Higher Nationals

Digital Technologies for England

Specification

For use with the Higher National Certificate and Higher National Diploma in Digital Technologies for England

First teaching from September 2023
First Certification from September 2024

Higher National Certificate Lvl 4

Higher National Diploma Lvl 5

Undergraduate Level Qualifications

Pearson BTEC

About Pearson

We are the world's leading learning company operating in countries all around the world. We provide content, assessment and digital services to learners, educational institutions, employers, governments and other partners globally. We are committed to helping equip learners with the skills they need to enhance their employability prospects and to succeed in the changing world of work. We believe that wherever learning flourishes so do people.

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Summary of Pearson BTEC Higher Nationals in Digital Technologies for England specification Issue 2 changes

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Updated "Digital Technologies" to "Digital Technologies for England" throughout the specification	
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6.2.1 Removed incorrect bullet point referring to a general pathway, which is not available: “Two core units and six optional units”	35
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Removed terms “black box testing”, “white box testing”, “black market” and replaced them with “functional testing”, “structural testing”, “illegal” respectively.	96, 150, 155, 277, 278, 325, 326
Unit 15: Fundamentals of Artificial Intelligence (AI) & Intelligent Systems Assessment criteria: D1 had a minor rephrase to provide more clarity on assessment.	174
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Unit 21: Emerging Technologies Assessment criteria: M4 had a minor correction to provide more clarity on assessment.	225
Unit 32: Digital Technologies as a Catalyst for Change Updates to essential content. Assessment criteria P2, P4, P5 M2 had minor rephrase, P3 and D2 updated, P5 and P6 interchanged.	303–311

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

Contents

1 Introduction

BTEC is an established brand of choice for the world's learning communities, engaging students in applied, practical, interpersonal and thinking skills for more than three decades. The BTEC suite of Pearson qualifications, Higher Nationals (HNs) are widely supported by higher education and industry as the principal vocational qualifications at Levels 4 and 5. BTEC is one of the world's most successful applied learning brands, helping students develop their practical, interpersonal and thinking skills for more than 30 years.

When developing our BTEC Higher National qualifications, we worked with a wide range of students, employers, higher education providers, colleges and subject experts to make sure the qualifications met their needs and expectations. We also work closely with professional organisations to make sure the qualifications were in line with recognised professional standards.

The Pearson BTEC Higher National qualifications are designed to reflect the increasing need for high quality professional and technical education at Levels 4 and 5. They provide students with a clear line of sight to employment and to a degree at Level 6 if they choose.

1.1 The Student Voice

Students are at the heart of what we do. That is why we consult them from the start when developing our Higher National qualifications. We involve them in writing groups, seek their feedback and take note of their opinions.

This helps us develop the best possible qualifications and learning experience for students worldwide.

1.2 Why choose Pearson BTEC Higher Nationals?

Pearson BTEC Higher National qualifications take a student-centred approach to the curriculum. There is a flexible, unit-based structure that focuses on developing the practical, interpersonal and thinking skills the student will need to succeed in employment and higher education. They represent the latest in professional standards and provide opportunities for students to develop skills and behaviours for work, for example by taking part in a group project or meeting a client brief. A student may achieve exemption from professional or vendor qualifications, or membership of selected professional organisations to help students on their journey to professional recognition or membership.

Pearson BTEC Higher Nationals are intended to keep doors open for future study if a student wishes to take their education further after completing a Higher National programme. They do this by allowing space for students to develop their higher education study skills, such as the ability to research. The study programme is clearly set out in line with the Quality Assurance Agency for Higher Education's Framework for Higher Education qualification standards at Levels 4 and 5. This means that students who want to progress to Levels 5 or 6 study should feel better prepared.

The Pearson BTEC Higher Nationals meet these requirements by providing:

- a range of general and specialist study units, both core and optional, each with a clear purpose, so there is something to suit each student's choice of programme and future progression plans
- up-to-date content, closely in line with the needs of employers, professional bodies and higher education, for a skilled future workforce
- learning outcomes mapped against professional body standards, where appropriate
- support for tutors, including Authorised Assignment Briefs, curriculum planning support and assessment guidance, and
- support for students, including digital learning resources and communities, through HN Global.

1.3 HN Global

Our HN Global website provides a specially designed range of digital resources to give tutors and students the best possible experience during their BTEC Higher Nationals course. More information is available at: https://www.highernationals.com/.

1.4 Qualification titles

Pearson BTEC Level 4 Higher National Certificate in Digital Technologies for England

Specialist pathways are in brackets within the qualification title:

- Pearson BTEC Level 4 Higher National Certificate in Digital Technologies for England (Cyber Security and Cloud Networking)
- Pearson BTEC Level 4 Higher National Certificate in Digital Technologies for England (Software Development and Programming)
- Pearson BTEC Level 4 Higher National Certificate in Digital Technologies for England (Data Analytics)
- Pearson BTEC Level 4 Higher National Certificate in Digital Technologies for England (Digital Communications Management)
- Pearson BTEC Level 4 Higher National Certificate in Digital Technologies for England (Business Analytics and Change Management)
- Pearson BTEC Level 4 Higher National Certificate in Digital Technologies for England (Artificial Intelligence (AI) Solutions and Applications).

Pearson BTEC Level 5 Higher National Diploma in Digital Technologies for England

Specialist pathways are in brackets within the qualification title:

- Pearson BTEC Level 5 Higher National Diploma in Digital Technologies for England (Cyber Security)
- Pearson BTEC Level 5 Higher National Diploma in Digital Technologies for England (Cloud Networking)
- Pearson BTEC Level 5 Higher National Diploma in Digital Technologies for England (Software Development and Programming)
- Pearson BTEC Level 5 Higher National Diploma in Digital Technologies for England (Data Analytics)
- Pearson BTEC Level 5 Higher National Diploma in Digital Technologies for England (Digital Communications Management)
- Pearson BTEC Level 5 Higher National Diploma in Digital Technologies for England (Business Analytics and Change Management).
- Pearson BTEC Level 5 Higher National Diploma in Digital Technologies for England (Artificial Intelligence (AI) Solutions and Applications).

1.5 Qualification codes

Ofqual Regulated Qualifications Framework (RQF) Qualification numbers:

Pearson BTEC Level 4 Higher National Certificate in Digital Technologies for England: **603/7868/2**

Pearson BTEC Level 5 Higher National Diploma in Digital Technologies for England: **603/7869/4**.

1.6 Awarding institution

Pearson Education Ltd.

1.7 Key features

Pearson BTEC Higher National in Digital Technologies for England qualifications offer:

- an exciting and informative study programme that stimulates and challenges students
- a simple and flexible structure that enables students to take the Higher National Certificate and then build on it in the Higher National Diploma, with units linked to their specialist area of study
- an opportunity for students to follow specialist routes of interest at Level 4 and Level 5, gaining the knowledge and skills they need to progress to higher education or employment in their specialist area
- core competencies throughout the curriculum, to support lifelong learning skills for personal and professional development
- the opportunity for centres to offer assessments that consider cognitive skills (what students know) along with effective and applied skills (how they behave and what they can do) to support a practical and dynamic approach to learning
- unit-specific assessment designed to encourage thorough and analytical learning, challenge students and develop skills in critical thinking, personal responsibility and decision making
- a flexible approach to assessment that supports progression to higher education or work and allows for different learning styles
- Quality Assurance measures that assure professional organisations, universities, businesses, colleges and students of the integrity and value of the qualifications, and
- a programme of learning designed to meet skills gaps in the current workforce and build today's talent to meet tomorrow's needs in an international environment.

Qualification frameworks

Pearson BTEC Higher National qualifications are recognised higher education qualifications in the UK. They are in line with the Framework for Higher Education Qualifications (FHEQ) in England, Wales and Northern Ireland, and Quality Assurance Agency (QAA) Subject Benchmark Statements. These qualifications are part of the UK Regulated Qualifications Framework (RQF).

1.8 Collaborative development

We are grateful to university and further education tutors, employers, professional bodies and others who have generously shared their time and expertise to help us develop these new BTEC Higher National qualifications in Digital Technologies for England. Our thanks go to:

- Activate Learning
- Aiimi Ltd.
- CCL Group, incorporating Evidence Talks
- Cranfield University
- Dell
- Drest
- Engine B
- FemaleTechpreneur
- Foreign, Commonwealth & Development Office
- KPMG International Limited
- London Metropolitan University
- McAfee
- Microsoft
- Milton Keynes College
- MKAI
- Retro Games Ltd.
- Sainsbury's
- SmartKlub
- South Central Institute of Technology
- South West Institute of Technology
- Tenable

- University of Portsmouth
- Uxbridge College
- Volkswagen Financial Services.

2 Programme purpose and objectives

2.1 Purpose of the Pearson BTEC Higher Nationals

The purpose of Pearson BTEC Higher Nationals is to develop students as independent-thinking professionals who can meet the demands of employers and adapt to a constantly changing world. The qualifications aim to widen access to higher education and improve the career prospects of those who take them.

2.2 Objectives of the Pearson BTEC Higher Nationals

The aims of the Pearson BTEC Higher Nationals in Digital Technologies for England are:

- to give students the skills, knowledge and understanding they need to achieve high performance in the national and international digital technologies environment
- to develop students with enquiring minds, who have the abilities and confidence to work across different digital technologies functions and to lead, manage, respond to change, and tackle a range of complex digital technologies
- to provide the core skills required for a range of careers in digital technologies, including cyber security, software development, data analytics, networking, animation, software testing, business analysis and change management
- to offer a balance between employability skills and the knowledge essential for students with entrepreneurial, employment or academic ambitions
- to develop students' understanding of the major impact that digital technologies have on the business environment
- to provide insight into digital technology operations and the opportunities and challenges presented by a global marketplace
- to equip students with knowledge and understanding of culturally diverse organisations, cross-cultural issues, diversity and values
- to allow flexible study to meet local and specialist needs.

2.3 Aims of the Pearson BTEC Level 4 Higher National Certificate in Digital Technologies for England

The Level 4 units lay the foundation of learning by providing a broad introduction to digital technologies and to a range of digital technology specialist functions. This develops and strengthens core skills, while preparing students to study specialist subjects at Level 5 or to enter employment with the qualities necessary for job roles that require some personal responsibility.

Students will gain a wide range of knowledge tied to practical skills gained through research, independent study, directed study and workplace scenarios. Students are involved in vocational activities that help them to develop vocational behaviours (the attitudes and approaches required for a competence) and transferable skills. Transferable skills are those such as communication, teamwork, research and analysis, which are highly valued in higher education and the workplace.

After studying a Level 4 Higher National Certificate in Digital Technologies for England students will have sound knowledge of the basic concepts of digital technology. They will be competent in a range of subject-specific skills as well as general skills and qualities relevant to key areas of digital-technology-related business.

2.4 Aims of the Pearson BTEC Level 5 Higher National Diploma in Digital Technologies for England

The Level 5 units give students the opportunity to specialise in a digital-technology-related occupational area and to progress to degree-level study. The units prepare students to move on to specific areas of digital technologies at Level 6 or to enter employment with the qualities and abilities necessary for roles that require personal responsibility and decision making.

Students will be able to develop and apply their own ideas to their studies, to deal with uncertainty and complexity, to explore solutions, demonstrate critical evaluation and use both theory and practice in a wide range of digital technology situations.

After studying a Level 5 Higher National Diploma in Digital Technologies for England students will have a sound understanding of the principles in their area of specialist study and will know how to apply those principles more widely in the area of digital technologies. They will be able to perform effectively in their specialist area.

2.5 Developing students' employability skills and academic study skills

Employability skills (sometimes referred to as transferable skills) are vital to increase students' career prospects and contribute to their personal development. Our BTEC Higher Nationals in Digital Technologies for England support students in developing the key skills, qualities and strengths that employers are looking for.

We divide employability skills into five main categories.

- **Problem-solving skills**

  These include:
  - critical thinking
  - using expert and creative solutions to solve non-routine problems
  - using systems and digital technology, and
  - generating and communicating ideas creatively.

- **Independent skills**

  These include:
  - self-management
  - adaptability and resilience
  - self-monitoring and self-development
  - self-analysis, and
  - reflection, planning and prioritising.

- **Interpersonal skills**

  These include:
  - leadership skills
  - communicating effectively
  - working with others
  - negotiating and influencing, and
  - presentation skills.

- **Commercial skills**

  These include:
  - awareness of the digital technologies sector
  - requirements and opportunities
  - digital innovation and commercialisation, and
  - managing and monitoring budgets.

- **Digital technology skills**

  These include:
  - use of digital technology
  - development, and
  - application of digital technology.

