describe why data should be normalised and carry out normalisation of tables	1M1 Compare the relational set operators, such as the relation operators, set operators and relational joins, to the SQL operators	1D1 Evaluate the importance of ensuring ACID properties and how it can be achieved
2. Understand and carry out definition and manipulation of database objects	2.1 Carry out the creation of tables as SELECT statements and by column definitions 2.2 Carry out the creation, amendment and deletion of databases, views, indexes, functions and stored procedures	2M1 Apply an appropriate SQL index to a table, and justify the choice of table and index configuration	

3. Understand the structure and function of database objects	3.1 Explain the advantages and types of views 3.2 Explain how functions and stored procedures are used 3.3 Explain what triggers are used for	3M1 Compare materialised and non-materialised views	3D1 Evaluate the ways views can improve query performance and the trade-offs this can have

Indicative Content

1. Understand advanced relational database concepts

- Relational Set Theory
 - Entities and classes
 - Tuples, relations, and predicates
 - Relation operators: e.g. projections, selection, rename
 - Set operators: e.g. union, difference and cartesian products
 - Relation joins: e.g. natural, theta, semi, anti and division
 - How SQL implements the mathematical theory
 - Relational Set Theory and standard SQL are not Turing complete
- The Relational Model
 - Relations; heading and body, collection of tuples
 - Attribute; values and names, domains
 - Tuples; unordered collection of attributes
 - Relationship to tables, keys, and relationships
 - Arity and cardinality
 - The practical use in relational database design
 - Data schema definitions by SQL DDL
- Normalisation
 - Reasons for normalisation, e.g. reuse, integrity and reduce redundancy
 - First, Second, Third, Boyce-Codd, Fourth, Fifth normal forms
 - Unique rows, no duplicate rows
 - Scalar vs composite values, noncompound values
 - Candidate and primary keys
 - Functional dependency
 - Transitive dependency
 - Superkeys
 - Multivalued dependency
 - Detection and treatment of anomalous data updates, inserts or deletions
 - Drawbacks of normalisation / reasons for denormalization
- Ensuring data integrity
 - Database transactions ACID properties
 - Atomicity; all or nothing transaction
 - Consistency; constrains on acceptable data
 - Isolation; single unit of work

- Durability; system failure
- How a RDBMS ensure data integrity with locking and transactions
- Commit and rollback commands
- Problems with locking, e.g. race conditions
- Referential integrity; dangling foreign keys, propagation
- Data Models
 - Abstract representations, focus on static properties not behaviours
 - Conceptual Models; what is in the system, business description
 - Logical Models; the implementation; business analysts and architects
 - Physical models; the specifics of the system, database administrators

2. Understand and carrying out definition and manipulation of database objects

- Databases
 - CREATE database
 - USE database
 - DROP database
- Tables
 - CREATE table as SELECT statement
 - CREATE temporary table
 - CREATE table with column definitions, primary key and constraints
 - Column names
 - Data types specifications, null/not null
 - RENAME table
 - ALTER table
 - ADD column
 - DROP column
 - DELETE table
 - With WHERE CLAUSE
 - TRUNCATE table
 - DROP table
- Views
 - CREATE view
 - RENAME view
 - UPDATE view
 - DROP view
- Index
 - CREATE index, unique and non-unique
 - DROP index
 - ALTER index
- Stored procedures and triggers
 - CREATE procedure
 - DROP procedure
 - CREATE trigger
 - Before or after
 - Insert, update or delete; referential integrity
 - ALTER trigger
 - DROP trigger

- DISABLE trigger

3. Understand the structure and function of database objects

- Views
 - Advantages: simplify/customise access, enabling security, providing interface etc.
 - Materialised vs non-materialised
 - Dynamic updating
- User Defined Functions & Stored procedures
 - Advantages: enabling security, reduced IO, providing interfaces, improving code reuse and maintenance etc.
 - Functions vs stored procedures
 - Input parameters and return types
- Triggers
 - Advantages: constraint management, security logging, etc.
 - Events types
- Indexes
 - Types of indexes; e.g. SQL server: clustered, non-clustered, column, filtered, hash and unique
 - Advantages; query optimisation, central logic etc.
 - Disadvantages, space requirements, slower insert, update and delete etc.

Suggested Resources

Forta, B., (2022), *SQL in 10 Minutes a Day*, 5th Edition, Sams Publishing

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

Bush, J., (2020), *Learn SQL Database Programming*, Packt Publishing

Date, C.J., (2009), *SQL and Relational Theory*, O'Reilly

Warner, S., (2019), *Set Theory for Beginners*, Get 800

Websites

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

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

<https://medium.com/visionnlp/fundamentals-of-sql-deep-dive-into-sql-theory-304fadf945a3>

<https://www.sqlshack.com/learn-sql-set-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 advanced relational database concepts	For many organisations, the databases concepts explored in this unit provide the structure and processes needed to manage data generated by day-to-day activities. For this reason, there are strong links with information systems in the core programme. Unit 4 learning outcomes U4 LO1, U4 LO2 and U4 LO3 examine the database as an information system, particularly examining how and why these systems are used to support strategic and operational decisions. In addition, databases are frequently targets for malicious attacks, either to steal data or to destroy data in order to disrupt the activities of the organisation. Therefore, this has strong links to the Cyber pathway's Unit 13 outcomes U13LO1, U13LO2, U13LO3.
LO2 Understand and carry out definition and manipulation of database objects.	As suggested above, databases are frequently targets for malicious attacks, either to steal data or to destroy data in order to disrupt the activities of the organisation. Therefore, this has strong links to the Cyber pathway's Unit 13 outcomes U13LO1, U13LO2, U13LO3. Understanding how databases are defined, how the data and database objects can be manipulated, can uncover potential weaknesses, particularly where weak website security is an issue.
LO3 Understand the structure and function of database objects	
Opportunities for Synoptic Assessment	
Unit 17 Advanced Project provides an opportunity for learners to demonstrate an understanding of the concepts of this unit when learners use the skills learned in both the core and their chosen 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 units.	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
Working independently- 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).	Self-organisation - 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). Time Management – Managing time to maximise study and derive a good work-life

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 (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).	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 sources 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 (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).
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Unit 6 Programming for Data Engineering			
Unit aims	This unit introduces various tools and languages used for data engineering. It presumes that the learners have a basic understanding of programming at the level normally taught in L3 or L4 computing programming syllabi. It will use the SciPy ecosystem of module in Python (mostly pandas and matplotlib) to perform efficient programmatic data loading and data manipulation using a variety of functions provided by the modules.		
Unit level	5		
Unit code	M/651/0155		
GLH	60		
Credit value	15		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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. For a Merit, all pass and all merit criteria must be met. For a Distinction, all pass, all merit and all distinction criteria must be met.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
1. Understand tools and languages used for data engineering	1.1 Explain, with examples, the difference between imperative and declarative programming techniques 1.2 Explain, with examples, the difference between scripted and compiled programming languages 1.3 Discuss why different languages are often used at different stages in the data and development lifecycles	1M1 Analyse the features and paradigms of three programming languages that are used for data engineering	1D1 Evaluate the benefits and drawbacks of proprietary languages used for data engineering
2. Understand data loading and manipulation techniques	2.1 Carry out appropriate data loading in Python using pandas 2.2 Carry out appropriate data manipulation in Python using pandas	2M1 Justify your choice of techniques used in data manipulation and aggregation	2D1 Analyse the benefits of doing the data loading and manipulation in an alternative way or

	2.3 Carry out appropriate aggregations in Python using pandas		using an alternative language
3. Understand data visualisation functions	3.1 Carry out basic data visualisations in Python using pandas and matplotlib 3.2 Apply colour schemes, titles and axis formats to make the data visualisations clear	3M1 Design and create an interactive data visualisation, e.g. an interactive graph	

Indicative Content

1. Understand languages used for data engineering

- Programming paradigms
 - Imperative; procedural and object-oriented
 - E.g. C/C++, Java, C#, JavaScript and Python all support imperative programming
 - Declarative; functional
 - E.g. SQL and Haskell are declarative languages, and Python, R, and many other languages contain declarative features
 - General purpose vs domain specific
 - E.g. C/C++, Java, C#, JavaScript, Python and Haskell are general purpose languages
 - E.g. SQL is a domain specific language (its domain is data definition and manipulation in RDBMS)
 - Scripting vs compiled languages
 - C/C++ code is typically compiled, whereas Python and R code are interpreted (aka. scripted)
 - Proprietary languages
 - Matlab is a proprietary language by MathWorks and C# was a proprietary language by Microsoft until it was defined as an ISO/IEC standard
- Popular languages used in data engineering
 - Why each language is popular
 - The paradigm(s) the languages implement
 - What is each language's role in the data and development lifecycle, e.g.:
 - Websites and mobile apps development
 - Back-end system development
 - Data movement or API development
 - Data organisation and storage management
 - Data analytics and data science

2. Understand data loading and manipulation techniques

The following indicative content is suggested for the Python programming language using the pandas library in an Anaconda/Spyder environment, but if another language, library or IDE is used, then equivalent content should be chosen.

- Learn typical data engineering tasks in Python using pandas.
- Integrated Development Environment
 - New, open and save python scripts
 - Installing packages from PyPI
 - Run file or run line/selection in interactive mode
 - Variable explorer
 - New and restart consoles
- Core Python
 - General purpose language, supports imperative programming paradigms
 - Comments, variables, build-in data types, casting, operators, variable scope
 - User input, print function, string formatting
 - Lists, tuples, sets, dictionaries, arrays
 - If...else, while and for loops
 - Functions, lambda, classes and objects, inheritance, polymorphism
 - Modules; import all or individual objects, using aliases
 - Try...except
 - File handling; reading, creating, appending files
 - Advanced topic: file handling with the os module
- Pandas Data Structures
 - Pandas uses declarative programming in python's imperative environment
 - Pandas is based on the mathematical numpy module which also supports machine learning algorithms
 - Copy of data structures vs pointers to data structures
 - In-memory storage and processing; benefits and drawbacks
 - DataFrames vs Series
 - Create empty series with/without row index
 - Create empty dataframes with/without column index and/or row index
 - DataFrame; 1st axis and 2nd axis
- Data Loading
 - Loading and exporting from/to csv files, json files, text files, dictionary, lists
 - Loading and exporting from/to databases tables and excel spreadsheets,
 - Advanced topic: reading, writing and manipulating data in an RDBMS' with the pyodbc or sqlite3 module
 - Advanced topic: use sqlite3 to create and manipulate data with SQL in python
 - Pickling and unpickling
- DataFrame Manipulation
 - Inplace manipulation vs new copies
 - View data
 - info, shape, describe, value_counts head and tail functions
 - columns and index attributes
 - Adding and removing columns
 - Selection and slicing
 - Selecting columns by name and index

- Selecting rows by name and index
- Selecting rows by filters with one or more conditions; loc, iloc, ix functions
- The tilde (~) operator
- Where and filter functions
- Drop_duplicates; keep first, keep last and drop all
- Rename; row index or columns
- Sort_values, sort_index
- Dropna, fillna, isnull, isna, notnull, notna functions
- Element wise operations
 - Numerical
 - Comparisons
- Set operations; all, any functions
- Aggregations
 - aggregate, sum, count, abs, mean, min, max etc.
 - cumsum, cummin, cummax etc.
 - groupby aggregations
- Apply functions to all rows in a dataframe
- Pivot, melt, stack, unstack and T functions
- Iteration over rows; iterrows
 - Computationally slow
- Combining DataFrames; join, merge, append and concatenate

3. Understand data visualisation functions

- Display plots directly from DataFrames
 - Histogram, bar chart, pie chart, line plot, scatter plot etc.
 - Changing plot parameters, colours schemes, labels etc.
- Display more complicated plots using matplotlib module
 - Importing matplotlib.pyplot submodule
 - Having multiple subplots
 - Creating plots; histogram, bar chart, pie chart, line plot, scatter plot etc.
 - Markers, line style/color/width etc
 - Plot titles, X and Y labels, annotations etc.
 - Manipulating axes; labels, number formats, ticks etc.
 - Show; will appear in plots pane in Spyder
 - Saving plots to pictures files, such as png
- Interactive data visualisations
 - Investigate more complex and visually appealing graphs with either the bokeh, plotly or seaborn library

Suggested Resources

Jones, C. B., (2021), *Understanding Programming Languages*, Springer

Romano, F. and Kruger, H., (2021), *Learn Python Programming*, Packt

Ramalho, L., (2022), *Fluent Python: Clear, Concise, and Effective Programming*, O'Reilly

Molin, S. and Jee, K., (2021), *Hands-On Data Analysis with Pandas*, Packt

Fischetti, T., (2018), *Data Analysis with R*, Packt

Hubbard, J. R., (2017), *Java Data Analysis*, Packt

Bhatia, A. and Kaluza, B., (2018), *Machine Learning in Java*, Packt

Websites

<https://www.geeksforgeeks.org/introduction-of-programming-paradigms/>

<https://www.freecodecamp.org/news/what-exactly-is-a-programming-paradigm/>

<https://www.python.org/about/gettingstarted/>

<https://www.w3schools.com/python/default.asp>

<https://www.udacity.com/course/introduction-to-python--ud1110>

https://www.w3schools.com/r/r_intro.asp

<https://www.datacamp.com/courses/free-introduction-to-r>

<https://towardsdatascience.com/machine-learning-in-java-e335b9d80c14>

<https://www.springboard.com/blog/data-science/which-is-better-for-ai-java-or-python/>

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 tools and languages used for data engineering	This unit from the Data pathway together with Unit 8, Unit 9 in the Software pathway and Unit 13 in the Cyber pathway are all interlinked because learners explore programming concepts and how scripting languages are used. U8 LO1 and U8 LO3 are particularly relevant because they involve code and algorithms. It is likely that learners will use Python as their language of choice in the Software pathway and equally it is likely that Python will be used in the Data units. This is because Python is one of the most popular languages because it is so versatile and it is often used when working with AI, statistics and it is also used in Penetration Testing and Ethical Hacking: U13 LO1, U13 LO2, U13 LO3 . This does not mean that C++, C and languages such as Java do not feature, it just means that for many contexts, Python may be the language of choice.
LO2 Understand data loading and manipulation techniques	
LO3 Understand data visualisation functions	
Opportunities for Synoptic Assessment	
Unit 17 Advanced Project provides an opportunity for learners to demonstrate an understanding of the concepts of this unit when learners use the skills learned in both the core and their chosen 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 units.	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
Working independently - 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). 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 (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).	Self-organisation - 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) 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 sources 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 (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).

