Oakswood College

Empowering Through Education

ATHE Level 5

Diploma in Computing

PROMOTING EXCELLENCE • ENSURING COMPLIANCE
SUPPORTING OUR COMMUNITY

GOVERNANCE | QUALITY | COMPLIANCE | EXCELLENCE

AWARDS FOR TRAINING AND HIGHER EDUCATION

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

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
	Total	*210*

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 date 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 The learner will demonstrate that they:	**Assessment criteria** 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

<table>
<tr><th colspan="2">Supporting information</th></tr>
<tr><th colspan="2">Opportunities for Synoptic Teaching and Learning</th></tr>
<tr><td colspan="2">Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.</td></tr>
<tr><th>Learning Outcome</th><th>Teaching and learning links to other unit LO/AC</th></tr>
<tr><td>LO1 Understand opportunities and drivers for digital transformation.</td><td>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.</td></tr>
<tr><td>LO2 Understand risks associated with digital transformation.</td><td rowspan="2">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.</td></tr>
<tr><td>LO3 Understand how risks associated with digital transformation are mitigated.</td></tr>
<tr><th colspan="2">Opportunities for Synoptic Assessment</th></tr>
<tr><td colspan="2">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.</td></tr>
</table>

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 The learner will demonstrate that they:	**Assessment criteria** 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 e 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 The learner will demonstrate that they:	**Assessment criteria** 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=HBMlQZeXMiA&pp=ygUac21hcnQgY2l0aWVzIG9mIHRoZSBmdXR1cmU%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 The learner will demonstrate that they:	**Assessment criteria** 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, poser 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/informationsystems2019/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

<table>
<tr><th colspan="2">Supporting information</th></tr>
<tr><th colspan="2">Opportunities for Synoptic Teaching and Learning</th></tr>
<tr><td colspan="2">Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.</td></tr>
<tr><th>Learning Outcome</th><th>Teaching and learning links to other unit LO/AC</th></tr>
<tr><td>LO1 Understand different types of information systems that are used in an organisation</td><td rowspan="3">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.

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.

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.</td></tr>
<tr><td>LO2 Understand the principal uses, advantages and disadvantages of information systems</td></tr>
<tr><td>LO3 Understand how organisations use information systems to support strategic and operational decisions</td></tr>
<tr><th colspan="2">Opportunities for Synoptic Assessment</th></tr>
<tr><td colspan="2">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.</td></tr>
</table>

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).

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 The learner will demonstrate that they:	**Assessment criteria** 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 <u>not</u> 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. **LO3** Understand the structure and function 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.
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).

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 The learner will demonstrate that they:	**Assessment criteria** 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 pythons 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/

<table>
<tr><th colspan="2">Supporting information</th></tr>
<tr><th colspan="2">Opportunities for Synoptic Teaching and Learning</th></tr>
<tr><td colspan="2">Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.</td></tr>
<tr><th>Learning Outcome</th><th>Teaching and learning links to other unit LO/AC</th></tr>
<tr><td>LO1 Understand tools and languages used for data engineering</td><td rowspan="3">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.</td></tr>
<tr><td>LO2 Understand data loading and manipulation techniques</td></tr>
<tr><td>LO3 Understand data visualisation functions</td></tr>
<tr><th colspan="2">Opportunities for Synoptic Assessment</th></tr>
<tr><td colspan="2">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.</td></tr>
</table>

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 The learner will demonstrate that they:	**Assessment criteria** 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

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-scds-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).

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 The learner will demonstrate that they:	**Assessment criteria** 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

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 **LO2** Understand ways to evaluate the performance of models **LO3** Understand and can apply popular machine learning algorithms	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.
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).

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 The learner will demonstrate that they:	**Assessment criteria** 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).

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 The learner will demonstrate that they:	**Assessment criteria** 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 connection-less 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

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 Berkely 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 Berkely 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 **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	**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**).
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).