Students also benefit from opportunities for deeper learning, where they can make connections between different study units and select areas of interest for detailed study. In this way, BTEC Higher Nationals in Digital Technologies for England provide a vocational context in which students can develop the knowledge and academic study skills they need to progress to university degree courses.

These academic study skills include:

- active research
- effective writing
- analytical skills
- critical thinking
- creative problem solving
- decision making
- preparing for exams, and
- using digital technology.

Appendix 3 includes a map of transferable and academic study skills to help tutors develop students' skills. Students can also develop their academic skills through independent study modules and resources on the HN Global platform: https://hnglobal.highernationals.com/.

2.5.1 Use of maths and English within the curriculum

A career in digital technology requires technical skills and broader employability skills. For example, appropriate communication with clients and colleagues is an essential skill, so the ability to use English in a professional context is a key area for student development.

This type of development is embedded throughout the BTEC Higher Nationals, in line with industry requirements. During their course, students may, for example, be involved in:

- preparing written reports
- giving formal presentations
- taking part in informal conversations, and
- using professional, sector specific language.

Some areas of digital technology, such as software development and business analytics, also require maths skills. We strongly recommend that all students complete maths diagnostic assessments before beginning a Higher National course, as well as having a grade A* to C or 9 to 4 in GCSE Maths. (See *Entry requirements and admissions* in *Section 5.2*.)

2.6 What could these qualifications lead to?

The Level 4 Higher National Certificate provides a solid grounding, enabling students to specialise, which students can build on if they decide to continue their studies. The Level 5 Higher National Diploma allows students to specialise by committing to specific career paths and progression routes to degree-level study.

Once students have achieved the Level 4 Higher National Certificate or the Level 5 Higher National Diploma, they can develop their careers in the respective sector by:

- entering employment
- continuing existing employment
- linking with the appropriate professional body
- committing to continuing professional development, or
- going to university.

2.6.1 Progression to university

The Level 5 Higher National Diploma is recognised by higher education providers as meeting admission requirements to many relevant digital technologies courses, for example:

- BSc (Hons) in Artificial Intelligence
- BSc (Hons) in Business Analytics
- BSc (Hons) in Computer Science
- BSc (Hons) in Cyber Security
- BSc (Hons) in Data Science and Analytics
- BSc (Hons) in Network Engineering
- BA (Hons) in Social Media Management
- BSc (Hons) in Software Engineering.

University recognition and articulations

We work with a range of higher education institutions around the world that accept Pearson BTEC Higher Nationals as a qualification for entry to their undergraduate degree courses. Many universities allow advanced entry to the second or third year of the course. Agreements can include transferring learning credits from one course or qualification to the other, articulation and case-by-case admission.

Students should be aware that each university sets its own admission criteria and that those criteria can change. Before applying, students should understand the course entry requirements for the subject and year in which they want to study. For more information on *entry requirements*, including 2+1 articulations, please visit: https://www.highernationals.com/degree-finder.

3 Preparing Students for employment

3.1 Designing with employers, for employers

As a large employer and qualification-awarding organisation, Pearson understands the value of developing the skills and talent of the future workforce. We believe in, and champion, higher technical education that is relevant to employers.

We work with employers, students, professional bodies, education providers and other experts to design qualifications with the future workforce in mind. Higher National qualifications blend employability skills with academic, business and technical knowledge. They support trainees and apprentices in their higher apprenticeship and other technical education programmes, as well as students working towards a degree. We update our programmes regularly to maintain their high quality and meet the changing needs of the workforce.

Employers contribute to our Higher Nationals in several ways.

- They are involved in every stage of designing our qualifications, from developing the structure and pathways to selecting subjects, developing content and approving qualifications
- They help us deliver qualifications, for example through vendor accreditation, letters of support and co-badging. Our qualifications actively encourage training providers to work with employers. Work placements and work through learning are key features of BTEC Higher Nationals
- They help us review and update our qualifications to meet occupational standards and provide supporting material such as case studies to reflect the real world of work.

We are committed to equipping apprentices, trainees and organisations with the tools and resources they need to support high-quality, innovative technical education and Higher Apprenticeship programmes that work.

Including a Higher National qualification as part of a Higher Apprenticeship or technical education programme gives students:

- an internationally recognised higher-level qualification in line with the Framework for Higher Education Qualifications, and
- a stepping-stone to continue their education or training and gain a recognised degree or professional qualification.

To find out more, and to access detailed mapping to higher apprenticeship and occupational standards for your qualification, please visit the *'Apprenticeship'* pages on HN Global.

3.1.1 Employability skills and competencies for student career success

Pearson is committed to delivering learning that is rooted in the real world and to developing work-ready graduates with the professional skills and behaviours that employers need. The Pearson BTEC Higher National curriculum provides a clear line of sight to employment, depending on which specialist areas students complete. The aim is to produce students who are equipped to thrive in the changing world of work, whether they leave with a Higher National Certificate or a Higher National Diploma qualification.

The table below shows the type of position that a student graduating at each educational level might expect to start in, and some examples of the competencies expected.

Levels of competency			
Employability level at learning level	**Level 4** **Operational**	**Level 5** **Managerial**	**Level 6** **Professional**
General employment outcomes for graduates at each level	Graduates can: • perform key tasks • understand processes and operations, and • work effectively.	Graduates can: • respond to digital transformation.	Graduates can: • set the context for digitalisation • lead change.
Examples of roles in different areas of digital technologies	• Cyber security specialist • Software developer • Data analyst • Network technician • Junior animator • Software tester • Business analyst.	• Risk analyst • Lead developer • Data analytics consultant • Network engineer • Network engineer • Animator • Business analyst • Senior business analyst.	• Cyber security manager • Technical architect • Data specialist • Systems engineer • Systems engineer • Animation director • Programme/ project manager • Programme/ project manager.

3.1.2 Developing competencies for the workplace

Core competencies developed on the specialist pathways of the programme will support students in preparing for a range of employment opportunities in their chosen sector. These core competencies collectively summarise the key capabilities that are important across the sector, covering areas of relevant expertise and technical skills that would be required within the sector to successfully perform a job, as defined in current advertised job vacancies.

Core competencies are developed on programme within a balanced framework of cognitive (knowledge), affective (behaviours) and psychomotor (practical) learning outcomes to encourage a more vocational and practical approach to learning.

The table below shows how the core competencies developed in pathways on the Pearson BTEC Higher Nationals fit a typical job description in various sectors. The job descriptions used are based on jobs advertised at the time this document was published.

Cyber Security	
Typical job description	**Core competencies gained through the Cyber Security pathway**
Responsible for testing consumer, business and enterprise security solutions, reporting and maintaining the test results, and their consistency and accuracy.	Explore the nature of cybercrime and cyber threat actors. Investigate cyber security threats and hazards. Evaluate the effectiveness of information assurance concepts applied to ICT infrastructure. Investigate incident response methods to cyber security threats.

Software Development and Programming	
Typical job description	**Core competencies gained through the Software Development and Programming pathway**
Working in a dynamic and agile environment, you will have constant exposure to new technologies and plenty of opportunities to grow your skills and learn from others. You will be involved in the full software development lifecycle, from rapid prototyping of new ideas to testing and continuous integration. Liaising closely with the other developers, you will be part of a multi-disciplinary team, focused on delivering fantastic products and a great user experience for our customers. • Core product development • Working on internal tools to improve operational efficiency • Creating prototype applications in-line with the business product strategy and roadmap.	Describe different software development lifecycles. Explain the importance of a feasibility study. Undertake a software development lifecycle. Discuss the suitability of software behavioural design techniques.

Cloud Networking	
Typical job description	**Core competencies gained through the Cloud Networking pathway**
You will collaborate with colleagues from different areas of the business to gain a wealth of technical expertise and business knowledge. With the support and guidance of experienced colleagues, you'll be making use of your engineering mindset and will have real responsibility from the start – fixing live issues, building automated tests or even developing new features, all while making use of Agile working practices.	Examine commonplace networking principles used in a cloud infrastructure to support communication. Explain the operation of networking technologies within a cloud infrastructure. Design a networking solution for a cloud-based system for a business use case. Enhance network performance for a cloud-based system developed for a given business use case.

Digital Communications Management	
Typical job description	**Core competencies gained through the Digital Communications Management pathway**
Design and write content. Ensure content is user focused and consistently meets publishing standards. Review, edit and publish content to strict deadlines using content management systems. Work with colleagues to co-ordinate digital content production. Produce and publish content for our digital channels and evaluate the impact. Provide specialist advice to staff, on using digital communication channels effectively. Develop excellent working relationships.	Examine the key concepts and features of social media for different business activities. Discuss the uses of social media and their impact on market and audience. Plan a social media campaign for an organisation, based on client need, market and user research. Implement a social media campaign plan for an organisation to meet business objectives.

Business Analytics and Change Management	
Typical job description	**Core competencies gained through the Business Analytics and Change Management pathway**
The data analytics team operates a world-class business information platform using Tableau, Alteryx and other tools to create a set of dynamic reports used by individuals across the firm, from individual teams to senior management. In this role you will: • Use analytical skills and business acumen to source, analyse and visualise a wide range of data • Meet with a diverse range of stakeholders to scope requirements • Use a range of analytical and statistical techniques to answer questions using data • Present findings and recommendations based on your analysis.	Discuss the theoretical foundation of data analytics that determine decision-making processes in management or business environments. Apply a range of descriptive analytic techniques to convert data into actionable insight using a range of statistical techniques. Investigate a range of predictive analytic techniques to discover new knowledge for forecasting future events. Demonstrate prescriptive analytic methods for finding the best course of action for a situation.
Accountable for the end-to-end change management lifecycle, from assessing change impacts, to planning business readiness, through to ensuring change is fully embedded within the relevant business areas, across our most complex initiatives. You will work cross-functionally, partnering with key stakeholders in other functions to successfully deliver in your role.	Explore how digital technologies impacts organisational change. Evaluate how the use of digital technology impacts on an organisation's strategy and operations to meet its needs. Analyse the factors that may affect the future development of digital technologies in a specific industry and influence leadership decision making. Present a new or emerging digital technology solution to manage a change initiative within a specific organisation.

Artificial Intelligence (AI) Solutions and Applications	
Typical job description	**Core competencies gained through the Artificial Intelligence (AI), Solutions and Applications pathway**
You will apply your coding, mathematical and scientific research skills to the leading edge of security technology. We are a global, diverse and multidisciplinary team, and you'll have the chance to broaden your horizons by working jointly with a team of Big Data, Machine Learning and Security domain experts on hard and impactful problems. You will gain valuable experience in a fast-paced, high-growth environment.	Discuss the theoretical foundation of Artificial Intelligence (AI), types and areas of application. Analyse the approaches, techniques and tools to deploy Intelligent Systems. Modify an AI-based system to improve how exhibits intelligence in response to a real-world problem. Evaluate the technical and ethical challenges and opportunities of Intelligent Systems.

3.1.3 Professional body recognition and exemption

With agreement from the British Computer Society (BCS) and the Institute of Science and Technology (IST), we have secured exemptions/recognition from certain membership types for students achieving Pearson BTEC Higher Nationals in Digital Technologies for England as follows:

British Computer Society:

- Student Member whilst studying
- Associate Member on graduation
- Exemption from 2 years IT related work experience towards becoming a Professional Member on graduation (3 years work experience as opposed to the normal 5 years).

All member grades will allow access to the Specialist Groups.

Institute of Science and Technology:

Recognition of the Pearson BTEC Higher Nationals in Digital Technologies for England for professional membership of IST. There are five grades of membership with the IST. An applicant does not initially apply for a specific grade of membership, the grade offered by the Institute being dependent upon both the qualifications and the experience of the applicant.

By aligning to professional body competency standards, the content and assessment supports student development as professional practitioners for the future. This adds value for students by offering them access to continuing professional development.

In some circumstances, professional bodies will enable students to gain certification of a professional qualification on completion of their Higher National in Digital Technologies for England.

For additional professional body recognition and membership details for this qualification, please see our *Progression Hub on HN Global* where the most up to date information can be found: https://hnglobal.highernationals.com/.

3.1.4 Alignment to Occupational Standards and Higher Apprenticeships

The BTEC Higher Nationals in Digital Technologies for England have been designed to align with several of the digital Occupational Standards (OS) as defined by the Institute for Apprenticeships and Technical Education (IfATE).

The knowledge, skills and behaviours (KSBs) required to meet specific OS are embedded in both the Level 4 and Level 5 units of each specific pathway.

Therefore, a pathway must be completed in full (Level 4 and Level 5), in order to achieve full coverage of the KSBs of the OS.