Unit 7 Implementing Data Flows and Data Warehouses			
Unit aims	This unit will familiarise learners with the techniques used to implement data flows, both near real-time and batch processing. It will introduce the ETL paradigm, the tasks performed at each stage and how they are typically implemented in a data warehouse. It will introduce the logical hierarchical modelling structure that is implemented in star and snowflake schemas in data warehouses.		
Unit level	5		
Unit code	R/651/0156		
GLH	60		
Credit value	15		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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. For a Merit, all pass and all merit criteria must be met. For a Distinction, all pass, all merit and all distinction criteria must be met.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
1. Understand the different types of data flows and data warehouses	1.1 Discuss the benefits of implementing data pipelines and data warehouses 1.2 Explain the differences between real-time and batch processing	1M1 Analyse the differences between Inmon, Kimball and data lake methodologies	1D1 Evaluate why data lakes could be a popular choice but could lead to difficult and inconsistent business analytics
2. Understand data extraction/capture, transformation and loading	2.1 Describe the purposes of each ETL step 2.2 Explain the actions performed to achieve each ETL step 2.3 Explain the difference between transformation and cleaning	2M1 Analyse how data capture in a data warehouse can ensure historical values are available for audit and reporting	
3. Understand multidimensional modelling and OLAP	3.1 Explain the role fact and dimension tables have in the	3M1 Assess how temporal schema features deal	3D1 Analyse how different types of slowly changing dimensions deal

	multidimensional model 3.2 Explain the features of star and snowflake schemas, and the difference between them 3.3 Explain the benefits and drawbacks for data cubes	with changing values	with temporally changing data
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Indicative Content

1. Understand the different types of data flows and data warehouses

- Benefits of Data Pipelines and Data Warehouses
 - Data Centralisation
 - Flexibility of data definitions
 - Data warehouses enable separation of data processing between front-end and analytical systems with different needs
 - Data Security
 - Central data repository with security for theft prevention
 - Ability to apply write controls and encryption
 - Access monitoring and data governance
 - Enabling monitoring of access to sensitive data
 - Ability to give different access depending on user needs
 - Standardisation and ease of use
 - Centrally apply data quality measures, e.g. cleaning the data
 - Single Version of the Truth
 - Increased adaptability
 - Central data processing enables faster integration of additional data sources
- Dedicated vs virtual data warehouses
- Real Time processing
 - Pull vs push data flow / Requests vs event listeners
 - Incremental vs differential updates
 - Snapshot data versions
- Batch processing
 - Point in Time data versions
 - Update frequency
 - Benefits of out-of-hours processing
- Inmon Data Warehouse methodology
 - Staging layer, warehouse layer, and data marts
 - Associated with normalisation, ROLAP, enterprise data models, and top-down design
 - Advantages: flexibility and completeness of enterprise data models, no data redundancy
 - Disadvantages: complexity, expert resources needed, on-going maintenance costs
- Kimball Data Warehouse methodology

- Staging layer, presentation layer, and access tools
- Associated with multidimensional modelling, MOLAP, and bottom-up design
- Advantages: easier to develop and understand, bottom-up design gives direct relevancy to business needs
- Disadvantages: data redundancy, performance degradation over time, complex legacy integration
- Data Lake methodology
 - Often used by machine learning and data science professionals
 - Associated with raw and unprocessed data that has not been transformed
 - Often uses the Extract-Load-Transform method
 - Advantages: flexibility of unprocessed data, no business knowledge required for setup
 - Disadvantages: complex data management, susceptible to data silos evolving, large data volumes could necessitate high initial investment costs

2. Understand data extraction/capture, data transformation and loading

- Often abbreviated ETL (extract, transform and load)
- Data extraction/capture
 - Data extraction, retrieval of transactions from source systems
 - Data capture, data snapshot from source systems that only store current values
 - Used to integrate heterogeneous source systems
 - Extraction from files, e.g. comma separated, aligned text files, proprietary formats
 - Different RDBMS, e.g. using different drivers for DB2, MySQL, Microsoft SQL Server, ODBC connections
 - From object-oriented source systems, e.g. XML or JSON files
 - Initial static extraction, subsequent regular incremental or snapshot extractions
- Data transformation and cleaning
 - Transformation rectifies formats, cleaning rectifies values
 - Rectification of values such as duplicates, inconsistent, missing, impossible/wrong values
 - Homogenisation of values, e.g. 'United Kingdom' and 'Britain' both becoming 'United Kingdom'
 - Transformation into reconciled enterprise data layer
 - Transformation into dimensional model, denormalised fact tables with surrogate dimension keys
 - Transformation by extracting information from text, uniform formats (e.g. date formats)
- Data loading
 - Refresh of all data, usually done initially in combination with static extraction
 - Update of new and amended records in data marts and/or fact tables

3. Understand multidimensional modelling and OLAP

- Fact tables
 - Measurements of same type
 - Dimension keys and attributes
- Dimension tables
 - Shared across organisations to ensure consistency
 - Using surrogate keys

- Star/snowflake schema
 - Use for multidimensional data in relational databases
 - One fact table, multiple dimension tables
 - Star vs snowflake, partial normalisation
- Slowly changing dimensions
 - Can apply both to facts and to dimension tables
 - Used to reduce data volumes caused by duplicate entries
 - Type 1: Overwrite
 - Type 2: Add a new row
 - Start date/timestamp and end date/timestamp
 - Sequential versions
 - Using a current flag
 - Type 3: Add a new attribute
 - Original, previous and current versions
 - Type 4: History table
 - Aka. change data capture
 - Type 6: Unpredictable Changes with Single-Version Overlay
 - Combination of 1+2+3=6
 - Other hybrid combinations
- Temporal database schemas
 - Uni-temporal, bi-temporal, tri-temporal
 - Multiple time instances and periods such as valid time, transaction time, decision time etc.
- Online analytical processing (OLAP) with data cubes
 - Benefits, e.g.
 - Multi-dimensional analysis
 - Interactive and user friendly
 - Speed through analytical optimisation of access to large data volumes
 - Allow complex analytical processing
 - Enable fast reporting to decision makers
 - Support by multiple vendors, systems, and platforms
 - Disadvantages, e.g.
 - Complex and costly initial development
 - Need for optimisations of storage and retrieval, e.g. indexes, materialised views etc.
 - Inflexibly to subsequent changes in business definitions and models.
 - Aggregation; functions: sum, mean, min, max, count etc.
 - Operations: roll-up, dill-down, slicing, dicing, pivot etc.

Suggested Resources

Inmon, W. H., (2005), *Building the Data Warehouse*, 4th Edition, Wiley

Kimball, R. and Ross, M., (2013), *The Data Warehouse Toolkit*, 3rd Edition, Wiley

Golfarelli, M. and Rizzi, S., (2009), *Data Warehouse Design*, McGraw-Hill

Adamson, C., (2010), *Star Schema The Complete Reference*, McGraw-Hill

Gorelik, A., (2019), *The Enterprise Big Data Lake*, O'Reilly

Reis, J. and Housley, M., (2022), Fundamentals of Data Engineering, O'Reilly

Websites

<https://www.kimballgroup.com/data-warehouse-business-intelligence-resources/kimball-techniques/>
<https://www.astera.com/type/blog/data-warehouse-concepts/>
<https://www.infosol.com/data-warehouse-design-inmon-vs-kimball-architecture/>
<https://www.telefonica.com/en/communication-room/blog/what-is-data-lake-advantages-disadvantages/>
<https://www.geeksforgeeks.org/multidimensional-data-model/>
<https://www2.cs.uregina.ca/~dbd/cs831/notes/dcubes/dcubes.html>
<https://www.sqlshack.com/implementing-slowly-changing-dimensions-scdds-in-data-warehouses/>

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 the different types of data flows and data warehouses	LO1 in this unit links with Unit 4 in the core programme, with Unit 11 in the Software pathway and Unit 16 in the Cyber pathway. This is because data warehouses and the flow of data to these warehouses links with the concept of Information systems across U4 LO1 , U4 LO2 , U4 LO3 . This unit also links with Unit 11 in the Software pathway, particularly because many data warehouses are stored in the Cloud. Therefore, being able to articulate how virtualisation contributes to organisational efficiency and productivity (U11 LO3), recognising dangers and threats to the virtual machines (U11 LO4) is relevant to this topic. Similarly, this links to the network and cloud design and configuration (Cyber pathway Unit 16). These are also relevant when you consider that data warehouses will be part of a plan to migrate existing systems into the cloud (U16 LO2) and the application of security measures to cloud infrastructure (U16 LO3).
LO2 Understand data extraction/capture, transformation and loading	
LO3 Understand multidimensional modelling and OLAP	
Opportunities for Synoptic Assessment	
Unit 17 Advanced Project provides an opportunity for learners to demonstrate an understanding of the concepts of this unit when learners use the skills learned in both the core and their chosen 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 units.	

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

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 (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).	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) 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 sources 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 (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).
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Unit 8 Data Analytics and Machine Learning			
Unit aims	This unit will introduce machine learning algorithms from an implementational point of view. It will present a few of the popular algorithms without delving into the statistical behaviour or mathematical theory behind them. It will also introduce methods to evaluate and document their performance.		
Unit level	5		
Unit code	T/651/0157		
GLH	60		
Credit value	15		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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. For a Merit, all pass and all merit criteria must be met. For a Distinction, all pass, all merit and all distinction criteria must be met. Learners may need tutor support with identifying publicly available datasets and algorithms appropriate for Task 3.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
1. Understand how machines learn from data	1.1 Describe the advantages and disadvantages of data mining in modern enterprises 1.2 Describe which types of models are used for different types of data 1.3 Explain why and how data preprocessing is done	1M1 Analyse why models typically require flattened and denormalised data	
2. Understand ways to evaluate the performance of models	2.1 Explain why and how to use separate training and validation datasets 2.2 Explain how a confusion matrix is constructed and what it shows	2M1 Discuss the dangers of overfitting a model	2D1 Evaluate how numeric performance metrics can enable automatic selection of models amongst multiple candidates

3. Understand and can apply popular machine learning algorithms	3.1 Describe the characteristics of a typical machine learning algorithm 3.2 Describe the type of data that the model uses, including any conditions on the data 3.3 Apply a typical machine learning algorithm to a data set	3M1 Analyse the performance of a machine learning algorithm	3D1 Evaluate the strengths and weaknesses of a machine learning algorithm
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Indicative Content

1. Understand how machines learn from data

- Data mining
 - Extracting information/patterns from large data sets
 - Integrate techniques from database/data warehouse, maths/stats, machine learning/artificial intelligence and many more
 - Statistical methods
 - Based on proven mathematical theory
 - Regression analysis, statistical summaries
 - Machine learning
 - Pragmatic results driven approach
 - Supervised and unsupervised algorithms
 - Reinforcement learning
 - Artificial intelligence
 - Inspired by biological processes, e.g. brain neurons, genetic selection or insect swarms
 - Advantages: better informed business knowledge, finding “golden nuggets” of knowledge, competitive advantage etc.
 - Disadvantages: privacy/safety issues, needing expensive experts, risks of data dredging etc.
- Learning from different types of data
 - Relational data
 - Often requires data to be denormalization
 - Object-oriented data
 - Often requires data to be flattened
 - Transactional and time-series data
 - Speech or text documents
 - Require natural language processing techniques, such as sentiment analysis, named entity recognition, document retrieval/querying, answering questions in natural languages etc.
 - Aggregated data, e.g. data warehouse marts
 - Transient/streaming data
- Steps to train models
 - Data preprocessing
 - The need for preprocessing

- Benefits of using reconciled data (e.g. data warehouses) vs raw data (e.g. data lakes)
- Descriptive statistics; central tendency, dispersion, graphic displays
- Data cleaning; missing values and noisy data
- Data integration and transformation
- Data reduction; aggregation, attribute selection, dimensionality reduction, sampling
- Model selection and creation
 - Considering multiple models
- Model training
- Model evaluation