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 The learner will demonstrate that they:	**Assessment criteria** 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/

<table>
<tr><th colspan="2">Supporting information</th></tr>
<tr><th colspan="2">Opportunities for Synoptic Teaching and Learning</th></tr>
<tr><td colspan="2">Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.</td></tr>
<tr><th>Learning Outcome</th><th>Teaching and learning links to other unit LO/AC</th></tr>
<tr><td>LO1 Understand virtualisation for local user and cloud computing environments</td><td rowspan="4">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.</td></tr>
<tr><td>LO2 Can deploy a virtualised environment in accordance with a software developer's requirements</td></tr>
<tr><td>LO3 Can quantify and qualify how virtualisation and cloud computing contribute to increased organisational efficiency and productivity</td></tr>
<tr><td>LO4 Can recognise dangers and threats to virtualised machines and cloud computing from bad actors</td></tr>
<tr><th colspan="2">Opportunities for Synoptic Assessment</th></tr>
<tr><td colspan="2">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.</td></tr>
</table>

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 The learner will demonstrate that they:	**Assessment criteria** 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).

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/

<table>
<tr><th colspan="2">Supporting information</th></tr>
<tr><th colspan="2">Opportunities for Synoptic Teaching and Learning</th></tr>
<tr><td colspan="2">Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.</td></tr>
<tr><th>Learning Outcome</th><th>Teaching and learning links to other unit LO/AC</th></tr>
<tr><td>LO1 Understand the role of ethical hacking, and the types of pen testing in the development of secure systems</td><td rowspan="3">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).</td></tr>
<tr><td>LO2 Understand a range of pen testing tools and explain their role with respect to adversarial behaviours and malware and attack technologies</td></tr>
<tr><td>LO3 Can plan, perform and report a pen test for a given scenario</td></tr>
<tr><th colspan="2">Opportunities for Synoptic Assessment</th></tr>
<tr><td colspan="2">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</td></tr>
</table>

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). 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).	**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 The learner will demonstrate that they:	**Assessment criteria** 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 The learner will demonstrate that they:	**Assessment criteria** 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		

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

<table>
<tr><th colspan="2">Supporting information</th></tr>
<tr><th colspan="2">Opportunities for Synoptic Teaching and Learning</th></tr>
<tr><td colspan="2">Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.</td></tr>
<tr><th>Learning Outcome</th><th>Teaching and learning links to other unit LO/AC</th></tr>
<tr><td>LO1 Understand the skills needed to plan and code complex network systems</td><td rowspan="3">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.</td></tr>
<tr><td>LO2 Understand the skills needed to build and test complex network systems</td></tr>
<tr><td>LO3 Can implement the deployment and subsequent monitoring of complex network infrastructure</td></tr>
<tr><th colspan="2">Opportunities for Synoptic Assessment</th></tr>
<tr><td colspan="2">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.</td></tr>
</table>

<table>
<tr><th colspan="2">Opportunities for Skills Development within this unit</th></tr>
<tr><th>Employability Skills</th><th>Study Skills</th></tr>
<tr><td>Problem-solving – Selecting and using appropriate tools and techniques to meet a range of requirements (LO1, LO2, LO3).</td><td>Using sources of information – Accessing information, e.g. choosing different sources of information to enable developing a balanced view (LO1, LO2, LO3).</td></tr>
</table>

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).

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 The learner will demonstrate that they:	**Assessment criteria** 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

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

<table>
<tr><th colspan="2">Supporting information</th></tr>
<tr><th colspan="2">Opportunities for Synoptic Teaching and Learning</th></tr>
<tr><td colspan="2">Learners and tutors will have the opportunity to link the learning from this unit with the content of other units.</td></tr>
<tr><th>Learning Outcome</th><th>Teaching and learning links to other unit LO/AC</th></tr>
<tr><td>LO1 Understand advanced problem-solving of network infrastructure</td><td rowspan="3">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 TSL 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.</td></tr>
<tr><td>LO2 Can research, plan and document a migration to integrate existing systems into the cloud</td></tr>
<tr><td>LO3 Can apply security measures to cloud infrastructure and networks</td></tr>
<tr><th colspan="2">Opportunities for Synoptic Assessment</th></tr>
<tr><td colspan="2">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.</td></tr>
</table>

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 The learner will demonstrate that they:	**Assessment criteria** 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 **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	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.

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).