The pathways are aligned to the digital OS as follows:

Level 4 Pathway	Cyber Security & Cloud Networking		Software Development & Programming	Data Analytics	Digital Communications Management	Business Analytics & Change Management	Artificial Intelligence (A)I Solutions and Applications
Level 5 Pathway	Cyber Security	Cloud Networking	Software Development & Programming	Data Analytics	Digital Communications Management	Business Analytics & Change Management	Artificial Intelligence (A)I Solutions and Applications
Occupational Standard	Cyber Security Technologist	Network Engineer	*Software Tester & Software Developer	Data Analyst	Digital Communications Management	Business Analyst	*Software Tester & Software Developer

The Software Development and Programming pathway and the AI Solutions and Applications pathway are both aligned to the Software Tester and the Software Developer occupational standards*.

3.1.5 Vendor accreditation

To see how the units in the BTEC Higher Nationals in Digital Technologies for England map against vendor certificates please visit the Digital Technologies subject page on the HN Global site for the most up-to-date mapping and alignment:

https://hnglobal.highernationals.com/.

This page on HN Global will be regularly updated to show which vendors we have aligned with, the most current mapping at unit level and how to achieve the vendor certificate.

Students will ***not*** automatically gain vendor accredited certificates as a result of studying a BTEC HNC and/or a BTEC HND. On completion of the relevant unit(s) of study, students can apply to the individual vendor to sit the appropriate exam or provide the relevant evidence to gain certification. Typically, but not always, students may need to study more than one unit to be equipped for the vendor's certification exam.

Certifications from the following vendors have been aligned to the BTEC Higher Nationals in Digital Technologies for England:

Microsoft Certifications give a professional advantage by providing globally recognised and industry-endorsed evidence of mastering skills in digital and cloud businesses. Fundamentals certifications are ideal for individuals just starting in technology or thinking about a career change.

If a unit is aligned to Microsoft certifications it is indicated in the unit introduction. Mapping details are available on *HN Global* under the subject page: https://hnglobal.highernationals.com/. For students to be in a position to achieve these certifications, the units must be delivered with Microsoft Azure technology. The certification aligned is:

- Microsoft Certified: Azure AI Fundamentals.

In addition, Microsoft Office Specialist (MOS) certifications allow demonstration of the skills needed to get the most out of Microsoft Office. There is a range of certifications available, which includes Microsoft Word, Microsoft Excel, and Microsoft PowerPoint. An MOS Certification validates expertise in Microsoft technology. Passing a first Microsoft Certification exam automatically makes the student a member of the Microsoft Certified Professional (MCP) community, with access to all of the benefits provided through the MCP.

All of the units in the BTEC Higher Nationals in Digital Technologies for England give students the opportunity to develop high-level Microsoft Office skills, thereby allowing students to be sufficiently prepared to take the MOS exams.

Further information on how to take any of the Microsoft certification exams can be found on the Microsoft learning website: https://www.microsoft.com/en-us/learning/.

Examinations may also be available through Pearson Vue: https://home.pearsonvue.com/Clients/Microsoft.aspx.

Huawei Certification provides leading talent certification standards across four key domains: telecoms networks, IT, smart devices and cloud services. Huawei offers three levels of certification: Huawei Certified ICT Associate (HCIA), Huawei Certified ICT Professional (HCIP), and Huawei Certified ICT Expert (HCIE).

The Huawei Certified ICT Associate (HCIA) offers foundational training and certification with small- and medium-sized enterprise network deployment and O&M capabilities and is the basis of progression to professional (HCIP) and expert (HCIE) status. The mapping in this qualification is at HCIA level.

For students to be in a position to achieve Huawei certification, the relevant units must incorporate the use of Huawei technologies.

Further information on how to take any of the Huawei certification exams can be found on the Huawei website: https://e.huawei.com/en/talent/portal/#/

Examinations may also be available through Pearson Vue: https://home.pearsonvue.com/Clients/Huawei.aspx.

CompTIA's vendor-neutral certifications are the starting point for a career in IT. They show employers that students have the skills to do the job, regardless of the vendor hardware or software. Earning a CompTIA certification proves that students have the right skills and is the starting place for a career in IT.

The certification aligned is:

- Network+: validates the essential knowledge and skills needed to confidently design, configure, manage and troubleshoot any wired and wireless networks

Further information on how to take any of the CompTIA certification exams can be found on the CompTIA website: https://www.comptia.org/

Examinations may also be available through Pearson Vue: http://www.pearsonvue.com/comptia/.

4 Centre support

Support for setting up your course and preparing to teach

You can access a wide range of resources and support to help you deliver our Pearson BTEC Higher Nationals with confidence. You will find a list of resources to support teaching, learning, assessment and professional development on HN Global.

4.1 This document

This specification gives you details of the administration of qualifications and information on the units included.

4.2 HN Global

HN Global is a dedicated online learning platform for all Pearson BTEC Higher National students and delivery centres. You can find various free resources to support staff delivering a Pearson BTEC Higher National programme and to guide students on their learning journey. The global forum connects students and tutors and provides the opportunity to discuss common themes and share good practice. HN Global also provides access to the following.

The learning zone includes student study materials such as core textbooks, study skills modules, a 'Progression hub' featuring opportunities to develop employability skills and an e-library and subject materials.

The tutor resources section hosts a wealth of delivery materials, reading lists, blended learning resources, video guidance on assessment, and professional development opportunities. Staff can also access the QA Hub for templates and more Centre support.

Short courses provide support for curriculum planning, developing schemes of work and developing students' academic skills.

These are available from the HN Global website at: www.highernationals.com.

4.3 Authorised Assignment Briefs

We provide a booklet of Authorised Assignment Briefs (AABs) for a sample of units. These AABs have been developed to support centres with their assessment strategy for the delivery of a sample of units, as well as, providing guidance and inspiration for effective planning and design of future assignment briefs.

They can be used in the following ways:

1 AABs ***can be used by centres if they meet your specific requirements following internal verification***. They have been written to assess students' knowledge, understanding and skills specifically relevant to the unit Learning Outcomes but, they have not been contextualised to meet local need and international diversity. ***Centres will still need to select and provide a relevant organisation.*** If using the AAB, the Assignment Brief should still be internally marked and made available for standards verification

2 AABs can be modified and customised to meet localisation.

The AABs offer a range of real and simulated assessment activities, for example group work to encourage cooperation and social skills, or a solution-focused case study to develop cognitive skills. The assessment grids for each unit explain the specific requirements for assessing these skills. All assignments must still be moderated in line with the internal verification process.

The tutor resources section on HN Global offers a wide range of resources and guidance documents to help you plan and design assessments effectively.
Please see the *Authorised Assignment Brief booklet* for more information.

4.4 Assignment checking service

This is a free service for BTEC centres to make sure that assignments enable students to produce suitable evidence across the required Learning Outcomes.

It is especially useful for programme teams who are relatively new to BTEC and who want to check that their assignments are fully meeting a unit's requirements. Please see: https://qualifications.pearson.com/en/support/Services/assignment-checking-service.html.

4.5 Pearson English

Pearson provides a full range of support for English learning, including diagnostics, qualifications and learning resources. Please see: www.pearson.com/english.

The Pearson English Portal also offers a variety of digital resources. The portal encourages users to get involved, improves teaching and results, and increases the learning experience.

5 Planning your programme

5.1 Delivering the Higher Nationals

As a large employer and qualification-awarding organisation, Pearson understands the value of developing the skills and talent of the future workforce. We believe in, and champion, higher technical education that is relevant to employers.

You play a central role in helping your students choose the right Pearson BTEC Higher National qualification.

Assess your students very carefully to make sure they take the right qualification and the right pathways and optional units. This will allow them to progress to the next stage in their learning or employment journey. You should also check the qualification structures and unit combinations carefully when giving students advice.

Make sure your students have access to a full range of information and advice to help them choose the right qualification and units. When students are recruited, you need to give them accurate information on the title and focus of the qualification they are studying for. Centres must provide a programme specification for approvals but it also essential that centres produce:

- a staff handbook to support full- and part-time members of your team, and
- a student handbook to guide students through the course requirements so they know what is expected of them and understand their rights.

You can find more information in the *BTEC Higher Nationals Centre Guide to Quality Assurance and Assessment* available on our website: https://qualifications.pearson.com/en/qualifications/btec-higher-nationals/about/quality-assurance-process.html

5.1.1 Centre approval

We need to approve all centres before they can offer our qualifications. This is to make sure that centres are ready to assess students and that we can provide the support you need.

For more information about becoming a Centre and gaining approval to run our qualifications, please visit *'UK Centre approvals for schools and colleges'* on our website: https://qualifications.pearson.com/en/forms/-uk-centre-approval-for-schools-and-colleges.html

5.1.2 Tutor knowledge

We do not set any requirements for tutors, but we do recommend that centres assess the overall skills and knowledge of the teaching team to make sure they are relevant, up to date and at the correct level.

5.1.3 Resources

As part of your Centre approval, you will need to show that the right resources and workspaces are available to deliver Pearson BTEC Higher Nationals. Some units need specific resources. This is clearly explained in the unit descriptions.

5.1.4 Delivering learning

With our approval, you can deliver our Pearson BTEC Higher Nationals using a mixture of learning options that meet your students' needs. We recommend you offer full-time, part-time, blended learning and distance learning.

If you are delivering distance learning, please see the *Pearson Distance Learning Self-Assessment Policy* at: https://qualifications.pearson.com/en/support/support-topics/understanding-our-qualifications/policies-for-centres-learners-and-employees.html.

5.1.5 Support from Pearson

For each programme with active registrations, we will provide an External Examiner (EE) to help you plan and review assessments. You will also be able to access training events and support from a dedicated team of Pearson higher national subject leads. Please see: https://qualifications.pearson.com/en/qualifications/btec-higher-nationals.html

5.2 Entry requirements and admissions

Pearson does not set formal entry requirements for our qualifications. But, as a Centre, you are responsible for making sure that the students you recruit have a reasonable chance of success on the programme.

Students who have recently been in education are likely to need:

- a BTEC Level 3 qualification in Computing, Business or Creative Digital Media Production
- a GCE Advanced Level profile that demonstrates strong performance in a relevant subject or adequate performance in more than one GCE subject. This profile is likely to be supported by GCSE grades at A* to C (or equivalent) and/or 9 to 4 (or equivalent) in subjects such as maths and English
- other related Level 3 qualifications
- an Access to Higher Education Diploma from an approved further education institution
- relevant work experience, or
- an international equivalent to the above qualifications.

Our Recognition of Prior Learning policy means that students' previous learning and experience can be taken into account, and they may be awarded certain qualifications or units of a qualification based on that learning or experience. Please see *Section 9* for more information.

5.2.1 English language requirements

Pearson's mission is to help people make more of their lives through learning. To assist centres to recruit students who have the skills to benefit from undertaking a Higher National programme of study, we are providing the following clarification regarding the English language **admission requirements** when offering places to applicants.

All centres delivering Pearson BTEC Higher National qualifications in English must ensure that each applicant can demonstrate their capability to learn and be assessed at the relevant level in English.

Students applying for a Pearson BTEC Higher National qualification that is taught and assessed completely in English will need a certain level of English language skills. Before accepting students onto a programme, you must make sure that those who are non-native English speakers and who have not carried out their final two years of schooling in English can demonstrate ability at a standard equivalent to:

- **Common European Framework of Reference (CEFR) level B2**
- **PTE Academic 51**, or
- **IELTS 5.5** (reading and writing must be at 5.5).

Students who have completed a Pearson BTEC Higher National qualification delivered partly or completely in another language but assessed in English will need to demonstrate ability in English to the standard above but at the **end** of the programme.

It is up to you to decide what proof of ability students will need to provide.

5.3 Access to study

This section focuses on the administration you will need to carry out when delivering our Pearson BTEC Higher National qualifications. It will be most relevant to quality controllers, programme leaders and examinations officers.

Our qualifications should:

- be available to everyone able to reach the required standards
- be free from any barriers that restrict access and progress, and
- provide equal opportunities for all those who want to access the qualifications.

For more information, please see our *Equality, diversity and inclusion policy* at: http://qualifications.pearson.com/

Please use your integrity when recruiting students to our Pearson BTEC Higher National programmes.

- Make sure that students applying have the information and advice they need about the qualification to be sure it meets their needs
- Check each student's qualifications and experience to make sure they have the potential to achieve the qualification
- For students with disabilities and specific needs, consider the support available to the student during teaching and assessment. For more guidance, please see *Section 5.6.2* on reasonable adjustments.

5.4 Student registration and entry

All students should be registered on the qualification they are studying, and suitable arrangements need to be made for internal and external verification. For information on making registrations, please see the information manual available in the support section of our website at: https://qualifications.pearson.com/en/support.html.