2. Understand ways to evaluate the performance of models

- The importance of splitting input data or using separate data sets for:
 - Training data
 - Testing data
 - Validation data
- The importance of evaluating individual models
- Simple graphs of the model output
- Bias vs variance
 - Underfitting; imposing inappropriate restrictions on underlying data structures
 - Overfitting; not appropriately restricting the model complexity
- Regression accuracy
 - Residual error graphs; independent and identically distributed
 - Explained variance, mean squared error, R squared
- Classification and prediction accuracy
 - True positive, true negative, type I error, type II error
 - Specificity and sensitivity
 - Accuracy, precision and recall, ROC curve and Gini coefficient
 - Confusion matrixes for models with more than 2 target classes
 - Chi-squared test

3. Understand and apply popular machine learning algorithms

- Typical machine learning algorithms, possible examples:
 - Classification and prediction (choose a maximum of 3)
 - Regression; linear, non-linear
 - Decision trees
 - Bayesian classification
 - Rule-based classification
 - Neural networks; backpropagation, deep learning
 - Support vector machines
 - K-Nearest-neighbour classifiers
 - Genetic algorithms
 - Cluster analysis
 - K-Means clustering
 - Time-series mining
 - Recurrent neural networks

- Graph mining
 - PageRank algorithm
- Text mining
 - Natural Language Processing
- The characteristics for each algorithm
 - What type of data the algorithm uses
 - The format of the data; tabular, graphs
 - The data type of columns; binary/categorical, continuous etc.
 - Restrictions on relationships between observations/data points
 - What parameters the algorithm takes, if any
 - The type of model learning; supervised, unsupervised
 - What the algorithm produces
 - Classification, regression, prediction, recommendations, annotations
 - The model strengths and weaknesses
 - How to evaluate the model performance
 - The graphs to use and what they show
 - The metrics to use, what they tell and whether they should be maximised or minimised

Suggested Resources

Müeller, A. C. and Guido, S., (2016), *Introduction to Machine Learning in Python*, O'Reilly
 Deisenroth, M. P., (2020), *Mathematics for Machine Learning*, Cambridge University Press
 Han, J. and Kamber, M., (2006), *Data Mining: Concepts and Techniques*, Morgan Kaufmann
 Smolyakov, V., (2023), *Machine Learning Algorithms in Depth*, Manning

Websites

<https://www.analyticsvidhya.com/blog/2017/09/common-machine-learning-algorithms/>
<https://www.simplilearn.com/10-algorithms-machine-learning-engineers-need-to-know-article>
<https://machinelearningmastery.com/a-tour-of-machine-learning-algorithms/>
https://www.w3schools.com/python/python_ml_getting_started.asp
<https://www.coursera.org/learn/machine-learning-with-python>

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 how machines learn from data	Data is the lifeblood of organisations who generate and use masses of data as a result of their activities. This links with Unit 1 because the data will be used to identify opportunities for digital transformation. This is evident when U8 LO1 is linked to U1 LO1 . As data is manipulated using code or scripting, there is also a direct link with U6 LO1 , U6 LO2 and U6 LO3 because they involve code and algorithms. It is likely that learners will use Python as their language of choice in the Software pathway and equally it is likely that Python will be used in the Data units.
LO2 Understand ways to evaluate the performance of models	
LO3 Understand and can apply popular machine learning algorithms	
Opportunities for Synoptic Assessment	
Unit 17 Advanced Project provides an opportunity for learners to demonstrate an understanding of the concepts of this unit when learners use the skills learned in both the core and their chosen 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 units.	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
Working independently - 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). 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 (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	Self-organisation - 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) 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 sources 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).

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).	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 (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).
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Unit 9 Advanced Programming			
Unit aims	This unit enables learners to focus on the popular Object-Oriented paradigm and associated SOLID principles as exemplified in programming languages such as Java, C++, C# and Python. It includes a strong promotion of the DevSecOps practice; the notion of security being “shifted to the left” to avoid costly baked-in bugs, encouraging a shared responsibility through the software’s lifecycle and its quality assurance processes. Furthermore, it encourages learners to consider modern approaches (and tooling) used when products are designed, written, and then deployed at scale in potentially costly (and high-profile) software engineering projects.		
Unit level	5		
Unit code	Y/651/0158		
GLH	60		
Credit value	15		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	Tutors will need to help learners set up suitable development, (potentially) staging and production environments, and make available suitable open-source automation servers and utilities. This may be achieved “on-prem”, i.e. without use of cloud or hybrid services. 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. For a Merit, all pass and all merit criteria must be met. For a Distinction, all pass, all merit and all distinction criteria must be met.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
1. Understand the importance of implementing SOLID principles on the OOP paradigm	1.1 Explain the aim of the 5 key SOLID principles and the many ways code can be evaluated to ensure compliance with design patterns 1.2 Define the four pillars of Object-Oriented Programming with a coded example for each	1M1 Design and implement a solution for a complex problem which uses all four pillars of OOP	1D1 Design and Implement a solution for a complex problem which requires two or more SOLID principles applied

2. Understand the importance of DevSecOps as a set of practices, cultural approaches, and tools in software development	2.1 Explain the importance of implementing Shift Left as a DevSecOps best practice 2.2 Explain the problems DevSecOps aims to solve during the development lifecycle	2M1 Design suitable SCA, SAST and DAST stages using appropriate tools and configuration	2D1 Implement a DevSecOps CI/CD pipeline using an open-source automation server
3. Can design, build and test a large dataset application using SOLID principles, clean coding techniques, and automated testing	3.1 Demonstrate designing and building a large dataset to a client's requirement 3.2 Describe examples of SOLID principles and clean coding techniques applied as part of the solution 3.3 Build an automated test to a set specification 3.4 Explain the benefits of automated testing over manual testing	3M1 Demonstrate the utilisation of automated testing tools	

Indicative Content

1. Understand the importance of implementing SOLID principles on the OOP paradigm

- Object Orientated Programming (OOP)
 - OOP paradigm characteristics (class (encapsulation), object (instantiation), properties, methods, inheritance, constructors, destructors, virtual classes, overriding, access modifiers etc.)
 - Object-oriented class relationships, e.g.
 - Inheritance
 - Realisation/Implementation
 - Composition
 - Aggregation
 - Association
 - Dependencies
 - Use of standard notation, visual modelling to communicate OO ideas, e.g. UML
 - Clean coding techniques, including use of design patterns, SOLID etc
- SOLID design principles:
 - Understanding and applying the component parts of SOLID design principles is important to make software that is understandable, extensible, and maintainable
 - To include the following five common principles:
 - Single responsibility principle (SRP)

- Open-closed principle
- Liskov substitution principle
- Interface segregation principle
- Dependency inversion principle

2. Understand the importance of DevSecOps as a set of practices, cultural approaches, and tools in software development

- DevSecOps
 - Multidisciplinary nature, e.g. software engineers (developers), Security, Operations
 - Secure development lifecycle surrounding 8 discrete DevOps stages
 - Dev
 - Plan
 - Code
 - Build
 - Test
 - Ops
 - Release
 - Deploy
 - Operate
 - Monitor
 - Defined security patterns for the services and applications built
 - Ending with automated security for automated operations
- DevSecOps - best implementation practices
 - Cultural shift and impact
 - Threat Modelling; risks to systems and data
 - “Shift Left” concept, i.e. implementing security as early as possible
 - Continuous Integration and Continuous Delivery (CI/CD); key components
 - CI/CD open-source automation server, e.g. Jenkins, Gitlab etc.
 - Types of security tests:
 - Source Composition Analysis (SCA)
 - Static Application Security Testing (SAST)
 - Dynamic Application Security Testing (DAST)
 - Obfuscation Techniques; protecting your code using uglification, minification etc.
 - Microservices Architecture; advantages (development, testing, deployment)
 - Cloud-native Technologies; Containers (Docker, Kubernetes – K8s), Microservices etc.
 - Role-based Access Control (RBAC) security model; types and rationale
 - Log Activity, Monitor, Regular Audit, and Review

3. Design, build, and test a large dataset application using SOLID principles, clean coding techniques and automated testing

- Datasets
 - Developing and handling of large datasets
 - Data structures
 - Data operations
 - Data implementation
 - Collect the raw data
 - Identify feature and label sources
 - Select a sampling strategy
 - Split the data
- Testing
 - Types of automatic testing
 - Tool automation parameters

- Follow common testing frameworks and methodologies
 - Tools
 - Self-built testing tools

Suggested Resources

Mellor, Alan, 2021, Java OOP Done Right: Creative object oriented code you can be proud of with modern Java, Self-publishing

Kalb and Irv, 2022, Object-Oriented Python: Master OOP by Building Games and GUIs, No Starch Press

Lott, Steven F., & Phillips, Dusty., 2021, Python Object-Oriented Programming: Build robust and maintainable object-oriented Python applications and libraries, 4th Edition, Packt Publishing

Mack, Sean D., 2023, The DevSecOps Playbook: Delivery Continuous Security at Speed, Wiley

Wilson, Glenn, 2020, DevSecOps: A leader's guide to producing secure software without compromising flow, feedback and continuous improvement, Self-publishing

McLean Hall, Gary, 2017, Adaptive Code: Agile coding and design patterns and SOLID principles (Developer Best Practices) Microsoft Press

Websites

www.skillsyouneed.com

www.coursera.org

www.geeksforgeeks.org/introduction-of-object-oriented-programming/

www.educative.io/blog/object-oriented-programming

www.tutorialspoint.com/human_computer_interface/object_oriented_programming.htm

www.ibm.com/topics/devsecops

www.redhat.com/en/topics/devops/what-is-devsecops

<https://aws.amazon.com/what-is/devsecops/>

www.geeksforgeeks.org/solid-principle-in-programming-understand-with-real-life-examples/

www.digitalocean.com/community/conceptual-articles/s-o-l-i-d-the-first-five-principles-of-object-oriented-design

www.freecodecamp.org/news/solid-principles-explained-in-plain-english/

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 the importance of implementing SOLID principles on the OOP paradigm	This unit from the Software pathway together with Unit 6 (LO1, LO2 and LO3) in the Data pathway and Unit 13 (LO1, LO2 and LO3) in the Cyber pathway are all interlinked because learners explore programming concepts and how scripting languages are used in contexts such as security. U8 LO1 and U8 LO3 are particularly relevant because they involve code and algorithms. It is likely that learners will use Python as their language of choice in the Software pathway and equally it is likely that Python will be used in the Data units. This is because Python is one of the most popular languages because it is so versatile and it is often used when working with AI, statistics and it is also used in Penetration Testing and Ethical Hacking: U13 LO1, U13 LO2, U13 LO3 . This does not mean that C++, C and languages such as Java do not feature, it just means that for many contexts, Python may be the language of choice.
LO2 Understand the importance DevSecOps as a set of practices, cultural approaches, and tools in software development	
LO3 Design, build and test a large dataset application using SOLID principles, clean coding techniques, and automated testing	
Opportunities for Synoptic Assessment	
Unit 17 Advanced Project provides an opportunity for learners to demonstrate an understanding of the concepts of this unit when learners use the skills learned in both the core and their chosen 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 units.	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
Problem-solving – Understanding the application of SOLID principles on the OOP paradigm (LO1). Recognising the importance of DevSecOps and the reasons why software development should embrace security at the point of design and implementation (LO2). Correctly using development tools and practices in the development of secure applications (LO1, LO2, LO3). Communication - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation &	Time management – Identifying and sticking with your objective, setting yourself realistic goals (LO3). Using sources 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

grammar (SPAG) (LO1, LO2, LO3). 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).	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).
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Unit 10 Client and Server Technologies	
Unit aims	This unit enables learners to understand how data can be transmitted between different client and server technologies in both unsecured and secured states. UDP and TCP based connections are the very heart of the transport layer of the ISO OSI 7-layer model, providing a way for commercial applications to transfer data between a range of client and server-oriented technologies. Although not intended as a networking unit as such, any aspiring software developer should have both an appreciation and technical understanding of the processes required to achieve this type of application connectivity in a commercially oriented programming language.
Unit level	5
Unit code	A/651/0159
GLH	60
Credit value	15
Unit grading structure	Pass, Merit and Distinction
Assessment guidance	Socket-based communication between client and server technologies using either UDP or TCP transport layer protocols can be implemented in several different programming languages, including C, C++, Python and Rust. Learners may select any available language and can, if they choose, use a combination of two different languages to demonstrate the standardisation of communication methods via the Sockets library. Data may be transmitted using a simple client/server set-up using the loopback address with packets captured through available tools, e.g. Wireshark etc. The operating system is equally the centre's choice, but a Linux distribution is recommended for ease of development and its abundant native tools. The number of Merit and Distinction criteria for this unit are higher than in other units, but this reflects technical skills needed rather than a significant requirement of evidence. Many of the criteria can be evidenced through annotated screenshots. 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. For a Merit, all pass and all merit criteria must be met. For a Distinction, all pass, all merit and all distinction criteria must be met.

Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
1. Understand transport layer protocols used in computer networks	1.1 Describe the concept, features and functionality of a network socket 1.2 Describe the purpose of a transport layer protocol 1.3 Explain why different transport layer protocols are implemented 1.4 Explain the role of the Berkeley Sockets API	1M1 Compare and contrast UDP and TCP transport layer protocols	
2. Can implement UDP communication between client and server	2.1 Code a working software application for a UDP client in a selected programming language 2.2 Code a working software application for a UDP server in a selected programming language	2M1 Transmit data between client and socket using a UDP connectionless protocol	2D1 Use network protocol analysis tools to capture and confirm network transmission between client and server
3. Can implement TCP communication between client and server	3.1 Code a working software application for a TCP client in a selected programming language 3.2 Code a working software application for a TCP server in a selected programming language	3M1 Transmit data between client and socket using a TCP connection-oriented protocol	3D1 Use network protocol analysis tools to capture and confirm network transmission between client and server
4. Can use SSL or TLS protocols to create secure communication between client and server technologies	4.1 Describe the role of SSL and TLS 4.2 Explain the role and significance of the OpenSSL cryptographic library	4M1 Transmit data programmatically between client and socket using a UDP connectionless protocol with	4D1 Use network protocol analysis tools to capture and confirm encrypted network transmission

	for secure communication 4.3 Explain the functions, features and role of packet capturing tools	SSL cryptographic implementation	between client and server
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1 Understand transport layer protocols used in computer networks

What is a network socket?

- Description of a socket as a programming interface that provides a communication endpoint for processes on a network
- Socket components: IP address (V4, V6); Port Number
- Concept of reserved and ethereal port numbers
- Socket types:
 - Stream Sockets (TCP)
 - Datagram Sockets (UDP)
- Traditional socket lifecycle: create, configure, use and close
- Blocking vs. Non-blocking operations; send, receive etc.
- Inter-process Communication (IPC)

Transport layer protocol

- Transport layer with respect to ISO OSI 7-layer model
- Role of the Transport Layer to facilitate communication between devices using end-to-end communication
- Key aspects:
 - Segmentation and reassembly of messages and segments
 - Establishment, maintenance, and termination of connections between devices
 - Error detection and correction
 - Congestion control via flow control
 - Multiplexing and demultiplexing
- Implemented Transport Layer protocols include (but not limited to):
 - Transmission Control Protocol (TCP)
 - User Datagram Protocol (UDP)

Why do UDP and TCP both exist?

- Different approaches to communication between network devices, e.g. client, server etc. is required; typical use cases, e.g. videogame vs. chat system, network file backup etc.
- Considerations include:
 - Reliability vs. Speed
 - Ordered vs. Unordered Delivery of data
 - Connection-oriented vs. Connectionless
 - Resource usage
 - Network suitability
 - Requirement for multicast and broadcast
 - Software application requirements

What is Berkeley Sockets?

- Role as an API (Application Programming Interface) for network communication
- Origin
- Set of structures and functions for creating, configuring and managing network sockets
- Enables network communication between devices on a network etc.
- Support in different programming languages, e.g. C, C++, Python, Rust etc.
- Key features:
 - Creation of socket (UDP, TCP)
 - Concept of binding socket with address and port
 - Establishing a connection; listening and accept on server
 - Transmission of data; send and receive
 - Terminating connection; close
 - Error handling; human-readable error message for socket issues
 - IPv4 and IPv6 support
 - Portability across different platforms (UNIX, Linux, MacOS, Microsoft Windows via Winsock etc.)

2 Can implement UDP communication between client and server

- Steps required to create a UDP client in target programming language using a Berkeley Sockets (or compatible) library
- Appropriate error handling
- Testing
- Analysis of data using appropriate network protocol analyser tool, e.g. Wireshark

3 Can implement TCP communication between client and server

- Steps required to create a TCP client in target programming language using a Berkeley Sockets (or compatible) library
- Appropriate error handling
- Testing
- Analysis of data using appropriate network protocol analyser tool, e.g. Wireshark

4 Can use SSL or TLS protocols to create secure communication between client and server technologies

- Cryptographic protocols that provide secure network communication, e.g.
 - Secure Sockets Layer (SSL)
 - Transport Layer Security (TLS)
- History, “Handshake” concept flaws, evolution/versions, and interoperability
- OpenSSL as an open-source library; a set of cryptographic functions and protocols
- Use in the industry, e.g. web servers, email servers, custom network applications etc.
- Key features including:
 - Cross-platform support
 - Algorithms (AES, ECC, hashing functions etc.)
 - SSL/TLS protocol support
 - X.509 digital certificate creation and management
 - Public Key Infrastructure (PKI) key pairs, certificate signing requests (CSRs) etc.
 - Command line tools
 - Libraries for programming languages
- How to implement SSL for UDP connection etc.

- Network protocol analysis tools; configuration, use and searching/filtering packets etc.

Suggested Resources

Van Winkle, Lewis, 2019, Hands-On Network Programming with C: Learn socket programming in C and write secure and optimized network code, Packt Publishing

Silaghi, Marius, 2021, Network Programming with Laboratory Work in C, C++ and Java, Self-published

Donahoo, Michael J., & Calvert, Kenneth L., 2009, TCP/IP Sockets in C: Practical Guide for programmers (TCP/IP Sockets in C Bundle), Morgan Kaufmann

Websites

www.skillsyouneed.com

www.coursera.org

www.geeksforgeeks.org/socket-in-computer-network/

www.techtarget.com/searchnetworking/feature/How-to-get-started-with-socket-programming-for-beginners

www.geeksforgeeks.org/transport-layer-protocols/

www.includehelp.com/computer-networks/functions-of-transport-layer-in-the-osi-model.aspx

www.freecodecamp.org/news/tcp-and-udp-protocols/

www.freecodecamp.org/news/tcp-vs-udp/

www.csperkins.org/teaching/2007-2008/networked-systems/lecture04.pdf

www.geeksforgeeks.org/berkeleys-algorithm/

www.geeksforgeeks.org/udp-server-client-implementation-c/

www.geeksforgeeks.org/tcp-server-client-implementation-in-c/

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 transport layer protocols used in computer networks	Unit 10 in the Software pathway closely aligns with Unit 15 and Unit 16 in the Cyber pathway; this is because more and more networks are becoming reliant on programming and scripting for configuration, monitoring and security. For example, U15 LO1 and U15 LO2 develops the skills needed to develop and text complex network systems before exploring U15 LO3 where learners will deploy and monitor complex infrastructure using code. Similarly, client and server technologies are involved in U16 in the Cyber pathway where problem solving (U16 LO1) is part of the network and cloud design and configuration, planning and documenting migration of existing systems to the cloud (U16 LO2) and applying security measures (U16 LO3).
LO2 Can implement UDP communication between client and server	
LO3 Can implement TCP communication between client and server	
LO4 Can use SSL or TLS protocols to create secure communication between client and server technologies	
Opportunities for Synoptic Assessment	
Unit 17 Advanced Project provides an opportunity for learners to demonstrate an understanding of the concepts of this unit when learners use the skills learned in both the core and their chosen 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 units.	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
Problem-solving – This unit is critical for programmers working on networks to ensure that data can be transmitted between client and server technologies in both secured and unsecured states. Although not intended as a networking unit as such, any aspiring software developer should have a technical understanding and appreciation of the processes required to achieve this type of application connectivity in a commercially oriented programming language (LO1, LO2, LO3, LO4).	Using sources 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).

Communication - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation & grammar (SPAG) (LO1, LO2, LO3, LO4). Oral communication, e.g. presenting and choosing appropriate presentation formats (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 (e.g. online research, presenting data) (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).
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Unit 11 Virtualisation and Cloud Computing			
Unit aims		This unit enables learners to understand how digital transformation using virtualisation and cloud computing can solve many issues experienced by organisations which need to operate efficiently and cost effectively in a rapidly changing world. This unit places additional focus on the impact of these technologies, and on the development, deployment and testing aspects of the software development discipline.	
Unit level		5	
Unit code		H/651/0160	
GLH		60	
Credit value		15	
Unit grading structure		Pass, Merit and Distinction	
Assessment guidance		Learners will need access to different types of virtualisation software and some limited access to cloud computing services, e.g. Amazon AWS, GCP, Microsoft Azure. 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. For a Merit, all pass and all merit criteria must be met. For a Distinction, all pass, all merit, and all distinction criteria must be met.	
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
1. Understand virtualisation for local user and cloud computing environments	1.1 Describe key components and types of virtualisation 1.2 Describe the benefits of virtualisation 1.3 Describe key concepts of cloud computing environments 1.4 Describe role of virtualisation in cloud computing environments	1M1 Differentiate Virtualised Machines and Virtualised Applications	1D1 Evaluate the benefits and drawbacks of virtualisation

2. Can deploy a virtualised environment in accordance with a software developer's requirements	2.1 Conduct the manual installation of a virtualised platform for a local user 2.2 Orchestrate a deployment of a VM in a systematic manner	2M1 Create virtual machines with operating systems and software applications required for software development on a local user system to a client brief	
3. Can quantify and qualify how virtualisation and cloud computing contribute to increased organisational efficiency and productivity	3.1 Describe common issues for organisations using "on prem"-only strategies		3D1 Produce a report for an organisation on the benefits of utilising virtualisation and cloud computing, referencing appropriate use cases
4. Can recognise dangers and threats to virtualised machines and cloud computing from bad actors	4.1 Describe common vulnerabilities affecting VMs and cloud computing 4.2 Describe mitigations to common vulnerabilities affecting VMs and cloud computing	4M1 Apply a range of appropriate measures to harden a Virtualised Machine from attack, justifying with industry best practice	

Indicative Content

1 Understand virtualisation for local user and cloud environments

- What is virtualisation?
- Relationship between VM and physical host machine
- Types of virtualisation, e.g. Virtual Machines (VMs), Hypervisors (e.g. type 1 (Bare-metal) and examples, e.g. Microsoft Hyper-V, VMware vSphere/ESXi, and Xen, type 2 (Hosted) and examples, e.g. Oracle VirtualBox, VMware Workstation etc.)
- Benefits and potential drawbacks of virtualisation, e.g.
 - Benefits e.g. improved resource utilisation, quicker scalability (horizontal and vertical) to meet demand, improved security, e.g. through isolation, greater flexibility, and mobility (installation of guest operating systems, easy migration of VM to another host, improving fault tolerance), faster disaster recovery, improved opportunities for automated deployment and orchestration improved development and testing (sandboxed) environments
 - Drawbacks e.g. performance overheads re: multiple VMs on single host, resource contention re: multiple VMs on single host, added complexity to the IT infrastructure, security

vulnerabilities, e.g. misconfigurations allowing malicious access from VM to host, vendor dependency and related licensing costs, hardware incompatibilities, potential over-allocation of resources impacting performance

- Application virtualisation
 - Concept of encapsulation of application (and dependencies) into a virtualised package
 - Practical examples and use cases
- Relationship between cloud computing and virtualisation
 - What is Cloud computing? e.g. technology model, providing on-demand access to a shared pool of computing resources, over the internet
 - Cloud computing key features: e.g. self-service provisioning and management, flexible access via a range of internet-aware devices, elastic scalability of resources, pooling of resources across multiple customers, measured services, tracking, monitoring, controlling, pay-as-you-go billing model
- Different Cloud computing service models: e.g. Platform as a Service (PaaS), Functions as a Service (FaaS), Infrastructure as a Service (IaaS), Software as a Service (SaaS)
- Different deployment models: e.g. Private Cloud, Public Cloud, Hybrid Cloud
- Role of virtualisation in cloud computing; key contributions, e.g. reduced hardware costs, multi-tenancy support, snapshots and cloning, security through isolation, scalability, key to different service models, e.g. IaaS, PaaS etc.

2 Can deploy a virtualised environment in accordance with a software developer's requirements

- Benefits of using virtualised environments as part of software development life cycle, e.g.
 - Sandbox environment, standardisation of environment, e.g. development vs. staging vs. production, rapid deployment, ability to rollback using snapshots, easy versioning, parallel CI/CD builds, automated testing, cost saving (reduction of new for new hardware deployment)
- Key processes required, e.g.
 - Planning and Assessment: goal and objectives of virtualisation, assessment of existing "on-prem" infrastructure, re: suitability for virtualisation, assessment of required capacity; CPU, memory, storage, network bandwidth etc.
 - Selection of virtualisation type
 - Preparation of host: compatibility with existing hardware, e.g. CPU support of virtualisation extensions such as Intel VT-x, AMD-V etc., host driver and firmware updates
 - Resource planning e.g. network connectivity; VLANs, subnets, bridging, security etc. memory and backing storage
 - Installation: e.g. manual, orchestrated (i.e. automated coordination and management via tools, scripts etc.), workflow definition, deployments, e.g. template-based, configuration management, lifecycle management; stop, start, decommissioning, monitoring, and logging, error handling (and remediation), integration with other systems and services
 - Configuration: e.g. fine-tuning, security
 - Optimisation: e.g. ensuring business continuity, e.g. clustering, fault tolerance etc., active monitoring of performance
 - Documentation production: e.g. organisational policies for provisioning, de-provisioning etc., configuration, staff training

3 Can quantify and qualify how virtualisation and cloud computing contribute to increased organisational efficiency and productivity

- Common issues for organisations using "on prem"-only strategies: e.g. poor scalability for increased workloads, underutilisation of available IT infrastructure, lengthy deployment times for new physical servers or applications, lack of global accessibility, inability to innovate and experiment quickly

- Key areas of contribution include: consolidation of resources (e.g. leading to cost savings, e.g. Total Cost of Ownership (TCO) etc., improved opportunities for collaboration, simplified management); rapid provisioning and deprovisioning of products and services (e.g. changing business environment, to meet altered customer needs, legislation), reactive scalability and flexibility, wider accessibility to resources, greater agility in development and testing (more rapid software development lifecycle (SDLC)), improved business continuity through improved disaster recovery options