Students can be formally assessed only for a qualification on which they are registered. If a student changes the qualification they want to study for (for example if they decide to choose a different specialist pathway), you must transfer their registration to the new pathway. We cannot sample a student's work unless they are registered on the correct pathway.

5.5 Access to assessments

Assessments need to be managed carefully so that all students are treated fairly and that results and certificates are published without delay.

Our equality policy requires that:

- all students have an equal opportunity to access our qualifications and assessments, and
- our qualifications are awarded in a way that is fair to every student.

We are committed to making sure that:

- students with a protected characteristic as defined by law (for example race, sexuality or religious belief) are not disadvantaged in comparison to students who do not share that characteristic
- all students achieve the recognition they deserve for taking a qualification, and
- this achievement can be compared fairly to the achievement of their peers.

For more information on access arrangements, please visit the *Joint Council for Qualifications (JCQ)* website at: http://www.jcq.org.uk/.

5.6 Administrative arrangements for internal assessment

5.6.1 Records

You are required to retain records of assessment for each student. Records should include assessments taken, decisions reached and any adjustments or appeals. Further information on *quality and assessment* can be found in our UK and international guides available in the support section on our website: https://qualifications.pearson.com/en/support.html. We may ask to audit your records, so they must be retained as specified. All student work must be retained for **a minimum of 12 weeks** after certification has taken place.

5.6.2 Reasonable adjustments to assessment

A reasonable adjustment is one that is made before a student takes an assessment, to ensure that they have fair access to demonstrate the requirements of the assessments.

You are able to make adjustments to internal assessments to take account of the needs of individual students. In most cases, this can be achieved through a defined time extension or by adjusting the format of evidence. We can advise you if you are uncertain as to whether an adjustment is fair and reasonable. You need to plan for time to make adjustments, if necessary.

Further details on how to make adjustments for students are available on the support section of our website: https://qualifications.pearson.com/en/support/support-topics/exams/special-requirements/reasonable-adjustment.html.

5.6.3 Special consideration

Special consideration is given after an assessment has taken place for students who have been affected by adverse circumstances, such as illness, and require an adjustment of grade to reflect normal level of attainment. You must operate special consideration in line with Pearson policy (see previous paragraph). You can provide special consideration related to the period of time given for evidence to be provided, or for the format of the assessment (if it is equally valid). You may not substitute alternative forms of evidence to that required in a unit or omit the application of any assessment criteria to judge attainment. Pearson can consider applications for special consideration in line with the JCQ Guide to Special Considerations policy, which can be found on the JCQ website: https://www.jcq.org.uk/.

Please note that your Centre must have a policy for dealing with mitigating circumstances if students are affected by adverse circumstances, such as illness, which result in non-submission or late submission of assessment.

5.6.4 Appeals against assessment

Your Centre must have a policy for dealing with appeals from students. These appeals may relate to assessment decisions being incorrect or assessment not being conducted fairly. The first step in such a policy could be a consideration of the evidence by a Programme Leader or other member of the programme team. The assessment plan should allow time for potential appeals after assessment decisions have been given to students. If there is an appeal by a student, you must document the appeal and its resolution. Students have a final right of appeal to Pearson, but only if the procedures that you have put in place have been followed.

Further details of our policy on *enquiries and appeals* is available on the support section of our website: https://qualifications.pearson.com/en/support.html.

If your Centre is located in England or Wales and the student is still dissatisfied with the final outcome of their appeal, they can make a further appeal to the Office of the Independent Adjudicator (OIA) by emailing: enquiries@oiahe.org.uk. In Northern Ireland, a further appeal may be lodged with the Northern Ireland Public Service Ombudsman (NIPSO) by emailing: nipso@nipso.org.uk.

5.7 Dealing with malpractice in assessment

'Malpractice' refers to acts that undermine the integrity and validity of assessment, the certification of qualifications and/or may damage the authority of those responsible for delivering the assessment and certification.

Pearson does not tolerate actual or attempted actions of malpractice by learners, Centre staff or centres in connection with Pearson qualifications. Pearson may impose penalties and/or sanctions on learners, Centre staff or centres where malpractice or attempted malpractice has been proven.

Malpractice may occur or be suspected in relation to any unit or type of assessment within a qualification. For further details on malpractice and advice on preventing malpractice by learners, please see Pearson's *Centre guidance: Dealing with malpractice and maladministration*, available on our website.

Centres are required to take steps to prevent malpractice and to investigate instances of suspected malpractice. Learners must be given information that explains what malpractice is for internal assessment and how suspected incidents will be dealt with by the Centre. The *Centre guidance: Dealing with malpractice and maladministration* document gives full information on the actions we expect you to take.

Pearson may conduct investigations if we believe a Centre is failing to conduct internal assessment according to our policies. The above document gives further information and examples, and details the penalties and sanctions that may be imposed.

In the interests of learners and Centre staff, centres need to respond effectively and openly to all requests relating to an investigation into an incident of suspected malpractice.

5.7.1 Learner malpractice

The Heads of Centres is required to report incidents of suspected learner malpractice that occur during Pearson qualifications. We ask centres to complete JCQ Form M1 (www.jcq.org.uk/malpractice) and email it with any accompanying documents (signed statements from the learner, invigilator, copies of evidence, etc.) to the Investigations Processing team at candidatemalpractice@pearson.com. The responsibility for determining appropriate sanctions or penalties to be imposed on learners lies with Pearson.

Learners must be informed at the earliest opportunity of the specific allegation and the centre's malpractice policy, including the right of appeal. Learners found guilty of malpractice may be disqualified from the qualification for which they have been entered with Pearson.

Failure to report malpractice constitutes staff or Centre malpractice.

5.7.2 Staff/Centre malpractice

The Heads of Centres is required to inform Pearson's Investigations team of any incident of suspected malpractice (which includes maladministration) by Centre staff, before any investigation is undertaken. The Heads of Centres is requested to inform the Investigations team by submitting a JCQ M2 Form (downloadable from www.jcq.org.uk/malpractice) with supporting documentation to pqsmalpractice@pearson.com. Where Pearson receives allegations of malpractice from other sources (for example Pearson staff, anonymous informants), the Investigations team will conduct the investigation directly or may ask the Heads of Centres to assist.

Pearson reserves the right in cases of suspected malpractice to withhold the issuing of results/certificates while an investigation is in progress. Depending on the outcome of the investigation, results and/or certificates may not be released or they may be withheld.

You should be aware that Pearson may need to suspend certification when undertaking investigations, audits and quality assurances processes. You will be notified within a reasonable period of time if this occurs.

5.7.3 Sanctions and appeals

Where malpractice is proven, we may impose sanctions or penalties, such as:

- mark reduction for affected external assessments
- disqualification from the qualification
- debarment from registration for Pearson qualifications for a period of time.

If we are concerned about your centre's quality procedures, we may impose sanctions such as:

- working with centres to create an improvement action plan
- requiring staff members to receive further training
- placing temporary suspensions on certification of learners
- placing temporary suspensions on registration of learners
- debarring staff members or the Centre from delivering Pearson qualifications
- suspending or withdrawing Centre approval status.

The Centre will be notified if any of these apply.

Pearson has established procedures for centres that are considering appeals against penalties and sanctions arising from malpractice. Appeals against a decision made by Pearson will normally be accepted only from the Heads of Centres (on behalf of learners and/or members or staff) and from individual members (in respect of a decision taken against them personally). Further information on appeals can be found in the *JCQ Appeals booklet:* https://www.jcq.org.uk/exams-office/appeals.

6 Programme structure

6.1 Units, credits and total qualification time (TQT)

The Higher National Certificate (HNC) is a Level 4 qualification made up of 120 credits. It is usually studied full time over one year, or part time over two years.

The Higher National Diploma (HND) is a Level 4 and Level 5 qualification made up of 240 credits. It is usually studied full time over two years, or part time over four years.

Pearson would expect an HND student to have achieved at least 90 credits at Level 4 before progressing to Level 5 units. This allows the student to submit the remaining 30 credits at Level 4 while continuing with their Level 5 study.

If an HND student does not complete the full qualification, they may be awarded an HNC if they have gained enough credits.

Pearson BTEC Higher Nationals consist of core units, specialist units and optional units.

- Core and specialist units are mandatory
- Specialist units provide a specific occupational focus to the qualification in line with professional body standards
- Optional units provide greater depth and breadth of study and can be localised.

Each unit usually carries 15 credits. Units are designed around the amount of time it will take for a student to complete them and receive a qualification. This is known as the total qualification time (TQT). TQT includes guided learning activities, directed learning activities and assessment. Each 15-credit unit has a TQT of 150 hours – 60 guided learning hours (GLH) and 90 hours of independent learning hours (ILH). (More information about guided and independent learning is provided below.)

- The total qualification time for Higher National Certificate (HNC) = 1,200 hours
- The total qualification time for Higher National Diploma (HND) = 2,400 hours.

Examples of activities that can contribute to TQT include:

- guided learning
- independent and unsupervised research and learning
- unsupervised creation of a portfolio of work experience
- unsupervised e-learning
- unsupervised e-assessments
- unsupervised coursework
- watching a recorded podcast or webinar, and
- unsupervised work-based learning.

Guided learning hours

These are the hours where a tutor is present to give specific guidance towards the learning aim being studied. Guided learning hours include lectures, tutorials and supervised study in, for example, open learning centres and learning workshops. They also include supervised assessment activities such as invigilated exams, observed assessments and observed work-based practice.

- The total guided learning hours for Higher National Certificate (HNC) = 480 hours
- The total guided learning hours for Higher National Diploma (HND) = 960 hours.

Some examples of activities that can contribute to guided learning include:

- classroom-based learning supervised by a tutor
- work-based learning supervised by a tutor
- a live webinar or telephone tutorial with a tutor
- live e-learning supervised by a tutor, and
- all forms of assessment guided or supervised at the time by a tutor or other education or training provider. This includes where the assessment is competence-based and turned into a learning opportunity.

Independent learning hours

These are the hours where a student is learning without the direct guidance of a member of Centre staff. They are critical to the student's ability to develop knowledge and skills, as well as providing them with the opportunity to develop key transferrable skills such as self-discipline, time management and self-motivation.

Some examples of activities that can contribute to independent learning include:

- self-directed research and investigation
- reading set texts or other sources of information
- watching subject-related videos as part of investigation and research
- reviewing recordings of scheduled sessions or notes from those sessions
- peer activities, such as group meetings and online discussions, where students explore their learning together, and
- reviewing and recording thoughts on their own learning
- The total independent learning hours for Higher National Certificate (HNC) = 720 hours
- The total independent learning hours for Higher National Diploma (HND) = 1,440 hours.

6.2 Programme structures

Programme structures specify:

- the total credit value of the qualification
- the minimum credit to be achieved at the level of the qualification
- the core units required
- the specialist units required
- the optional units available, and
- the maximum credit value in units that can be Centre commissioned.

When combining units for our Pearson BTEC Higher National qualification, it is up to the Centre to make sure the correct combinations are followed.

6.2.1 Pearson BTEC Level 4 Higher National Certificate in Digital Technologies for England

- Requires at least 120 credits = eight units, each with a value of 15 credits
- Total qualification time = 1,200 hours
- Total guided learning hours = 480 hours
- All units are at Level 4.

Pearson BTEC Level 4 Higher National Certificate in Digital Technologies for England (Cyber Security & Cloud Networking)		Unit credit	Level
Core unit *Mandatory*	**Unit 1: Professional Practice in the Digital Economy**	15	4
Core unit *Mandatory*	**Unit 2: Innovation & Digital Transformation**	15	4
Specialist unit *Mandatory*	**Unit 3: Cyber Security**	15	4
Specialist unit *Mandatory*	**Unit 4: Programming**	15	4
Specialist unit *Mandatory*	**Unit 5: Big Data & Visualisation**	15	4
Specialist unit *Mandatory*	**Unit 6: Networking in the Cloud**	15	4
Specialist unit *Mandatory*	**Unit 8: Security**	15	4
Specialist unit *Mandatory*	**Unit 9: Networking**	15	4

Pearson BTEC Level 4 Higher National Certificate in Digital Technologies for England (Software Development and Programming)		Unit credit	Level
Core unit *Mandatory*	**Unit 1: Professional Practice in the Digital Economy**	15	4
Core unit *Mandatory*	**Unit 2: Innovation & Digital Transformation**	15	4
Specialist unit *Mandatory*	**Unit 3: Cyber Security**	15	4
Specialist unit *Mandatory*	**Unit 4: Programming**	15	4
Specialist unit *Mandatory*	**Unit 5: Big Data & Visualisation**	15	4
Specialist unit *Mandatory*	**Unit 6: Networking in the Cloud**	15	4
Specialist unit *Mandatory*	**Unit 10: Database Design & Development**	15	4
Specialist unit *Mandatory*	**Unit 11: Software Development Lifecycles**	15	4

Pearson BTEC Level 4 Higher National Certificate in Digital Technologies for England (Data Analytics)		Unit credit	Level
Core unit *Mandatory*	**Unit 1: Professional Practice in the Digital Economy**	15	4
Core unit *Mandatory*	**Unit 2: Innovation & Digital Transformation**	15	4
Specialist unit *Mandatory*	**Unit 3: Cyber Security**	15	4
Specialist unit *Mandatory*	**Unit 4: Programming**	15	4
Specialist unit *Mandatory*	**Unit 5: Big Data & Visualisation**	15	4
Specialist unit *Mandatory*	**Unit 6: Networking in the Cloud**	15	4
Specialist unit *Mandatory*	**Unit 10: Database Design & Development**	15	4
Specialist unit *Mandatory*	**Unit 12: Data Analytics**	15	4

Pearson BTEC Level 4 Higher National Certificate in Digital Technologies for England (Digital Communications Management)		Unit credit	Level
Core unit *Mandatory*	**Unit 1: Professional Practice in the Digital Economy**	15	4
Core unit *Mandatory*	**Unit 2: Innovation & Digital Transformation**	15	4
Specialist unit *Mandatory*	**Unit 3: Cyber Security**	15	4
Specialist unit *Mandatory*	**Unit 4: Programming**	15	4
Specialist unit *Mandatory*	**Unit 5: Big Data & Visualisation**	15	4
Specialist unit *Mandatory*	**Unit 7: Cloud Fundamentals**	15	4
Specialist unit *Mandatory*	**Unit 16: Website Design & Development**	15	4
Specialist unit *Mandatory*	**Unit 17: Management in the Digital Economy**	15	4

Pearson BTEC Level 4 Higher National Certificate in Digital Technologies for England (Business Analytics and Change Management)		Unit credit	Level
Core unit *Mandatory*	**Unit 1: Professional Practice in the Digital Economy**	15	4
Core unit *Mandatory*	**Unit 2: Innovation & Digital Transformation**	15	4
Specialist unit *Mandatory*	**Unit 3: Cyber Security**	15	4
Specialist unit *Mandatory*	**Unit 4: Programming**	15	4
Specialist unit *Mandatory*	**Unit 5: Big Data & Visualisation**	15	4
Specialist unit *Mandatory*	**Unit 7: Cloud Fundamentals**	15	4
Specialist unit *Mandatory*	**Unit 17: Management in the Digital Economy**	15	4
Specialist unit *Mandatory*	**Unit 18: Project Management**	15	4

Pearson BTEC Level 4 Higher National Certificate in Digital Technologies for England (Artificial Intelligence (AI) Solutions and Applications)		Unit credit	Level
Core unit *Mandatory*	**Unit 1: Professional Practice in the Digital Economy**	15	4
Core unit *Mandatory*	**Unit 2: Innovation & Digital Transformation**	15	4
Specialist unit *Mandatory*	**Unit 3: Cyber Security**	15	4
Specialist unit *Mandatory*	**Unit 4: Programming**	15	4
Specialist unit *Mandatory*	**Unit 5: Big Data & Visualisation**	15	4
Specialist unit *Mandatory*	**Unit 7: Cloud Fundamentals**	15	4
Specialist unit *Mandatory*	**Unit 11: Software Development Lifecycles**	15	4
Specialist unit *Mandatory*	**Unit 15: Fundamentals of Artificial Intelligence (AI) & Intelligent Systems**	15	4

6.2.2 Pearson BTEC Level 5 Higher National Diploma in Digital Technologies for England

- Requires 240 credits, of which 120 credits are at Level 5 (eight units) and 120 credits are at Level 4 (eight units)
- Total qualification time = 2,400 hours
- Total guided learning hours = 960 hours
- Mix of core, specialist and optional units totalling 240 credits
- Optional units are selected to make up the remaining credit value
- At Level 5, students may study one of the seven specialist pathways which follows on from the level 4 pathway they studied.

Pearson BTEC Level 5 Higher National Diploma in Digital Technologies for England (Cyber Security)		Unit credit	Level
Core unit *Mandatory*	**Unit 1: Professional Practice in the Digital Economy**	15	4
Core unit *Mandatory*	**Unit 2: Innovation & Digital Transformation**	15	4
Specialist unit *Mandatory*	**Unit 3: Cyber Security**	15	4
Specialist unit *Mandatory*	**Unit 4: Programming**	15	4
Specialist unit *Mandatory*	**Unit 5: Big Data & Visualisation**	15	4
Specialist unit *Mandatory*	**Unit 6: Networking in the Cloud**	15	4
Specialist unit *Mandatory*	**Unit 8: Security**	15	4
Specialist unit *Mandatory*	**Unit 9: Networking**	15	4
Level 5 units			
Core unit *Mandatory*	**Unit 19: Business Intelligence**	15	5
Core unit *Mandatory*	**Unit 20: Internet of Things**	15	5
Core unit *Mandatory*	**Unit 21: Emerging Technologies**	15	5
Specialist unit *Mandatory*	**Unit 23: Applied Security in the Cloud**	15	5
Specialist unit *Mandatory*	**Unit 24: Applied Cryptography in the Cloud**	15	5
Specialist unit *Mandatory*	**Unit 25: Information Security Management in the Cloud**	15	5
Plus 30 credits from the following Level 5 optional units.			
Optional unit	Unit 22: Work-based Learning in the Digital Economy	15	5
Optional unit	Unit 41: Digital Sustainability	15	5
Optional unit	Unit 42: Pitching and Negotiating Skills	15	5

Pearson BTEC Level 5 Higher National Diploma in Digital Technologies for England (Cloud Networking)		Unit credit	Level
Core unit *Mandatory*	**Unit 1: Professional Practice in the Digital Economy**	15	4
Core unit *Mandatory*	**Unit 2: Innovation & Digital Transformation**	15	4
Specialist unit *Mandatory*	**Unit 3: Cyber Security**	15	4
Specialist unit *Mandatory*	**Unit 4: Programming**	15	4
Specialist unit *Mandatory*	**Unit 5: Big Data & Visualisation**	15	4
Specialist unit *Mandatory*	**Unit 6: Networking in the Cloud**	15	4
Specialist unit *Mandatory*	**Unit 8: Security**	15	4
Specialist unit *Mandatory*	**Unit 9: Networking**	15	4
Level 5 units			
Core unit *Mandatory*	**Unit 19: Business Intelligence**	15	5
Core unit *Mandatory*	**Unit 20: Internet of Things**	15	5
Core unit *Mandatory*	**Unit 21: Emerging Technologies**	15	5
Specialist unit *Mandatory*	**Unit 23: Applied Security in the Cloud**	15	5
Specialist unit *Mandatory*	**Unit 31: Network Management**	15	5
Specialist unit *Mandatory*	**Unit 32: Digital Technology as a Catalyst for Change**	15	5
Plus 30 credits from the following Level 5 optional units.			
Optional unit	Unit 22: Work-based Learning in the Digital Economy	15	5
Optional unit	Unit 41: Digital Sustainability	15	5
Optional unit	Unit 42: Pitching and Negotiating Skills	15	5

Pearson BTEC Level 5 Higher National Diploma in Digital Technologies for England (Software Development and Programming)		Unit credit	Level
Core unit *Mandatory*	**Unit 1: Professional Practice in the Digital Economy**	15	4
Core unit *Mandatory*	**Unit 2: Innovation & Digital Transformation**	15	4
Specialist unit *Mandatory*	**Unit 3: Cyber Security**	15	4
Specialist unit *Mandatory*	**Unit 4: Programming**	15	4
Specialist unit *Mandatory*	**Unit 5: Big Data & Visualisation**	15	4
Specialist unit *Mandatory*	**Unit 6: Networking in the Cloud**	15	4
Specialist unit *Mandatory*	**Unit 10: Database Design & Development**	15	4
Specialist unit *Mandatory*	**Unit 11: Software Development Lifecycles**	15	4
Level 5 units			
Core unit *Mandatory*	**Unit 19: Business Intelligence**	15	5
Core unit *Mandatory*	**Unit 20: Internet of Things**	15	5
Core unit *Mandatory*	**Unit 21: Emerging Technologies**	15	5
Specialist unit *Mandatory*	**Unit 26: Data Structures & Algorithms**	15	5
Specialist unit *Mandatory*	**Unit 27: Advanced Programming**	15	5
Specialist unit *Mandatory*	**Unit 28: Risk Analysis and Systems Testing**	15	5
Plus 30 credits from the following Level 5 optional units.			
Optional unit	Unit 22: Work-based Learning in the Digital Economy	15	5
Optional unit	Unit 41: Digital Sustainability	15	5
Optional unit	Unit 42: Pitching and Negotiating Skills	15	5

Pearson BTEC Level 5 Higher National Diploma in Digital Technologies for England (Data Analytics)		Unit credit	Level
Core unit *Mandatory*	**Unit 1: Professional Practice in the Digital Economy**	15	4
Core unit *Mandatory*	**Unit 2: Innovation & Digital Transformation**	15	4
Specialist unit *Mandatory*	**Unit 3: Cyber Security**	15	4
Specialist unit *Mandatory*	**Unit 4: Programming**	15	4
Specialist unit *Mandatory*	**Unit 5: Big Data & Visualisation**	15	4
Specialist unit *Mandatory*	**Unit 6: Networking in the Cloud**	15	4
Specialist unit *Mandatory*	**Unit 10: Database Design & Development**	15	4
Specialist unit *Mandatory*	**Unit 12: Data Analytics**	15	4
Level 5 units			
Core unit *Mandatory*	**Unit 19: Business Intelligence**	15	5
Core unit *Mandatory*	**Unit 20: Internet of Things**	15	5
Core unit *Mandatory*	**Unit 21: Emerging Technologies**	15	5
Specialist unit *Mandatory*	**Unit 28: Risk Analysis & Systems Testing**	15	5
Specialist unit *Mandatory*	**Unit 29: Applied Analytical Models**	15	5
Specialist unit *Mandatory*	**Unit 30: Business Information Technology Systems**	15	5
Plus 30 credits from the following Level 5 optional units.			
Optional unit	Unit 22: Work-based Learning in the Digital Economy	15	5
Optional unit	Unit 41: Digital Sustainability	15	5
Optional unit	Unit 42: Pitching and Negotiating Skills	15	5

Pearson BTEC Level 5 Higher National Diploma in Digital Technologies for England (Digital Communications Management)		Unit credit	Level
Core unit *Mandatory*	**Unit 1: Professional Practice in the Digital Economy**	15	4
Core unit *Mandatory*	**Unit 2: Innovation & Digital Transformation**	15	4
Specialist unit *Mandatory*	**Unit 3: Cyber Security**	15	4
Specialist unit *Mandatory*	**Unit 4: Programming**	15	4
Specialist unit *Mandatory*	**Unit 5: Big Data & Visualisation**	15	4
Specialist unit *Mandatory*	**Unit 7: Cloud Fundamentals**	15	4
Specialist unit *Mandatory*	**Unit 16: Website Design & Development**	15	4
Specialist unit *Mandatory*	**Unit 17: Management in the Digital Economy**	15	4
Level 5 units			
Core unit *Mandatory*	**Unit 19: Business Intelligence**	15	5
Core unit *Mandatory*	**Unit 20: Internet of Things**	15	5
Core unit *Mandatory*	**Unit 21: Emerging Technologies**	15	5
Specialist unit *Mandatory*	**Unit 38: Planning Social Media Campaigns**	15	5
Specialist unit Mandatory	**Unit 39: Digital Marketing**	15	5
Specialist unit *Mandatory*	**Unit 40: Customer Value Management**	15	5
Plus 30 credits from the following Level 5 optional units.			
Optional unit	Unit 22: Work-based Learning in the Digital Economy	15	5
Optional unit	Unit 41: Digital Sustainability	15	5
Optional unit	Unit 42: Pitching and Negotiating Skills	15	5