4 Can recognise dangers and threats to virtualised machines and cloud computing from bad actors

- Motivations: e.g. industrial espionage, competitive advantage etc., monetary gain, financial extortion etc., data theft, corruption, or modification, disruption of products and services, identify theft, political or activist agendas, repurposing cloud resources for illegal activities, e.g. botnet etc.
- Common vulnerabilities: e.g. unauthorised access, insufficient Identity and Access Management (IAM), inadequate isolation between tenants in multi-tenant system, compromised Hypervisor layer, insecure Application Programming Interfaces (APIs), distributed Denial of Service (DDoS) attacks, malware, including ransomware, supply chain attacks, insufficient logging, too infrequent monitoring
- Hardening and security measures: e.g. use Security Information and Event Management (SIEM), apply isolation of Virtual Machines, apply regular software updates/patch, reduce attack surface, e.g. uninstall or disable unnecessary applications and services, use strong authentication, apply firewall configuration, implement tailored Identity and Access Management (IAM), implement encryption (in three states), use anti-malware and/or anti-virus software, perform regular monitor and audit, keep technically updated
- How to implement: e.g. creating a comprehensive security approach, consider and implement industry/vendor best practices (e.g. NIST Cybersecurity Framework, National Cyber Security Centre (NCSC) Cloud Security Collection, Cloud Security Alliance (CSA) Security Guidance, OWASP Cloud-Native Application Security Top 10, VMware Security Configuration Guide), regular assessment and review

Suggested Resources

Singh, SK., 2022, Cloud Computing: Cloud Computing Fundamentals (IaaS, PaaS, SaaS, FaaS, Serverless Computing, Virtualisation, Virtual Machine, Hypervisor, Docker, Self-published Portnoy Matthew 2016 Virtualisation Essentials, 2nd Edition, Sybex

Shackleford, Dave, 2012, Virtualisation Security: Protecting Virtualized Environments, Sybex Jain Shashank Mohan 2020 Linux Containers and Virtualisation: A Kernel Perspective

Apress Mather, Jayne, 2023, Super user Networks for Software Projects: Best practices for training and change management BCS, The Chartered Institute for IT

Websites

www.skillsyouneed.com

www.coursera.org

<https://aws.amazon.com/what-is/virtualisation/>

<https://blog.serverhub.com/cloud-computing-vs-local-virtualisation/>

www.redhat.com/en/topics/cloud-computing/cloud-vs-virtualisation

www.geeksforgeeks.org/virtualisation-cloud-computing-types/

<https://www.parallels.com/blogs/ras/service-models-of-cloud-computing/>

www.techtarget.com/searchitoperations/feature/Build-a-virtualized-development-environment-with-these-guidelines

www.techadvisory.org/2019/03/best-practices-for-virtualisation-first-timers/
www.sciencedirect.com/science/article/abs/pii/S2214785321075726
www.abcservices.com/5-reasons-why-virtualisation-can-benefit-your-company/
www.liquidweb.com/kb/virtualisation-security-issues-and-risks/
www.helpnetsecurity.com/2010/03/16/six-common-virtualisation-security-risks-and-how-to-combat-them/
<https://dataconomy.com/2022/05/16/cloud-computing-vulnerabilities/>

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 virtualisation for local user and cloud computing environments	This unit links to Unit 7 in the Data pathway, specifically U7 LO2, U7 LO3 because data warehouses are stored in the cloud. Using data from the cloud will help to increase organisational efficiency and productivity. In addition, it links to Unit 13 in the Cyber pathway, particularly U13 LO1, because ethical hacking and pen testing are used to test the security of virtualised and cloud-based systems.
LO2 Can deploy a virtualised environment in accordance with a software developer's requirements	
LO3 Can quantify and qualify how virtualisation and cloud computing contribute to increased organisational efficiency and productivity	
LO4 Can recognise dangers and threats to virtualised machines and cloud computing from bad actors	
Opportunities for Synoptic Assessment	
Unit 17 Advanced Project provides an opportunity for learners to demonstrate an understanding of the concepts of this unit when learners use the skills learned in both the core and their chosen 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 units.	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
Problem-solving – This unit focuses on virtualisation and cloud computing by examining both local user and cloud environment, problem solving to deploy a virtualised environment whilst understanding its role in growing organisational efficiency and productivity. The recognition of threats and potential dangers to virtualised machines from a range of bad actors also feature. Learners must be able to deploy virtualised environments and (because it is Level 5) must be able to quantify and qualify the benefits of deployment to an organisation (LO1, LO2, LO3, LO4). Communication - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation & grammar (SPAG) (LO1, LO2, LO3, LO4). Oral communication, e.g. presenting and choosing appropriate presentation formats (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 (e.g. online research, presenting data) (LO1, LO2, LO3, LO4).	Time management – Identifying and sticking with your objective, setting yourself realistic goals (LO2, LO3). Using sources 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).

Unit 12 Cloud Native Solutions			
Unit aims	This unit enables learners to understand how digital transformation is facilitated through the use of cloud native solutions, an approach which incorporates the building and running of applications that fully leverages the advantages of a cloud computing platform.		
	It also provides learners with knowledge and experience in designing and building cloud-native applications that are cost-effective, automated, scalable, and resilient.		
	This is achieved using modern DevOps tools, design applications, microservice architectures, and the deployment of containerised applications to cloud platforms using cloud-native best practices.		
	Note: learners would benefit if they have studied the Cloud Computing unit prior to this unit.		
Unit level	5		
Unit code	J/651/0161		
GLH	60		
Credit value	15		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	Learners will need access to open-source tooling, e.g. Docker, Kubernetes etc. and have access to public cloud infrastructure in which they can build, configure, and deploy sample cloud native applications. Examples of these include Amazon Web Services (AWS), Microsoft Azure, Google Cloud Platform (GCP), Oracle Cloud Infrastructure (OCI) and DigitalOcean.		
	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. For a Merit, all pass and all merit criteria must be met. For a Distinction, all pass, all merit, and all distinction criteria must be met.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
1. Understand key components of cloud native solutions	1.1 Describe the key goals of cloud native solutions 1.2 Describe the key components of cloud native solutions 1.3 Explain why Security and Access control frameworks are a	1M1 Assess the benefits gained from using key cloud native tools, practices, and processes	

	useful component of cloud native solutions, using real-world examples to illustrate your reasoning		
2. Can design, build, and deploy cloud-native (non-containerised) applications	2.1 Design a cloud native solution for a given scenario by identifying the key components required and their role	2M1 Build and deploy a cloud native (non-containerised) solution for a given scenario	2D1 Evaluate the differences in cloud native solutions and traditional on-prem or hybrid approaches
3. Can optimise cloud resources by leveraging modern architectural patterns in software engineering	3.1 Describe key aspects of microservice architectures 3.2 Describe Functions as a Service (FaaS) 3.3 Describe suitable use cases for microservice architectures 3.4 Describe suitable use cases for Functions as a Service (FaaS)	3M1 Demonstrate the engineering benefits of utilising microservices and FaaS in cloud computing solutions	3D1 Evaluate the key differences between microservices and FaaS, citing real-world examples
4. Can create, manage, and deploy containerised solutions using industry standard tools	4.1 Describe the range of tools and processes required to create, manage, and deploy containerised solutions	4M1 Demonstrate using appropriate tools to create and deploy a containerised solution	

Indicative Content

1. Understand key components of cloud native solutions

- What is cloud native?
- Goals of cloud native solutions:
 - Greater Flexibility
 - Higher Agility
 - Easier Scalability
 - Faster Delivery of products and services
 - Greater Resilience
 - Easier Management
 - Improved Observability
 - Superior Security Model
- Key components of cloud native solutions:
 - Microservices
 - Containers
 - Orchestration
 - DevSecOps practices
 - Continuous Integration/Continuous Delivery (CI/CD)
 - Immutable infrastructure / Infrastructure as Code (IaC)
 - Distributed systems
 - Secure coding practices
 - Security and Access control framework, e.g. Identity and Access Management (IAM)
 - User authentication
 - Authorisation
 - Provisioning and De-provisioning
 - Single Sign-on (SSO) and Multi-factor authentication (MFA)
 - Audit
 - Compliance
 - Policy enforcement

2. Can design, build, and deploy cloud-native applications

- Overview of Cloud Computing
 - Cloud Deployment Models
 - Cloud Service Models
 - IaaS
 - PaaS
 - SaaS
 - Managed/Serverless Services
 - IT Ops, SysOps, DevOps, Low Ops, No Ops
- Cloud-Native Development
 - Traditional Development vs. Cloud-Native
 - Agile Practices
 - Feature-Driven Development
 - Value-Driven Development
 - Automation and DevOps
 - Infrastructure as Code (IaC)
 - Continuous Integration and Continuous Delivery (CI/CD)
- Application Lifecycle Management

- Package Management
- Managing Application Dependencies

3. Can optimise cloud resources by leveraging modern architectural patterns in software engineering

- Key features of microservices
 - Modularity
 - Independence
 - API communication
 - Multiple Programming Languages
 - Diverse technologies
 - Containerisation and Orchestration
 - Autonomous teams performing development, deployment, and management
 - Resilience
- Key features of FaaS
 - Event driven nature
 - Serverless (micro-billing AKA “pay as you go”)
 - Statelessness
 - Zero Infrastructure Management
 - Rapid development
 - Scalability
 - Parallel execution
 - Multiple Language Support
 - Monitoring and Logging Support
 - Control via Security and Access control framework
- Comparison of microservices and FaaS aspects such as:
 - Typical Use Cases, e.g. web application backend, IoT data processing, voice assistants, file processing and transcoding, mobile app backends, image recognition, API gateways etc.
 - Granularity
 - Execution model
 - Development and Deployment
 - Resource Management
 - Scaling
 - Challenges, e.g. distributed systems, network communication etc.

4. Can create, manage, and deploy containerised solutions using industry standard tools

- Containerised vs. non-Containerised Cloud Native Solutions
- Containerisation using Docker
 - Understanding Docker
 - Concept of containers
 - Comparison to Virtual Machines (VMs)
 - Advantages of Containers, e.g.
 - Portability
 - Isolation (of process and filesystem for improved security, dependencies etc.)
 - Resource Efficiency
 - Speed of Deployment

- Scalability
 - Images and Image Registry
 - Using Docker
- Container Orchestration using Kubernetes
 - Kubernetes Clusters
 - Kubernetes Architecture
 - Kubernetes Security
- DevSecOps Automation (CI/CD)
 - Automation and DevSecOps
 - Automated Testing
 - Cloud-Based (AWS, Azure, Google Cloud) CI/CD Tools
- Platform as a Service and Serverless
 - Automated Platforms
- Cloud Data Services
 - Storing Binary Data
 - Cloud Storage
 - Relational Data Services

Suggested Resources

Shrivastava, Saurabh et al., 2023, AWS for Solutions Architects - Second Edition: The definitive guide to AWS Solutions Architecture for migrating to, building, scaling, and succeeding in the cloud, Packt Publishing

Eyskens, Stephane et al., 2021, The Azure Cloud Native Architecture Mapbook: Explore Microsoft Cloud's infrastructure, application, data, and security architecture, Packt Publishing

Kasun, Indrasiri et al., 2021, Design Patterns for Cloud Native Applications: Patterns in Practice Using APIs, Data, Events, and Streams, O'Reilly

Carpenter, Jeff, & McFadin, Patrick, 2022, Managing Cloud Native Data on Kubernetes: Architecting Cloud Native Data Services Using Open Source Technology, O'Reilly

Dutt, Dines, 2019, Cloud Native Data–Center Networking: Architecture, Protocols, and Tools, O'Reilly

Ruecker, Bernd, 2021, Practical Process Automation: Orchestration and Integration in Microservices and Cloud Native Architectures, O'Reilly

Websites

www.skillsyouneed.com

www.coursera.org

www.container-solutions.com/learn-with-cs/cloud-native

www.redhat.com/architect/portfolio/detail/4-building-your-cloud-native-applications

www.oracle.com/uk/cloud/cloud-native/what-is-cloud-native/

<https://blog.opstree.com/2021/05/25/running-non-containerized-microservices/>

www.techtarget.com/searchcloudcomputing/definition/cloud-native-application

www.weave.works/technologies/going-cloud-native-6-essential-things-you-need-to-know/