Pearson BTEC Level 5 Higher National Diploma in Digital Technologies for England (Business Analytics and Change Management)		Unit credit	Level
Core unit *Mandatory*	**Unit 1: Professional Practice in the Digital Economy**	15	4
Core unit *Mandatory*	**Unit 2: Innovation & Digital Transformation**	15	4
Specialist unit *Mandatory*	**Unit 3: Cyber Security**	15	4
Specialist unit *Mandatory*	**Unit 4: Programming**	15	4
Specialist unit *Mandatory*	**Unit 5: Big Data & Visualisation**	15	4
Specialist unit *Mandatory*	**Unit 7: Cloud Fundamentals**	15	4
Specialist unit *Mandatory*	**Unit 17: Management in the Digital Economy**	15	4
Specialist unit *Mandatory*	**Unit 18: Project Management**	15	4
Level 5 units			
Core unit *Mandatory*	**Unit 19: Business Intelligence**	15	5
Core unit *Mandatory*	**Unit 20: Internet of Things**	15	5
Core unit *Mandatory*	**Unit 21: Emerging Technologies**	15	5
Specialist unit *Mandatory*	**Unit 29: Applied Analytical Models**	15	5
Specialist unit *Mandatory*	**Unit 30: Business Information Technology Systems**	15	5
Specialist unit *Mandatory*	**Unit 32: Digital Technology as a Catalyst for Change**	15	5
Plus 30 credits from the following Level 5 optional units.			
Optional unit	Unit 22: Work-based Learning in the Digital Economy	15	5
Optional unit	Unit 41: Digital Sustainability	15	5
Optional unit	Unit 42: Pitching and Negotiating Skills	15	5

Pearson BTEC Level 5 Higher National Diploma in Digital Technologies for England (Artificial Intelligence (AI) Solutions and Applications)		Unit credit	Level
Core unit *Mandatory*	**Unit 1: Professional Practice in the Digital Economy**	15	4
Core unit *Mandatory*	**Unit 2: Innovation & Digital Transformation**	15	4
Specialist unit *Mandatory*	**Unit 3: Cyber Security**	15	4
Specialist unit *Mandatory*	**Unit 4: Programming**	15	4
Specialist unit *Mandatory*	**Unit 5: Big Data & Visualisation**	15	4
Specialist unit *Mandatory*	**Unit 7: Cloud Fundamentals**	15	4
Specialist unit *Mandatory*	**Unit 11: Software Development Lifecycles**	15	4
Specialist unit *Mandatory*	**Unit 15: Fundamentals of Artificial Intelligence (AI) & Intelligent Systems**	15	4
Level 5 units			
Core unit *Mandatory*	**Unit 19: Business Intelligence**	15	5
Core unit *Mandatory*	**Unit 20: Internet of Things**	15	5
Core unit *Mandatory*	**Unit 21: Emerging Technologies**	15	5
Specialist unit *Mandatory*	**Unit 28: Risk Analysis and Systems Testing**	15	5
Specialist unit *Mandatory*	**Unit 36: Application Development**	15	5
Specialist unit *Mandatory*	**Unit 37: Application Program Interfaces**	15	5
Plus 30 credits from the following Level 5 optional units.			
Optional unit	Unit 22: Work-based Learning in the Digital Economy	15	5
Optional unit	Unit 41: Digital Sustainability	15	5
Optional unit	Unit 42: Pitching and Negotiating Skills	15	5

6.2.3 Units selected from the Pearson BTEC Higher Nationals suite

Some units in this qualification have been selected from the Pearson BTEC Higher Nationals suite of qualifications. The table below gives details of the unit numbers in this qualification and also the corresponding unit number as it appears in the alternative Pearson BTEC Higher National qualification in the suite.

Unit title	Specification unit number			
	HN in Computing	HN in Cloud Computing	HN in Creative Media Production	HN in Business (2021)
Unit 1: Professional Practice in the Digital Economy				
Unit 2: Innovation & Digital Transformation				8
Unit 3: Cyber Security				
Unit 4: Programming	1			
Unit 5: Big Data & Visualisation				
Unit 6: Networking in the Cloud		2		
Unit 7: Cloud Fundamentals		1		
Unit 8: Security	5			
Unit 9: Networking	2			
Unit 10: Database Design & Development	4			
Unit 11: Software Development Lifecycles	7			
Unit 12: Data Analytics	8			
Unit 13: Principles of Animation			30	
Unit 15: Fundamentals of Artificial Intelligence (AI) & Intelligent Systems	15			
Unit 16: Website Design & Development	13			
Unit 17: Management in the Digital Economy				
Unit 18: Project Management				
Unit 19: Business Intelligence				57
Unit 20: Internet of Things	45			
Unit 21: Emerging Technologies	47			
Unit 22: Work-based Learning in the Digital Economy				
Unit 23: Applied Security in the Cloud		17		
Unit 24: Applied Cryptography in the Cloud		18		

Unit title	Specification unit number			
	HN in Computing	HN in Cloud Computing	HN in Creative Media Production	HN in Business (2021)
Unit 25: Information Security Management in the Cloud		16		
Unit 26: Data Structures & Algorithms	19			
Unit 27: Advanced Programming				
Unit 28: Risk Analysis & Systems Testing	23			
Unit 29: Applied Analytical Models	33			
Unit 30: Business Information Technology Systems				44
Unit 31: Network Management	39			
Unit 32: Digital Technology as a Catalyst for Change				
Unit 36: Application Development	22			
Unit 37: Application Program Interfaces	21			
Unit 38: Planning Social Media Campaigns				55
Unit 39: Digital Marketing				34
Unit 40: Customer Value Management				48
Unit 41: Digital Sustainability				
Unit 42: Pitching & Negotiating Skills				37

6.3 Unit descriptor example

The unit descriptor is how we define the individual units of study that make up a Higher National qualification. Students will complete the units included in the programme you offer at your Centre.

You can use any of the unit descriptors listed in *Section 10*. We have described each part of the unit as follows.

Unit title	A general statement of what the unit will cover.
Unit code	The Ofqual unit code.
Unit type	There are three-unit types. • Core (mandatory to all pathways) • Specialist (mandatory to specific pathways) • Optional (available to most pathways).
Unit level	All our Pearson BTEC Higher National units are at Levels 4 or 5.
Credit value	The credit value relates to the total qualification time (TQT) and unit learning hours (ULH). It is easy to calculate: • 1 credit = 10 ULH, so • 15 credits = 150 ULH. To complete a Higher National Certificate or Diploma, students must achieve all of the credits required.
Introduction	Some general notes on the unit: • setting the scene • stating the purpose, and • outlining the topics and skills gained through the unit.
Learning Outcomes	These clearly explain what students will be able to do after completing the unit. There are usually four Learning Outcomes for each unit.
Essential Content	This section covers the content that students can expect to study as they work towards achieving their Learning Outcomes.

Learning Outcomes and Assessment Criteria	Tutors can refer to this table when grading assignments. The table connects the unit's Learning Outcomes with the student's work. Assignments can be graded at 'Pass' (P), 'Merit' (M) and 'Distinction' (D), depending on the quality of the student's work.
Recommended Resources	Lists the resources that students should use to support their study for the unit. Includes books, journals and online material. The programme tutor may also suggest resources, particularly on local information.

Web resources – referencing

Some units have web resources as part of their recommended resources list. Hyperlinking to these resources directly can cause problems, as their locations and addresses may change. To avoid this problem, students and tutors should reference web resources as follows.

[1] A link to the main page of the website

[2] The title of the site

[3] The section of the website where the resource can be found

[4] The type of resource it is, for example:

- research
- general reference
- tutorials
- training
- e-books
- report
- wiki
- article
- datasets
- development tool
- discussion forum.

Examples

[1] aws.amazon.com	[2] Amazon Web Services [3] AWS Training and Certification [4] (Training)
[1] ipda.org.uk/	[2] International Professional Development Association [4] (General Reference)

7 Assessment

7.1 Principles of internal assessment

This section summarises the main features of internal assessment and explains how you can offer it effectively. Full details are given in the *BTEC Higher Nationals Centre Guide to Quality Assurance and Assessment*, available in the Quality Assurance process section of our website: https://qualifications.pearson.com/en/qualifications/btec-higher-nationals/about/quality-assurance-process.html. All your assessment team will need to refer to this document.

For Pearson BTEC Higher Nationals, you must meet the expectations of stakeholders and the needs of students by providing a programme that is practical and applied. You can tailor programmes to meet local needs and should use links with local employers and the wider business sector.

Effective internal assessment is challenging, engaging, practical and up to date. It must also be fair to all students and meet national standards.

7.1.1 Assessment through assignments

For internally assessed units, assessment takes the form of an assignment carried out after the unit (or part of the unit if several assignments are used) has been delivered. An assignment may take a variety of forms, including practical and written. It is a distinct activity completed independently by students (alone or in a team). It is separate from teaching, practice, exploration and other activities that students complete with direction from tutors.

Students should receive each assignment as an Assignment Brief with a hand-out date, a completion date and clear requirements for the evidence they must provide. There may also be specific practical activities which the student must complete under tutor observation as part of the assignment. Assignments can be divided into separate parts and may require several forms of evidence. A valid assignment will enable a clear and formal assessment grade based on the assessment criteria.

7.1.2 Using unit-based criteria

You must base your assessment decisions for Pearson BTEC Higher Nationals on the specific criteria we have provided for each unit and grade level. We have based these criteria on a framework to make sure that standards are consistent in the qualification and across the whole range of qualifications. We have developed each unit to assess the student's understanding, practical skills and the vocational qualities necessary for the qualification.

The assessment criteria for a unit are based on a hierarchy. For example, if a merit criterion requires the student to show 'analysis' and the related pass criterion requires the student to 'explain', then to gain a merit the student will need to cover both 'explain' and 'analyse'. The unit assessment grid shows the relationships among the criteria so that assessors can apply all the criteria to the student's evidence at the same time.

Assessors must show how they have reached their decisions using the criteria in the assessment records. When a student has completed all the assessments for a unit, the assessment team can give a grade for the unit. This grade is based on the highest level the student is judged to have met for all the criteria.

- To achieve a Pass, a student must have met all the Pass criteria for the Learning Outcomes, demonstrating that they have covered the unit content and achieved Level 4 or 5 of the national framework
- To achieve a Merit, a student must have met all the Merit criteria (and the pass criteria) through high performance in each Learning Outcome
- To achieve a Distinction, a student must have met all the Distinction criteria (and the Pass and Merit criteria), demonstrating outstanding performance across the whole unit.

A Pass cannot be awarded just because the student has completed all the assignments. Students must meet all the Pass criteria. If they do not, their grade should be reported as 'unclassified'.

7.1.3 The assessment team

You will need an effective team for internal assessment. There are three key roles involved, each with different responsibilities. These roles are listed below.

- The **Programme Leader** is responsible for the programme, its assessment and internal monitoring to meet our requirements. They must register with us each year. They are also responsible for:
  - record keeping
  - liaising with the Standards Verifier (SV)
  - acting as an Assessor
  - supporting the rest of the assessment team
  - making sure that the team has the information it needs about our assessment requirements
  - organising training, and
  - using our guidance and support materials.
- **Internal Verifiers** oversee all assessment activity with the Programme Leader. They check that assignments and assessment decisions are valid and meet our requirements. All Internal Verifiers will follow the same standards and procedures as instructed by your Programme Leader. Internal Verifiers are usually also assessors, but they do not verify their own assessments

- **Assessors** set assignments or use assignments to assess students to national standards. Before taking any assessment decisions, they are trained by the Programme Leader to all work to the same standards and procedures. They also work with the Programme Leader and Internal Verifiers to make sure the assessment is planned and carried out in line with our requirements
- Our External Examiner will sample student work across your assessors. They will also want to see evidence of how you have verified assignments and assess your decisions.

Full information is provided in the *BTEC Higher Nationals Centre Guide to Quality Assurance and Assessment*, available in the enhanced Quality Assurance process section of our website: https://qualifications.pearson.com/en/qualifications/btec-higher-nationals/about/quality-assurance-process.html

7.1.4 Effective organisation

Internal assessment needs to be well organised so that you can track student progress and so that we can make sure your assessments are in line with national standards. It is particularly important that you manage the overall assignment programme and deadlines to make sure that all your students can complete their assignments on time.

When developing an overall plan for delivering and assessing your programme, you will need to consider:

- the order in which you deliver units
- whether delivery will take place over short or long periods of time, and
- when assessment can take place.

We support you in this through:

- assessment and feedback guidance documents available on HN Global, and
- training materials and sample templates for curriculum planning.

Please also see to the *BTEC Higher Nationals Centre Guide for Quality Assurance and Assessment*, which can be found on our website: https://qualifications.pearson.com/en/qualifications/btec-higher-nationals/about/quality-assurance-process.html

7.1.5 Preparing students

You need to make sure that your students understand their responsibilities for assessment and the centre's arrangements. From induction onwards, you will want to make sure that students are motivated to work consistently and independently to achieve their qualifications. They need to understand:

- how assignments are used
- the importance of meeting assignment submission deadlines, and
- that all the work submitted for assessment must be their own.

To support them, you should provide a guide that explains:

- how you use assignments for assessment
- how assignments relate to the teaching programme
- how to use and reference source materials, including how to avoid plagiarism, and
- your centre's approach to assessments – for example how students must submit assignments, what happens if they submit late work, and how they can request an extended deadline in special circumstances.

7.2 Making valid assessment decisions

7.2.1 Authentic student work

An Assessor must assess only student work that is authentic – in other words, the student's own independent work. Students must sign a declaration for each assessment to confirm that it is their own work. This declaration must confirm that:

- any evidence submitted for the assignment is the student's own, and
- the student understands that if this is not the case, they may face penalties for malpractice.

Assessors must make sure that evidence is authentic by setting valid assignments and supervising students during the assessment period. Assessors must also take care not to provide direct input, instructions or specific feedback that may influence the student's work and final grade.

You can use Pearson templates or your own templates to document authentication.

If your Assessor suspects that a student's evidence is not authentic, they must take action in line with our policies for malpractice. (See *Section 5.7* for more information.)

7.2.2 Making assessment decisions using criteria

Assessors must use our criteria to make assessment decisions. They can judge the evidence from a student using all the relevant criteria at the same time, but they must be satisfied that there is enough detailed evidence for each of the criterion required. For example, including a concluding section may not be enough evidence to meet the criterion requiring 'evaluation'.

Assessors should use the information and support available to help them reach their decisions. This includes:

- examples of moderated assessed work, and
- their Programme Leader and assessment team's experience.

7.2.3 Dealing with late assignments

For assessment to be fair, it is important that students are all assessed in the same way and that some students are not given an advantage by having extra time or the opportunity to learn from others. You should develop and publish your own regulations on late assignments and circumstances where you may agree to an extension.

Students must understand your policy on completing assignments by the deadlines you give them. You may agree to extend a deadline for a genuine reason such as illness in line with your Centre policies. (See also *Section 5.6 Administrative arrangements for internal assessment*).

You can apply a penalty to assignments that are submitted late. To do this, you should:

- assess the assignment normally
- apply the penalty or cap to the grade awarded
- tell the student their uncapped grade to recognise the learning they have achieved and provide genuine assessment feedback
- record both the uncapped and capped grades, and
- have both grades verified by a suitable Assessment Board, taking into account any genuine reasons for the assignment being late.

Please also see to the *BTEC Higher Nationals Centre Guide for Quality Assurance and Assessment*, which can be found on our website: https://qualifications.pearson.com/en/qualifications/btec-higher-nationals/about/quality-assurance-process.html

7.2.4 Providing assessment decisions and feedback

Once your assessment team has completed the assessment process for an assignment, they will provide a formal assessment decision. This should be recorded formally and reported to the student. The information given to the student:

- must show the formal decision and how it has been reached, including how assessment criteria have been met
- may show why they have not demonstrated achievement against assessment criteria
- must not provide feedback on how to improve evidence, and
- may provide feedback on how to improve in the future.

7.2.5 The opportunity to resubmit an assignment

If a student's assignment does not pass after the first assessment, they must have the opportunity to resubmit the assignment for reassessment.

- Students can have the assignment reassessed once only
- If coursework, project- or portfolio-based assignments need to be reassessed, this will usually involve carrying out the original activity again
- For examinations, reassessment will involve completing a new activity
- The grade for a reassessed assignment will be capped at a pass
- Assignments already graded at a pass or higher cannot be reassessed.

7.2.6 Repeat units

If a student fails to achieve a pass for a unit following reassessment, your Assessment Board may agree that they can repeat the unit. In this case:

- the student must pay the unit fee and study the unit again, with full attendance
- the grade for the unit (if successfully completed) will be capped at a pass.

Students can repeat a unit once only.

7.2.7 Assessment boards

It is a formal Pearson requirement that centres hold must have an Assessment Board for all your Pearson BTEC Higher National programmes. The main purpose of an Assessment Board is to make recommendations on:

- the grades achieved by students on the units
- extenuating circumstances
- cases of cheating and plagiarism
- students progressing to the next stage of the programme
- the awards to be made to students, and
- students resubmitting assignments and repeating units.

Assessment boards may also monitor academic standards. The main board meetings normally take place at the end of the session, but if your Centre operates on a semester system there may be meetings at the end of the first semester. There may also be separate meetings to deal with referrals.

If you do not have an Assessment Board, our external examiner will discuss this with your quality nominee and Programme Leader. Assessment Board reports and minutes provide valuable evidence of your Quality Assurance processes.

7.3 Planning and record keeping

For internal processes to be effective, your assessment team needs to be well organised and keep effective records. We will work closely with you to make sure you are meeting national standards. This process gives stakeholders confidence in your assessment approach.

Your Programme Leader must have an assessment plan, produced as a spreadsheet. This plan should include:

- the time required to train the assessment team and make sure they are working to the same standards and procedures
- the time available for teaching and carrying out assessments, including when students may complete assessments and when Quality Assurance will take place
- the completion dates for different assignments

- who is acting as Internal Verifier for each assignment and the date by which the assignment needs to be verified
- a procedure for Internal Verifiers to sample assessors' decisions that covers all assignments, assessors and a range of students
- a process to assess and verify students' work so that they receive formal decisions quickly, and
- a system for scheduling resubmissions.

The Programme Leader must also keep records of all assessments carried out. The key records are:

- checking of assignment briefs
- student declarations
- Assessor decisions on assignments, with feedback given to students, and
- confirmation of assessment decisions.

Examples of records and more information are available in the *BTEC Higher Nationals Centre Guide to Quality Assurance and Assessment*, available on the enhanced Quality Assurance process section of our website: https://qualifications.pearson.com/en/qualifications/btec-higher-nationals/about/quality-assurance-process.html.

7.4 Calculating the final qualification grade

7.4.1 Conditions for the award

Conditions for awarding our HNC

To achieve our Pearson BTEC Level 4 Higher National Certificate qualification, a student must have:

- completed units equivalent to 120 credits at Level 4, and
- achieved at least a pass in 105 credits at Level 4.

Conditions for awarding our HND

To achieve our Pearson BTEC Level 5 Higher National Diploma qualification, a student must have:

- completed units equivalent to 120 credits at Level 5
- achieved at least a pass in 105 credits at Level 5
- completed units equivalent to 120 credits at Level 4, and
- achieved at least a pass in 105 credits at Level 4.

7.4.2 Compensation

Compensation for the HNC

Students who have attempted but not achieved a pass in one of their Level 4 15-credit units can still be awarded an HNC as long as they have completed and passed the remaining units.

Compensation for the HND

Students who have attempted but not achieved a pass in one of their Level 4 15-credit units and one of their Level 5 15-credit units can still be awarded an HND as long as they have completed and passed the remaining units at both levels as per rules of combination of the required qualification.

7.4.3 Calculating the overall qualification grade

A student's overall qualification grade is based on their performance in all units. They are awarded a Pass, Merit or Distinction using the points gained through all 120 credits, at Level 4 for the HNC or Level 5 for the HND. The overall qualification grade is calculated in the same way for the HNC and the HND. For HND, the overall qualification grade is based on student performance in Level 5 units only.

Students must have attempted all units in a valid combination for each qualification. The conditions of award and compensation arrangements will apply as explained above. If a student has been granted compensation for a unit attempted but not achieved, that unit will appear as unclassified (a 'U' grade) on the notification of performance provided with their certificate.

Points per credit

Grade	Points
Pass	4
Merit	6
Distinction	8

Point boundaries

Grade	Point boundaries
Pass	420–599
Merit	600–839
Distinction	840 +

7.4.4 Modelled student outcomes

Pearson BTEC Level 4 Higher National Certificate

				STUDENT 1		STUDENT 2		STUDENT 3		STUDENT 4		STUDENT 5	
	Credits	Level	Grade point	Grade	Unit points	Grade	Unit points	Grade	Unit points	Grade	Unit points	Grade	Unit points
Core 1	15	4	4	P	60	P	60	P	60	D	120	D	120
Core 2	15	4	4	P	60	P	60	P	60	D	120	M	90
Core 3	15	4	4	P	60	P	60	P	60	D	120	M	90
Core 4	15	4	4	P	60	P	60	M	90	M	90	M	90
Core 5	15	4	6	M	90	P	60	M	90	M	90	M	90
Core 6	15	4	6	M	90	P	60	M	90	M	90	M	90
Opt 1	15	4	6	M	90	M	90	D	120	D	120	D	120
Opt 2	15	4	6	M	90	M	90	D	120	D	120	D	120
TOTAL	120				600		540		690		870		810
GRADE					M		P		M		D		M

Optional (Opt)

The table above is provided as a general example of using unit grades to calculate qualification grades. It does not reflect the specifics of this qualification.

Pearson BTEC Level 5 Higher National Diploma

				STUDENT 1		STUDENT 2		STUDENT 3		STUDENT 4		STUDENT 5	
	Credits	Level	Grade point	Grade	Unit points	Grade	Unit points	Grade	Unit points	Grade	Unit points	Grade	Unit points
Core 1	15	4	0	P	0	P	0	P	0	D	0	P	0
Core 2	15	4	0	P	0	P	0	P	0	D	0	M	0
Core 3	15	4	0	P	0	P	0	P	0	D	0	M	0
Core 4	15	4	0	P	0	P	0	M	0	M	0	M	0
Core 5	15	4	0	M	0	P	0	M	0	M	0	P	0
Core 6	15	4	0	M	0	P	0	M	0	D	0	U	0
Opt 1	15	4	0	M	0	P	0	D	0	D	0	D	0
Opt 2	15	4	0	M	0	P	0	D	0	D	0	D	0
Core 7	30	5	6	M	180	M	180	M	180	P	120	D	240
Core 8	15	5	6	M	90	M	90	M	90	P	60	D	120
Opt 3	15	5	6	M	90	M	90	D	120	P	60	D	120
Opt 4	15	5	6	M	90	P	60	D	120	P	60	D	120
Opt 5	15	5	6	M	90	P	60	D	120	M	90	M	90
Opt 6	15	5	6	M	90	P	60	M	90	M	90	P	60
Opt 7	15	5	6	M	90	P	60	M	90	M	90	M	90
TOTAL	240				720		600		810		570		840
GRADE					M		M		M		P		D

Optional (Opt)

The table above is provided as a general example of using unit grades to calculate qualification grades. It does not reflect the specifics of this qualification.

8 Quality Assurance

The Quality Assurance system for all Pearson BTEC Higher National programmes is linked to Level 4 and Level 5 of the Quality Assurance Agency (QAA) Framework for Higher Education Qualifications (FHEQ). This means that centres have effective Quality Assurance processes to review their programme delivery. It also means that assessment grades are in line with national standards.

The Quality Assurance process for centres offering our Pearson BTEC Higher National programmes has five main features.

1 The approval process

2 Monitoring internal systems

3 Independent review of assessments

4 Annual programme monitoring report

5 Annual student survey.

8.1 The approval process

If you want to deliver our programmes at your Centre, you must apply first through the existing Centre approval process and then through the programme approval process. We can consider your application by:

- carrying out a desk-based review, or
- visiting your Centre.

You will need to provide evidence that your Centre:

- has the human and physical resources needed to deliver and assess the programme effectively
- understands the rules of independent assessment and agrees to follow them
- has a strong internal assessment system supported by 'fit for purpose' assessment documentation, and
- has a system to internally verify assessment decisions so that they are consistent across all assessors and sites.

Your application must be supported by the Heads of the Centres (your principal or chief executive). It must include a declaration that you will operate the programmes strictly and in line with our requirements.

If your Centre is already approved and you want to renew approval, you may be able to use our automatic approval process.

We may withdraw qualification or Centre approval if we believe you can no longer quality assure your programme delivery or assessment standards.

8.2 Centre and qualification approval

As part of the approval process, your Centre must meet the conditions listed below before offering the qualification.

- You must have suitable physical resources (for example equipment, IT, learning materials, teaching rooms) to support delivery and assessment of the qualifications
- You must provide the specific resources required for individual units
- Staff involved in the assessment process must have relevant skills or experience
- You must have systems to provide continuing professional development for staff delivering the qualification
- You must have suitable Health and Safety policies for students and staff using equipment
- You must deliver the qualification in line with current equality legislation.

In this way, we can provide qualifications that meet the needs and expectations of students worldwide.

8.3 Monitoring internal systems

You will need to demonstrate that you continue to meet our Centre approval criteria over time and across all Higher National programmes. This involves providing evidence to our external examiners for review.

Our examiners will check that:

- your systems and the way you use them remain suitable for supporting the programmes
- you apply student registration and appeals policies consistently, and
- you have effective internal examination and standardisation processes.

In some cases, you may present evidence of your operation within a recognised code of practice such as that of the Quality Assurance Agency for Higher Education. However, we may still want to confirm independently that these arrangements are operating to our standards.