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 units LO/AC
LO1 Understand key components of cloud native solutions	Using cloud native solutions to facilitate digital transformation means that this unit links with core Unit 1 , particularly U1 LO1 because these solutions incorporate the building and running of applications that fully leverage the advantages of a cloud computing platform. This is achieved using modern DevOps tools run on cloud-based networks and incorporating NetDevOps concepts (Unit 15 and Unit 16 in the Cyber pathway). There will also be a link to Cyber pathway Unit 13 (LO1, LO2 and LO3) as these solutions will also need to be made secure.
LO2 Can design, build, and deploy cloud-native (non-containerised) applications	
LO3 Can optimise cloud resources by leveraging modern architectural patterns in software engineering	
LO4 Can create, manage, and deploy containerised solutions using industry standard tools	
Opportunities for Synoptic Assessment	
Unit 17 Advanced Project provides an opportunity for learners to demonstrate an understanding of the concepts of this unit when learners use the skills learned in both the core and their chosen 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 units.	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
Problem-solving – This unit focuses on the development of cloud native solutions and as such is wholly centred on problem solving. Learners must be able to build cloud native solutions (both containerised and non-containerised) and understand how these technologies are used in industry (LO1, LO2, LO3, LO4). Communication - Written communication, e.g. appropriate formats, style and tone, spelling, punctuation & grammar (SPAG) (LO1, LO2, LO3). Oral communication, e.g. presenting and	Time management – Identifying and sticking with your objective, setting yourself realistic goals (LO2, LO4). Using sources 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

choosing appropriate presentation formats (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 (e.g. online research, presenting data) (LO1, LO2, LO3, LO4).	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).
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Unit 13 Penetration Testing and Ethical Hacking			
Unit aims	This unit aims to teach the learner to understand the role of ethical hacking and the types of penetration testing (“pen testing”) used in the development of secure systems. Learners who aspire to the pen testing/ethical hacking role will need to understand a range of pen testing tools and be able to explain their role with respect to adversarial behaviours and to malware and attack technologies. Learners will need to be capable of planning, performing, and reporting on a pen test for a given scenario. Learners should appreciate that successful hacking is largely down to the skills of the hacker (analytical skills, problem solving skills, understanding of networks, computer systems and programming) than their respective equipment/tools and methodologies.		
Unit level	5		
Unit code	K/651/0162		
GLH	60		
Credit value	15		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	Learners must get permission from the owner of the system before performing penetration tests. Please see list of online tools that tutors can use to support this unit in the ‘Websites’ section at the end of the unit. Learner work should demonstrate the ability to successfully carry out ethical hacking and penetration testing on given scenarios. 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. For a Merit, all pass and all merit criteria must be met. For a Distinction, all pass, all merit, and all distinction criteria must be met.		
Learning outcomes The learner will demonstrate that they:	Assessment criteria The learner can:		
	Pass	Merit	Distinction
1. Understand the role of ethical hacking and the types of pen testing in the development of secure systems	1.1 Classify the different types of threats, attack surfaces and attack vectors 1.2 Examine hacking concepts and phases and the role of penetration testing	1M1 Appraise the current trends in network and data security requirements	1D1 Evaluate the potential impacts of financial and reputational loss and how ethical hacking can improve network security

	1.3 Demonstrate how ethical hacking can ensure compliance with standards and regulations		
2. Understand a range of pen testing tools and explain their role with respect to adversarial behaviours, and malware and attack technologies	2.1 Explain enumeration in the context of hacking 2.2 Outline and explain the use of a range of hacking tools 2.3 Explore the role of coding and scripting in ethical hacking	2M1 Identify a hacking process that would benefit from the use of programming or scripting, and create a suitable script	3D1 Develop an ethical hacking plan and select appropriate tools 3D2 Perform penetration tests on a given system, report vulnerabilities and draw conclusions
3. Can plan, perform and report a pen test for a given scenario	3.1 Examine the Certified Ethical Hacker methodology 3.2 Explore network scanning techniques 3.3 Outline how to perform defensive measures against a known attack 3.4 Outline how to perform penetration testing on a system	3M1 Justify the rules of engagement between the penetration testers and the owners of the system	

Indicative Content

1. Understand the role of ethical hacking and the types of pen testing in the development of secure systems

- Threats, attack surfaces and attack vectors
 - Computers and operating systems
 - Networking and network devices
 - People, social engineering
- The role of ethical hacking
 - Identify and address security vulnerabilities within computer systems, applications, networks and other IT infrastructure
 - Simulate authorized cyberattacks and assess the security defences of an organization
 - Document and share findings
 - Make recommendations
 - Aid in response planning, security awareness training etc.
 - To prepare appropriately for real cybersecurity incidents

- Ethical hacking benefits
 - Improved network security
 - Compliance with standards and regulations, e.g. legal frameworks for data privacy etc.
 - Reduced risks
 - Financial loss
 - Reputational loss
- Hacking concepts and phases
 - The CEH methodology
 - System access and privilege escalation
 - Remote system access
 - Steganography and steganalysis
 - Rootkits
- Malware
 - Viruses, Trojans and Worms, how they infect files and systems
 - How malware can be used as a delivery method for a remote access trojan (RAT)
 - Malware detection and countermeasures

2. Understand a range of pen testing tools and explain their role with respect to adversarial behaviours, and malware and attack technologies

- Types of tools
 - Enumeration and footprinting tools
 - Network discovery tools
 - Packet sniffing tools
 - DoS/DDoS tools
- Common tool suites
 - Kali Linux
 - Parrot Security OS Linux
 - BlackArch
 - CAINE (Computer Aided Survey environment)
 - Tails
 - Commando VM
- The importance of understanding scripting and coding
 - The need for programming in scripting for security, configuration etc.
 - Java, JavaScript, PHP, SQL, C, C++, Bash, Python, PowerShell, Perl, etc
 - Common vulnerabilities and exploits
 - Use of cookies to analyse browsing habits
 - Hijacking user sessions
 - Using code to delete all data on a website
 - Using SQL injection techniques to access unauthorised data

3. Can plan, perform and report a pen test for a given scenario

- The main phases
 - Reconnaissance; gathering information about the target system; passive and active techniques
 - Footprinting and Scanning; live hosts, open ports, services etc. on target network
 - Enumeration of accounts, configurations, potential vulnerabilities
 - Vulnerability analysis; finding weaknesses in software, configuration, architecture etc.
 - Exploitation; gaining authorized access through identified vulnerabilities
 - Post-exploitation; maintain control over the compromised system
 - Covering tracks; removing or obscuring evidence to test detection abilities of target's security systems

- Analysis and reporting; findings, vulnerabilities, overall status; providing risk factors for each element; recommendations and mitigations to reduce risk
- The extra steps to make it ethical
 - Rules of engagement between the penetration testers and the owners of the system
 - Gaining permission
 - The extent of technical information provided by the owners of the system initially to the tester
 - Assessing the impact of a successful attack and evaluating the extent of unauthorised access possible
 - Reporting
- Enumeration and footprinting concepts and techniques
 - Platforms: social networking sites, websites, email, search engines, web services, etc.
 - Networks: WHOIS, SNMP, NTP, LDAP, NetBIOS, DNS etc.
 - Social engineering
- Network scanning concepts and techniques
 - Active and passive scanning
 - Services and open ports, NMAP, etc.
 - Banner grabbing
 - Scanning beyond firewalls and Intrusion Detection Systems
 - Network discovery tools
 - Radio scanning – Wi-Fi, mobile devices
- Packet sniffing concepts and techniques
 - Packet sniffing concepts
 - MAC and DHCP attacks
 - ARP and DNS poisoning
 - Packet sniffing detection
- DoS and DDoS concepts and techniques
 - DoS/DDoS mitigation practices

Suggested Resources

Wylie, Phillip L et al., 2020, The Pentester BluePrint: Starting a Career as an Ethical Hacker, Wiley Publishing

Graham, Daniel, 2021, Ethical Hacking: A Hands-On Introduction to Breaking in, No Starch Press

Nastase, Ramon, 2022, The Ethical Hacking Book for Beginners: A Step-by-Step Guide for you to Learn the Fundamentals of Ethical Hacking and CyberSecurity, Self-published

Harper Allen et al., 2022, Gray Hat Hacking: The Ethical Hacker's Handbook, Sixth Edition, McGraw Hill

Bramwell, Phil, 2022, Windows and Linux Penetrating Testing from Scratch, Packt Publishing

Websites

Common Weaknesses Enumeration (CWE): <https://cwe.mitre.org/data/index.html>

Common Vulnerabilities and Exposures (CVE): <https://cve.mitre.org/>

Coding for Cybersecurity Guide: <https://cybersecurityguide.org/resources/coding-for-cybersecurity/>

Open Web Application Security Project (OWASP): <https://owasp.org/>

Hack this site provides safe and legal training grounds for hackers to test their skills.
<https://www.hackthissite.org/>

Gruyere is a google website designed to be hacked as like the cheese it is full of holes. The site is provided by Google and provides some guidelines: <https://google-gruyere.appspot.com/>

Try Hack Me is a site that allows the creation and uploading of resources to be hacked. Ideal for tutors to create and store resources, some resources are free such as the compete rooms and King of the Hill. <https://tryhackme.com/develop-rooms>

Root Me Hacking and IS Learning platform: <https://www.root-me.org>

Cybersecurity Training for Universities, Schools and Students: <https://www.hackthebox.com>

Hacking-Lab: <https://www.hacking-lab.com/services/>

Exploit Exercises: <https://exploit-exercises.com/>

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 the role of ethical hacking, and the types of pen testing in the development of secure systems	With increases in security incidents around the world, organisations are employing groups of ethical hackers and penetration testers to test the security resilience of their systems, devices and network communications. For this reason, this unit links to all other units, but, in particular, it links to Unit 5 in the Data pathway (LO1, LO2 and LO3), Unit 9 and Unit 11 in the Software pathway (U9 LO1, LO2 and LO3 and U11 LO4).
LO2 Understand a range of pen testing tools and explain their role with respect to adversarial behaviours and malware and attack technologies	
LO3 Can plan, perform and report a pen test for a given scenario	
Opportunities for Synoptic Assessment	
Some of the Distinction criteria require knowledge from one or more of the LOs. In this unit AC 3D1 and 3D2 include assessment across LO2 and LO3 . Unit 17 Advanced Project provides an opportunity for learners to demonstrate an understanding of the concepts of this unit when learners use the skills learned in both the core and their chosen 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 units.

Opportunities for Skills Development within this unit

Employability Skills

Problem-solving – Selecting and using appropriate tools and techniques to meet a range of requirements (LO1, LO2, LO3). Learners should understand that this skill is key in pen testing and ethical hacking in general.

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, presenting data (LO1, LO2, LO3).

Study Skills

Using sources of information – Accessing information, e.g. choosing suitable methods and techniques (LO1, LO2, LO3).

Reading Skills – Identifying different sources of information (LO1, LO2, LO3).

Thinking Skills – Using critical thinking skills, e.g. reading all information, identifying and interpreting 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).

Unit 14 Digital Forensics			
Unit aims	This unit is designed to help students acquire the necessary skills to fulfil the increasing need for computer forensics in the security and law enforcement sectors. It introduces the fundamentals of computer forensics and enhances cyber security knowledge through an exploration of the evolution and history of digital forensics. The unit also provides opportunities for students to consider professional standards and policies, as well as to learn about the management and investigation of digital crime scenes.		
Unit level	5		
Unit code	L/651/0163		
GLH	60		
Credit value	15		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	Please see list of online tools that you can use to support this unit in the 'Websites' section at the end of the unit. 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. For a Merit, all pass and all merit criteria must be met. For a Distinction, all pass, all merit, and all distinction criteria must be met.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
1. Understand the fundamentals of computer and mobile forensics	1.1 Examine the history and development of digital forensics 1.2 Explain the file types that may contain evidence and where they can be found 1.3 Explain methods of data preservation	1M1 Compare the types of data file that can be discovered and their suitability as evidence in a court of law	1D1 Critically analyse the impact current developments in technology might have on the suitability of forensic evidence in a court of law
2. Understand the principles of computer and mobile forensic investigation	2.1 Explain how data can be extracted for a forensic investigation 2.2 Describe how automated tools can be used to collect evidence 2.3 Explain common documentation used to	2M1 Compare the relative merits of techniques and tools used to collect evidence in a range of scenarios	2D1 Critically appraise the methodologies used and demonstrate justified conclusions from the evidence

	record a forensic investigation		
3. Understand the application of professional guidelines and best practice in the discipline of digital forensics	3.1 Research and explain the legal aspects of digital forensics 3.2 Explain how standards and best practice guidelines are applied 3.3 Explain how to present findings in written or oral form	3M1 Develop a crime scene report that meets professional guidelines for a given scenario	

Indicative Content

1. Understand the fundamentals of computer and mobile forensics

- History and development of forensics:
 - Criminal
 - Computer analysis and research team (CART)
 - Fraud Squad
 - Serious Fraud office and inland revenue
 - Drug offences
 - Grooming offences, Childcare
 - Business
 - Workplace data theft
 - Intellectual property (IP) theft
 - Computer and Internet misuse at work
 - Political
 - Election tampering (election anomaly detection)
 - Election fraud (voter irregularities)
- Devices that may contain evidence:
 - Computers and laptops
 - Network devices and servers
 - Mobile phones and tablets
 - IoT devices
 - Wearables (Including medical devices)
 - Drones and CCTV
 - Cloud services
- Data types within devices that may contain evidence:
 - Documents
 - Emails
 - Browsing activity
 - Multimedia including images, images and sound files
 - Messages
 - Event logs
 - Deleted files and data fragments
- Data acquisition:
 - Internal storage such as SSD, HDD,
 - External storage such as SIM cards SD cards, USB devices

- Service log providers, ISPs, call logs, Geo location, legal implications
- Methods of data preservation, interpretation and documentation:
 - Contamination risks to the integrity of evidence
 - Live acquisition, use of faraday cages
 - Manual and logical acquisition
 - File and physical acquisition using cloning and imaging
 - Write-blocking and hashing

2. Understand the principles of computer and mobile forensic investigation

- Techniques used in data analysis:
 - Keyword searching
 - File carving
 - Timeline analysis
 - Live analysis
 - Anomaly detection
 - Stochastic forensics
 - Reverse steganography and decryption
- Tools and software suites to automate data extraction and analysis:
 - Digital investigation software suits:
 - EnCase,
 - Forensic Tool Kit
 - Autopsy Forensic Browser
 - MicroSystemation GSM.XRY and.XACT
 - Cellebrite UFED
 - Susteen Secure View2
 - Paraben Device Seizure
 - Radio Tactics Aceso
 - Oxygen Phone Manager
 - Compelson MobilEdit Forensic
 - File viewers, and file analysis tools:
 - The Sleuth Kit,
 - Autopsy
 - Bulk Extractor
 - Registry analysis tools:
 - Registry Viewer
 - Registry Explorer
 - RegRipper
 - Alternative open-source forensic tools:
 - Digital Forensics Framework
 - Open Computer Forensics Architecture (OCFA)
 - HashKeeper
 - Computer-Aided Investigative Environment
 - SANS Investigative Forensics Toolkit
- Common documentation methods to record processes:
 - Use of contemporaneous notes
 - Photography/Video/Sketches
 - Chain of custody
 - ACPO Good Practice Guide for Digital Evidence
 - Documentation software
 - Forensic Notes

- Trimble Forensics Capture
- Belkasoft Evidence Center X
- Data extraction method validation (FSR-G-218)

3. Understand the application of professional guidelines and best practice in the discipline of digital forensics

- Legislation and regulation:
 - Electronic Communications Privacy Act (ECPA)
 - Computer Fraud and Abuse Act (CFAA)
 - Council of Europe Convention on Cybercrime (Budapest Convention) and the subsequent Directive 2013/40/EU
 - National Institute of Justice (NIJ) Digital Evidence Policies and Procedures Manual (USA)
 - Patriot Act 2001 (USA)
- Standards and best practice:
 - Quality Standards for Digital Forensics (QSDF)
 - ISO/IEC 17020
 - The Forensic Science Regulator
 - Council of the Inspectors General on Integrity and Efficiency (CIGIE)
- Presentation of the findings:
 - Technical report outlining the findings relevant to the inquiry being conducted
 - Manual of Guidance Streamlined Forensic Reports (MG SFR)
 - Forensic Information report
 - Forensic results report
 - Expert response statement
 - Factual response statement

Suggested Resources

Marcella Albert J., 2021, Cyber Forensics: Examining Emerging and Hybrid Technologies, CRC Press

Moustafa Nour, 2022, Digital Forensics in the Era of Artificial Intelligence, CRC Press

Nhien-An Le-Khac et al., 2020, Cyber and Digital Forensic Investigations: A Law Enforcement Practitioner's Perspective: 74 (Studies in Big Data, 74), Springer Publishing

Tamma Rohit et al., 2020, Practical Mobile Forensics: Forensically investigate and analyse iOS, Android, and Windows 10 devices, 4th Edition, Packt Publishing

Oettinger William, 2022, Learn Computer Forensics: Your one-stop guide to searching, analysing, acquiring, and securing digital evidence, 2nd Edition, Packt Publishing

Kävrestad Joakim, 2020, Fundamentals of Digital Forensics: Theory, Methods, and real-life Applications, Springer Publishing

Websites

Computer Forensic Reference dataset portal (CFReDS) <https://cfreds.nist.gov/>

This portal provides access to documented digital forensic image datasets. These datasets can assist in a variety of tasks including tool testing, developing familiarity with tool behaviour for given tasks, general practitioner training and other unforeseen uses that the user of the datasets can devise.

NIST – Computer Forensics Tool Testing Program (CFTT)

<https://www.nist.gov/itl/ssd/software-quality-group/computer-forensics-tool-testing-program-cftt/federated-testing>

This site has several self-booting ISO files that can be used to test tools. Also, it contains several tool test reports.

Digital Corpora <https://digitalcorpora.org/>

DigitalCorpora.org is a website of digital corpora for use in computer forensics education research. All of the disk images, memory dumps, and network packet captures available on this website are freely available and may be used without prior authorisation or IRB approval. Also available is a research corpus of real data acquired from around the world. Use of that dataset is possible under special arrangement.

GitHub <https://github.com/frankwxu/digital-forensics-lab>

Hands on labs using Linux and open source tools

Other useful websites include:

<https://resources.infosecinstitute.com/topics/general-security/election-security-cybersecurity-concerns-for-future-elections/>

<https://www.eccouncil.org/cybersecurity/what-is-digital-forensics/>

<https://www.ukcybersecuritycouncil.org.uk/careers-and-learning/cyber-career-framework/digital-forensics/>

<https://www.bluevoyant.com/knowledge-center/understanding-digital-forensics-process-techniques-and-tools>

<https://www.spiceworks.com/it-security/cyber-risk-management/articles/what-is-digital-forensics/>

<https://www.upguard.com/blog/digital-forensics>

<https://www.bcs.org/articles-opinion-and-research/what-is-digital-forensics/>

<https://nij.ojp.gov/digital-evidence-and-forensics>

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 the fundamentals of computer and mobile forensics	These two learning outcomes have no direct links topic to other units except in general terms because the other units focus on technologies that may need to be forensically explored, from devices to databases and networks.
LO2 Understand the principles of computer and mobile forensic investigation	
LO3 Understand the application of professional guidelines and best practices in the	The main link that this unit has to other units is to core Unit 2 LO3 where professional guidelines and the understanding and demonstration of best practice are explored. Learners have to consider why it is necessary to have professional guidelines

discipline of digital forensics	and demonstrate best practice, particularly in the preparation of data and information as digital forensic evidence.
Opportunities for Synoptic Assessment	
Unit 17 Advanced Project provides an opportunity for learners to demonstrate an understanding of the concepts of this unit when learners use the skills learned in both the core and their chosen 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 units.	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
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 – Judging the reliability of information, problem-solving, presenting data (LO1, LO2, LO3).	Using sources of information – Accessing information, e.g. choosing different sources of information to enable developing a balanced view (LO1, LO2, LO3). Reading Skills – Identifying different sources of information (LO1, LO2, LO3). Thinking Skills – Using critical thinking skills, e.g. reading all information, identifying and interpreting 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).

Unit 15 Network Developer and IT Operations (NetDevOps)			
Unit aims	The continuing growth of cloud-based networks has led to the concept of Infrastructure as Code. Network engineers now need to think about their networks differently and this unit aims to develop the skills required to plan and code complex cloud systems. It will form a basis to gain the skills needed to build and operate cloud-based networks and examine how they can be deployed and monitored using manual and automated systems.		
Unit level	5		
Unit code	M/651/0164		
GLH	60		
Credit value	15		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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. For a Merit, all pass and all merit criteria must be met. For a Distinction, all pass, all merit, and all distinction criteria must be met.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
1. Understand the skills needed to plan and code complex network systems	1.1 Explain planning methodologies associated with complex systems 1.2 Explain the principles of DevOps and infrastructure as code (IaC)	1M1 Demonstrate how key system components can be configured using code	1D1 Analyse how coherence between development, operation, and security is achieved in accordance with DevOps and (IaC) principles
2. Understand the skills needed to build and test complex network systems	2.1 Design and create a build process for an integration build 2.2 Identify and document system integration components for recording in the configuration management system	2M1 Recommend and implement improvements to processes and tools	2D1 Review and verify the network design

3. Can implement the deployment and subsequent monitoring of complex network infrastructure	3.1 Configure tools and/or creates scripts to automate the provisioning, testing and deployment of new and changed infrastructure 3.2 Use infrastructure management tools to determine load and performance statistics 3.3 Maintain operational procedures and checks that they are executed following agreed standards		
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Indicative Content

1. Understand the skills needed to plan and code complex network systems

- Planning methodologies associated with complex systems:
 - Agile
 - SCRUM
 - Kanban
 - Loosely Coupled Architecture
 - Waterfall
- Principles of DevOps and infrastructure as a code:
 - All-in-one and open toolchains
 - DevOps -Planning and lean project management:
 - Version control
 - Continuous integration and delivery
 - Monitoring and logging
 - Validated learning
 - DevOp tools:
 - Github
 - Visual studio
 - Azure devOps
 - Jira
 - IAC -Declarative and Imperative tools:
 - Chef
 - Ansible
 - Puppet
 - CFEngine
 - Terraform
 - Pulumi
 - CloudFormation

- Techniques to enable the configuration of system components using code:
 - Pull Requests
 - Merge Conflict
 - Feature Toggling
 - Peer Review
 - Trunk based branching
- DevOps and (IaC) principles for documentation to enable coherence between development, operations and security teams:
 - Define goals
 - Identify interdependencies
 - Responsible, Accountable, Consulted, Informed (RACI matrix)
 - Communication channels
 - IaC implementation

2. Understand the skills needed to build and test complex network systems

- Deploying the principal IT stacks:
 - Microsoft Windows Server
 - Linux server distributions, Debian, Fedora, Ubuntu, etc
 - Private cloud, e.g. OpenStack, CloudStack, Open Nebula, etc.
 - Virtual Platforms, e.g. vSphere, Linux KVM, etc.
 - Container platforms, e.g. Docker, OpenVZ, Kubernetes
- Using the 'Big 3' public cloud platforms:
 - Azure
 - AWS
 - GCP
 - Cloud security
- Development platforms:
 - #CloudGuruChallenges
 - Cloud Resume Challenges
 - Pluralsight
- Automation:
 - Continuous Integration/Continuous Delivery (CI/CD)
 - Code repositories, e.g. GitHub, GitLab, Subversion
 - Programming and scripting, e.g: Python, Bash, Ruby, PHP, Java, C++, C#, etc
- Soft skills:
 - Communication
 - Cross-team collaboration
 - Understanding the customer goals and pain points
- Documentation:
 - Identifying system integration components for recording in the configuration management system

3. Can implement the deployment and subsequent monitoring of complex network infrastructure

- Configuration tools and/or scripts to automate the provisioning, testing and deployment of new and changed infrastructure:
 - Jenkins
 - Terraform
 - Docker

- Kubernetes
- Python
- Git
- Ansible
- Chef
- Puppet
- Nodegrid
- Continuous integration management tools:
 - SignalFX
 - NewRelic
 - Parasoft LoadTest
 - Jenkins
 - Apache Maven, Ant
 - SolarWinds
 - DynaTrace
 - Nagios
 - Prometheus
 - Grafana
- Using standards for documentation of operational procedures and checks:
 - Define the standards that need to be met e.g., ISO/IEC 27001
 - Identify and document the necessary procedures required by the standards
 - Identify and document required checks, such as log files, CPU usage, memory, disk transfers, etc.
 - Automating documentation

Suggested Resources

Kim, G. et al., 2021, The DevOps Handbook: How to Create World-Class Agility, Reliability, and Security in Technology Organizations, IT Revolution Press

Forsgren, N. et al., 2018, Accelerate: The Science of Lean Software and DevOps: Building and Scaling High Performing Technology Organizations, IT Revolution Press

Abbes, Mohamed Ghassen, 2023, Start NetDevOps with Python: Set of ideas from Source of Truth to Automation System, Self-published

Chou, Eric, 2023, Mastering Python Networking: Utilize Python packages and frameworks for network automation, monitoring, cloud, and management, 4th Edition, Packt Publishing

Limoncelli, T. A., Hogan, C., & Chalup, S., (2016), The Practice of Cloud System Administration: Designing and Operating Large Distributed Systems, Volume 2. Addison-Wesley Professional

Websites

Pluralsight: <https://www.pluralsight.com/resources/blog/cloud/10-fun-hands-on-projects-to-learn-aws>

Microsoft learn: <https://learn.microsoft.com/en-us/devops/>
<https://learn.microsoft.com/en-us/azure/devops/pipelines/process/resources>

DevopsCube resources: <https://devopscube.com/>

Other useful websites include:

<https://www.futuriom.com/articles/news/what-is-netdevops/2023/01>

<https://zpesystems.com/resources/what-is-netdevops-the-definitive-guide-zs/>

<https://www.networkworld.com/article/971243/what-is-netdevops-and-how-can-it-help-it-meet-business-goals.html>

<https://aws.amazon.com/blogs/networking-and-content-delivery/netdevops-a-modern-approach-to-aws-networking-deployments/>

<https://techcommunity.microsoft.com/t5/core-infrastructure-and-security/netdevops-on-azure/ba-p/3730812>

<https://hackernoon.com/from-devops-to-netdevops-where-are-we-now-in-networking>

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 the skills needed to plan and code complex network systems	The primary links to other units are to Unit 10 and Unit 12 in the Software pathway because of the reliance on programming and scripting in the development and security of network and cloud-based systems. This means that NetDevOps links to Client and Server Technologies and Cloud Native Solutions.
LO2 Understand the skills needed to build and test complex network systems	
LO3 Can implement the deployment and subsequent monitoring of complex network infrastructure	
Opportunities for Synoptic Assessment	
Unit 17 Advanced Project provides an opportunity for learners to demonstrate an understanding of the concepts of this unit when learners use the skills learned in both the core and their chosen 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 units.	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
Problem-solving – Selecting and using appropriate tools and techniques to meet a range of requirements (LO1, LO2, LO3).	Using sources of information – Accessing information, e.g. choosing different sources of information to enable developing a balanced view (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 – Judging the reliability of information, problem-solving, presenting data (LO1, LO2, LO3).	Reading Skills – Identifying different sources of information (LO1, LO2, LO3). Thinking Skills – Using critical thinking skills, e.g. reading all information, identifying and interpreting 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).
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Unit 16 Network and Cloud Design and Configuration			
Unit aims	This unit aims to develop the skills required to be a network engineer with advanced problem-solving and troubleshooting skills. It involves exploration of cloud infrastructure architecture to design and provision cloud-based solutions, providing the opportunity to discuss, apply and analyse network and cloud infrastructure security measures.		
Unit level	5		
Unit code	R/651/0165		
GLH	60		
Credit value	15		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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. For a Merit, all pass and all merit criteria must be met. For a Distinction, all pass, all merit, and all distinction criteria must be met. Learners will need to select an appropriate organisation where they have access to suitable materials.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
1. Understand advanced problem-solving of network infrastructure	1.1 Gather information to replicate or diagnose the issue 1.2 Identify access and security criteria 1.3 Align with the correct framework		
2. Can research, plan and document a migration to integrate existing systems into the cloud	2.1 Research and document the steps required for a migration into a datacentre 2.2 Document the deployment and configuration of the clusters and applications	2M1 Report on system migration and a chosen management method	2D1 Deploy a SAN cluster system

3. Can apply security measures to cloud infrastructure and networks	3.1 Explain current security management frameworks 3.2 Conduct risk assessment 3.3 Explain cloud security principles	3M1 Make recommendations on the deployment and management of the security measures in relation to a specific scenario	3D1 Configure security around the deployed SAN cluster
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Indicative Content

1. Understand advanced problem-solving of network infrastructure

- Diagnosis tools and techniques
 - Test networks or sandbox
 - Artificial Neural Networks using multilayer perceptron (MLP) architecture
 - Adaptive fault diagnosis of data replication
 - Transfer relation network (TRN)
 - Model based fault detection
 - Spectral analysis
 - Parameter Estimation of autoregressive moving average models
 - State estimation
 - Parity equation approaches
 - Knowledge based fault detection
 - Expert systems
 - Knowledge graphs
 - Historical monitoring data
 - Data-Driven methods
 - Fischer discriminant analysis
 - Partial least squares
 - Principle component analysis
 - Independent component analysis
 - Deep learning methods
 - Automatic deep encoder/decoder
 - Deep belief network
 - Generative adversarial network
 - Capsule network
 - Graph neural network
 - Automatic fault diagnosis
- Access and security criteria
 - Access control, including biometric devices
 - Identify and access management (IAM) software
 - Forefront identify manager
 - Microsoft Azure
 - Okata identity management
 - Physical security measures
 - Telecommunication infrastructure standard for data centers (TIA-942)
- Frameworks
 - Fault tolerance mechanisms

- Data centre Infrastructure management (DCIM) software
 - Serverfarm
 - Sunbird
 - Netzoom
 - Siemens
 - Panduit
- Problem solving frameworks
 - Root cause analysis
 - Pheonix checklist
 - CIRCLES method
 - DMAIC model

2. Can research, plan and document a migration to integrate existing systems into the cloud

- Datacentre migration planning
 - Establish roles
 - Choose level of integration
 - Shallow
 - Deep
 - Single or multi-cloud
 - Create a data migration plan
 - Establish KPI's
 - Establish baselines(pre-migration)
 - Prioritise components
 - Identify service connections
- Configuration of clusters and applications
 - Size and purchase clusters
 - Cluster deployments
 - Kubernetes
 - Docker
 - Rancher
 - K9s
 - Nutanix OS
 - Configuration infrastructure
 - SUSE Linux enterprise high availability extension
 - Oracle real application cluster
 - Red Hat cluster suite
 - Ubuntu
 - VMware vSphere
 - Windows server failover clustering
 - IBM PowerHA system mirror
 - Application migration
 - Prism software
 - AWS server and application migration services
 - Cisco AppDynamics
 - Azure Migrate
- Migration monitoring and management
 - Single interface management
 - Datadog
 - SolarWinds data centre management solutions
 - AWS database migration service

- IBM lift (for IBM cloud)

3. Can apply security measures to cloud infrastructure and networks

- Security management frameworks
 - Physical security measures
 - Layered security
 - Defence in depth
 - USA
 - NIST SP 800-53
 - NIST 800-39
 - NIST 800-37
 - NIST 800-30CIS Critical Security Controls
 - RoW
 - ISO27001
 - ISO20000
 - ISAE3402
 - UK
 - National technical authority for physical and personnel protective security (NPSA) guidelines
- Risk assessment and mitigation
 - ISO9001
 - Prioritise assets
 - Pen testing
 - IT Audits
 - IT Risk assessment
 - Vulnerability Assessment
- Security principles
 - Methods of monitoring and reviewing remote access
 - Education of employees for security awareness
 - Employee screening
 - Data encryption (end to end encryption E2EE)
 - Network segmentation
 - Firewall and VPN configuration
 - Resilience for communication methods, power supply, supply chain
 - Standards:
 - EN50600
 - TIA942
 - Uptime Tiers

Suggested Resources

Davis, Cornelia, 2019, Cloud Native Patterns: Designing Change-Tolerant Software, Manning Publications

Erl, Thomas et al., 2023, Cloud Computing: Concepts, Technology, Security, and Architecture, Pearson Publishing

Ruparelia, Nayan B., 2023, Cloud Computing, revised and updated edition, MIT Press

Limoncelli, Thomas A. et al., 2014, The Practice of Cloud System Administration: Designing and Operating Large Distributed Systems, Volume 2, Addison-Wesley Professional

Websites

<https://www.npsa.gov.uk/data-centre-security>

<https://learn.microsoft.com/en-us/azure/architecture/>

<https://www.comptia.org/content/guides/cloud-network-setup-guide>

<https://www.cisco.com/c/en/us/solutions/collateral/enterprise/design-zone-security/zt-network-cloud-dg.html>

<https://docs.aws.amazon.com/whitepapers/latest/establishing-your-cloud-foundation-on-aws/network-designing-and-planning.html>

https://www.ipspace.net/Designing_a_Private_Cloud_Network_Infrastructure

Cloud Diagrams and supporting blogs:

<https://www.gliffy.com/resources/cloud-architecture-diagrams>

<https://cloud.google.com/blog/topics/developers-practitioners/10-considerations-help-you-design-cloud-networks>

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 advanced problem-solving of network infrastructure	This unit links to Unit 7 in the Data pathway, specifically U7 LO1 as the network design and configuration will potentially need to accommodate connectivity and security for data warehouses and will need to assure data transmission across the network. The Software pathway Unit 10 (client and server technologies) is linked to this outcome where transport protocols, the implementation of UDP and TCP connections and the use of SSL or TLS protocols create secure communications. Unit 12 in the Software pathway also links through the development of cloud native solutions that will be deployed on network technologies.
LO2 Can research, plan and document a migration to integrate existing systems into the cloud	
LO3 Can apply security measures to cloud infrastructure and networks	
Opportunities for Synoptic Assessment	
Unit 17 Advanced Project provides an opportunity for learners to demonstrate an understanding of the concepts of this unit when learners use the skills learned in both the core and their chosen 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 units.	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
Problem-solving – Selecting and using appropriate tools and techniques to meet a range of requirements (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 – Judging the reliability of information, problem-solving, presenting data (LO1, LO2, LO3).	Using sources of information – Accessing information, e.g. choosing different sources of information to enable developing a balanced view (LO1, LO2, LO3). Reading Skills – Identifying different sources of information (LO1, LO2, LO3). Thinking Skills – Using critical thinking skills, e.g. reading all information, identifying and interpreting 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).

Unit 17 Advanced Project			
Unit aims	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 other units making up their qualification.		
Unit level	5		
Unit code	T/651/0166		
GLH	60		
Credit value	15		
Unit grading structure	Pass, Merit and Distinction		
Assessment guidance	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. For a Merit, all pass and all merit criteria must be met. For a Distinction, all pass, all merit, and all distinction criteria must be met. The assessment will be made against the planning of the project, the use of project management tools, including the creation of a risk register, and a plan that outlines how the project should be reviewed so that valuable lessons are learned. Learners may implement their project/solution if they choose. However, the implementation of the project is not required for assessment purposes. This is the synoptic unit for the qualification and should be delivered as the final unit for learners in their qualification.		
Learning outcomes	Assessment criteria		
The learner will demonstrate that they:	The learner can:		
	Pass	Merit	Distinction
1. Understand the tools and techniques of IT project management	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 Choose appropriate stakeholder engagement channels and explain the reasons why good stakeholder management is important	1M1 Justify your choice of stakeholder engagement channels	1D1 Evaluate how stakeholder engagement should be managed

	1.3 Use project management tools to plan a project		
2. Understand risk and risk mitigation in relation to IT projects	2.1 Create a risk register 2.2 Identify the risks associated with the project		2D1 Recommend and justify mitigations to manage the risks identified in the risk register
3. Understand how and why projects are reviewed and how learning from project reviews is embedded into future practice	3.1 Plan a post-project review 3.2 Explain who should be included in the review process and why 3.3 Explain why projects are reviewed and how the outcomes of reviews are used to inform future practice	3M1 Analyse the impact that a lack of involvement and commitment by stakeholders/users will make on the project	

Indicative Content

1. Understand the tools and techniques of IT project management

- Project management tools
 - Project management software
 - Risk register
- Planning and implementing projects (managing workflow)
 - Plan project activities including timescales
 - Plan regular reviews to look at: progress, budget, stakeholder/user feedback
 - Risk register
 - Implementing the project against the plan
- Stakeholder engagement
 - Identifying key stakeholders and key relationships
 - Identifying key messages and ensuring consistency
 - Identifying appropriate communication channels for different types of stakeholders
 - Importance of good stakeholder engagement:
 - Involve stakeholders in the project
 - Manage expectations
 - Set the tone for the project
 - Ensure that stakeholders have a common understanding of the objectives of the project

2. Understand risk and risk mitigation in relation to IT projects

- Components of a risk register and how to use it (RAG rating, Red Amber Green)
- Key risks to IT projects with mitigations:
 - Costs - know your budget and review it regularly

- Potential scope creep - know the boundaries of the project and be prepared to say no
- Stakeholder/user engagement - know your stakeholders/users and plan the right level of interaction with them; plan when users will be available so that prototypes or completed features or functionality can be shared for feedback
- Data preparation - examine your data needs and any preparation work that must be completed to ensure that the data is in the right format and is available on time
- Deadlines - use software to plan and monitor activity (and make files available to teams); review activity regularly; create an environment where your team will alert you to emerging problems
- Project handover - discuss how the project will be handed over with customers and end users to ensure that their expectations are met
- Testing - ensure that test data is prepared and used, but also that the customer provides enough real data for testing purposes
- The unexpected - try to identify emerging issues quickly; have a disaster recovery plan
- Regulatory/legislative requirements - which regulatory/legislative requirements are relevant
- Ethical considerations - are there any ethical considerations (such as how data is used, how programmed systems are made secure, how the physical systems themselves are protected)

3. Understand how and why projects are reviewed and how learning from project reviews is embedded into future practice

- What to review (e.g.):
 - Each phase of the project lifecycle: feasibility study/systems analysis, design, planning, implementation, testing, handover
 - Involvement and commitment of stakeholders and users
 - Management of timescales
 - Management of costs
- Who to include in a review:
 - Internal: users, teams, departments, business owners, directors, employees, shareholders
 - External: external client or customer and their users, suppliers, the public, government, local community
- Reasons for review:
 - Examining how well project objectives were met
 - Examining any issues such as how well risks were managed
 - Enabling all stakeholders to share their perspectives on the activities and outcomes of a project
 - Identifying good practice so that this can be used in future practice
 - Identifying what went wrong to avoid this happening again
 - Identifying any training or development needs for development and project staff
- Potential impact of stakeholders/users lack of commitment to an IT project (e.g. project delays, product does not have expected functionality, stakeholder/user dissatisfaction in project outcomes, potential litigation for failing to deliver contract)

Suggested Resources

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

Hanke, Daniel, (2022), The 10 most important methods in traditional project management: Rapidly acquire the most important skills to manage your projects successfully, Self-published

Hayden, Jack, 2023, Project Management Mastery: A comprehensive guide to successfully implementing the core principles of project planning and scope management from concept to completion, Self-published

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

Websites

https://assets.publishing.service.gov.uk/media/5bc72a97ed915d0ad7db6cd0/Project_Business_Case_2018.pdf

www.capterra.com/resources/mitigate-project-management-risks/

www.asana.com/resources/project-risks

www.stakeholdermap.com/risk/register-common-project-risks.html

www.tractivity.co.uk/blog/managing-stakeholder-relationships

www.consultationmanager.com/7-tactics-to-maintain-positive-stakeholder-relationships/

<https://yourprojectmanager.com.au/managing-costs-project-manager/>

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 the tools and techniques of IT project management	To complete the project, learners will use appropriate project management tools and techniques to undertake a project in a similar way to that undertaken at Level 4. The difference with this project is that learners will need to place more emphasis on the mitigation of risk and the process of review. The project should access core learning and learning appropriate for the pathway they are studying. If learners are studying an open pathway, they should access learning from the units they have chosen to study. This does not imply that the learning must come from all units studied but should draw on content that is appropriate to solve the problem identified.
LO2 Understand risk and risk mitigation in relation to IT projects	
LO3 Understand how and why projects are reviewed and how learning from project reviews is embedded into future practice	

Opportunities for Skills Development within this unit	
Employability Skills	Study Skills
Problem Solving – Understanding the need for structured processes to ensure successful projects (LO1, LO2, LO3). 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, 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).	Using sources 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).