If our examiners identify problems with your internal systems, we will take steps to help you correct them.

8.4 Independent review of assessments

The External Examiner will review your internal assessments for all Pearson BTEC Higher National programmes benchmarked to Levels 4 and 5 of the Quality Assurance Agency (QAA) Framework for Higher Education Qualifications. They will either:

- confirm that your internal assessments meet national standards and allow certification
- provide actions to improve the quality of your assessments before allowing certification.

8.5 Annual programme monitoring report (APMR)

This annual review form gives you the opportunity to analyse and reflect on the most recent teaching year. It also provides us with information to help us improve the Quality Assurance of the Pearson BTEC Higher National programmes. An overview report is produced to outline the findings of the APMR each year. You can access this at HigherNationals.com at: http://monitoring-report.highernationals.com.

8.6 Annual student survey

Pearson will conduct an annual survey of Pearson BTEC Higher National students. This provides us with a snapshot of every Higher National student's experience as part of the Quality Assurance process. Each Centre with enough students taking part in the survey will get its own report about their results. You can access the report on HN Global at: http://hnglobal.highernationals.com.

8.7 Continuing Quality Assurance and standards verification

Each year we update our *BTEC Higher Nationals Centre Guide to Quality Assurance and Assessment* available in the enhanced Quality Assurance section of our website: https://qualifications.pearson.com/en/qualifications/btec-higher-nationals/about/quality-assurance-process.html. The handbook contains detailed guidance on the quality processes you should follow.

Our key principles of Quality Assurance

- A Centre delivering Pearson BTEC Higher National programmes must be approved by us and must have our approval for the programmes or groups of programmes it is delivering
- As part of gaining our approval, the Centre agrees to always follow our terms and conditions for delivering programmes effectively and assessment Quality Assurance

- We provide approved centres with a range of materials and opportunities for reviewing internal materials through our assessment-checking service. This service demonstrates the processes required for effective assessment and provides examples of effective standards. You must use these materials and services to make sure all staff delivering Pearson BTEC Higher National qualifications keep up to date with the guidance on assessment
- You must follow agreed processes for:
    - making sure assessors and verifiers all work to the same standards and procedures
    - planning, monitoring and recording assessment processes, and
    - dealing with special circumstances, appeals and malpractice.
- We will work in partnership with you to help you achieve quality-assured assessment
- We will help you follow best practice and use suitable technology to support Quality Assurance processes
- We will try to make sure our Quality Assurance processes do not create unnecessary administrative work for you
- We will monitor and support you in achieving effective assessment and Quality Assurance.

We will do this by:

- making sure that you complete a suitable declaration at the time of approval
- carrying out approval visits to your Centre
- making sure you have a well-trained, effective team of assessors and verifiers
- sampling and verifying your assessments, assessed student work and other relevant documents, and
- reviewing your strategy for assessing and quality-assuring your BTEC programmes.

As an approved Centre, you must advertise your certification only with our permission and in line with our reporting requirements.

If you do not have and maintain a strong approach to Quality Assurance, you will not be able to apply for certification for any of Pearson BTEC Higher National qualifications.

If you do not follow our recommendations for improving your Quality Assurance, we may withdraw approval for you to deliver our qualifications.

8.8 Use of Higher Technical Qualifications (HTQ) quality mark

When delivering the BTEC Higher Nationals in Digital Technologies for England, centres must take care to ensure that they use the HTQ quality mark with due care and attention
on promotional material.

The quality mark must be only used by centres in relation to an approved Higher Technical Qualification to demonstrate that the qualification has been:

- approved by the Institute for Apprenticeships and Technical Education (IfATE), and to advertise a specific course leading to a Higher Technical Qualification
- for careers advisory purposes, to explain and promote the Higher Technical Qualifications programme as a whole.

It should only be used to promote approved Higher Technical Qualifications and must not be used in a way that could reasonably be misinterpreted as a wider endorsement of any other qualifications or your centre overall.

For more information about who can use the quality mark, and how it should be used, please refer to The Higher Technical Qualification quality mark Guidelines at: https://www.gov.uk/guidance/higher-technical-education-reforms.

9 Recognition of prior learning and attainment

Recognition of prior learning (RPL) is a way of awarding credit if a student can demonstrate they meet the assessment requirements for a unit through knowledge, understanding or skills they already have. As long as the assessment requirements are met, RPL can be used to accredit a unit, units or a whole qualification.

RPL provides a route for recognising the achievements of continuous learning from a range of activities using any valid assessment procedure. We encourage you to recognise students' previous achievements and experiences at work, at home, in leisure and in the classroom. Evidence of learning must be valid and reliable.

For full guidance on RPL, please see *Recognition of prior learning policy and process* in the support section of our website: https://qualifications.pearson.com/en/support/support-topics/understanding-our-qualifications/policies-for-centres-learners-and-employees.html.

10 Equality and diversity

Equality and fairness are central to our work. The design of these qualifications embeds equality and diversity as set out in the qualification regulators' general conditions of recognition.

Promoting equality and diversity involves:

- treating everyone with equal dignity and worth, and
- raising ambitions and supporting achievement for people with different needs and backgrounds.

Creating an inclusive learning environment means anticipating students' varying needs and trying to make sure all students have equal access to educational opportunities. This involves providing access for people who have differing individual needs and removing unnecessary barriers to learning. Qualification design must be inclusive so that students with and without disabilities have equal access to learning opportunities.

Our equality policy requires that:

- all students have an equal opportunity to access our qualifications and assessments, and
- our qualifications are designed and awarded in a way that is fair to every student.

We are committed to making sure that:

- students with a protected characteristic as defined by law (for example race, sexuality. religious belief) are not disadvantaged in comparison to students who do not share that characteristic
- all students achieve the recognition they deserve for taking a qualification, and
- this achievement can be compared fairly to the achievement of their peers.

Our qualifications should:

- be available to everyone capable of reaching the required standards
- be free from any barriers that restrict access and progress, and
- offer equal opportunities for all those who want to access them.

Please see our *Equality, diversity and inclusion policy* in the support section of our website: https://qualifications.pearson.com/en/support.html.

Please use your integrity when recruiting students to our Higher National programmes.

- Make sure they have the information and advice they need about the qualification to be sure it meets their needs
- Check each student's qualifications and experience to make sure they have the potential to achieve the qualification
- For students with disabilities and specific needs, consider the support available to them and any other support they may need during teaching and assessment.

Please see our policy documents on students with particular needs.

Access to qualifications for students with disabilities or specific needs

Students can be assessed in a recognised regional sign language.

Further information on access arrangements can be found in the Joint Council for Qualifications (JCQ) document *Access Arrangements, Reasonable Adjustments and Special Consideration for General and Vocational Qualifications*. Details on how to make adjustments for students with protected characteristics are provided in the Pearson document *Guidance for reasonable adjustments* and *special consideration in vocational internally assessed units*. See the support section of our website for both documents: https://qualifications.pearson.com/en/support.html.

11 Units

Unit 1: Professional Practice in the Digital Economy

Unit code	**F/618/6250**
Unit type	**Core**
Unit level	**4**
Credit value	**15**

Introduction

The rapid pace of technological change and development is transforming the way we work. The World Economic Forum highlights that in a world of increasing automation, where smart technologies take on routine tasks there is a need for individuals who can solve complex problems, who are able to communicate well and be resilient, creative and innovative. In the workplace, these skills are needed daily to show proficiency in designated tasks. The continuation of professional development is required to ensure that individuals have a valued set of skills that can be applied to any problem-solving situation or environment.

This unit provides a foundation for good practice in a variety of contexts and provides an opportunity for students to examine the evolution and impact of digital technologies on work environments. Students will explore the importance of professional development for career success and the benefits of working towards goals for career success. In addition, problem solving extends the need to demonstrate transferable and communication skills. Finally, working with others is an integral part of everyday life and the ability to give and receive feedback is a necessary skill to support professional development planning. Therefore, understanding role responsibilities and how to work with peers and colleagues will ensure that there is a better understanding and awareness to support own professional development.

On successful completion of this unit, students will be able to explain how work and skills in the digital sector have been influenced by the Fourth Industrial Revolution, justify the use and application of transferable and communication skills for problem solving, and make recommendations on how professional development planning and feedback are used to develop skills to support own future role in the workplace. As a result, they will develop skills such as problem solving, critical thinking, analysis, reasoning, and interpretation, which are crucial for professional practice and workplace competence in a digital world.

Learning Outcomes

By the end of this unit, students will be able to:

LO1 Explore the evolution and impact of digital technologies on work environments

LO2 Examine the importance of professional development for career success

LO3 Demonstrate a range of transferable and communication skills used for effective problem solving

LO4 Review ways in which feedback can be used to support professional development planning and role in the workplace.

Essential Content

LO1 Explore the evolution and impact of digital technologies on work environments

Evolution and impact:

Power of digital technology, e.g. internet, mobile technology, social media, digital currency, diversification

Impact, e.g. evolving nature of jobs and the workplace, greater automation of repetitive tasks, personal data misuse, digital footprint, fake news.

Improvements and trends in the digital sector:

Innovation and transformation trends, e.g. digital data (big data, Internet of Things (IoT)), applications (software solutions, autonomous vehicles, intelligent processes), digital customer access (social networks, apps, mobile internet), networking (cloud computing, sensor technology, broadband), design (augmented reality, virtual reality, mobile games)

Hardware advancement and exponential progress of computing, e.g. number of transistors on integrated circuits (Moore's Law), cost of chip fabrication (Rock's Law), computational power operations/calculations per second.

Changing work environment:

Employment status, e.g. employee, self-employed, contracted

Types of contract, e.g. full-time, part-time, fixed-term, agency, freelance, zero-hours contract

Working practices, e.g. remote/virtual working, teleworking, flexi-hours, gig economy, job sharing, working in tandem with robots

Work and skills influenced by Fourth Industrial Revolution and other factors, e.g. generational perceptions; new technologies (automation, robotics, artificial intelligence); digital literacy and education; non-cognitive skills and new opportunities; employment landscape (economic structures, labour market); digital labour platforms and design thinking.

LO2 **Examine the importance of professional development for career success**

Career advice, guidance and success factors:

Sources of information, advice and guidance, e.g. National Careers Service (nationalcareers.service.gov.uk), UCAS (ucas.com), Prospects (prospects.ac.uk), Institute for Apprenticeships (instituteforapprenticeships.org), Bright Network (brightnetwork.co.uk)

Career success, e.g. growth, fulfilment, valued, recognised, health, financial stability, relationships, work/life balance, flexibility, authenticity, integrity.

Importance of ongoing professional development:

Employer benefits such as a skilled workforce, up-to-date knowledge, a competitive edge through human capital, employee engagement through development opportunities, organisational brand image.

Employee benefits such as intrinsic motivation, personal satisfaction, increased employability, added value on CVs and future employment, ownership of role, self-directed approaches gain more buy-in

Professional standards and expectations, such as personal presentation and appearance, appropriateness of appearance in specific contexts, e.g., role-appropriate dress code, projecting brand image, uniforms

Importance of projecting the brand image and understanding professional interactions are on behalf of the organisation and not person

Maintaining professional standards, such as conduct in the workplace, representation out of work

Maintaining up to date knowledge of technological developments, e.g., hardware, software, software testing, optimisation of IT processes, innovation led technological strategies.

Professional bodies:

e.g. BCS, The Chartered Institute for IT, IEEE Computer Society, Association for the Advancement of Artificial Intelligence (AAAI), The Institution of Analysts and Programmers (IAP), Institute of Analytics (IoA), UK Cyber Security Association (UKCSA), International Game Developers Association (IGDA), Institute of Data & Marketing (IDM).

Benefits of professional development:

For an individual, e.g. increase confidence, credibility, efficiency, ability to influence and lead, enable networking, achieve career goals

For an organisation, e.g. job satisfaction, collective knowledge and expertise, employee retention, future talent and pipeline, workplace engagement

Value of up-to-date knowledge of technological developments

Commitment to continuous professional development to ensure growth including psychological approaches such as neuro linguistic programming theory and practice.

LO3 **Demonstrate a range of transferable and communication skills used for effective problem solving**

Transferable skills:

Punctuality, personal effectiveness, self-motivation, working independently and collaboratively, taking responsibility, use of initiative, leadership, negotiating skills, assertiveness skills, listening and social skills, attention to detail and accuracy, critical thinking, flexibility and adaptability, showing resilience and working effectively under pressure, an interest in industry sector

Time management to include methodical, thorough and organised behaviour; prioritising workloads; setting objectives; using time effectively; making and keeping appointments; planning and scheduling tasks and activities; managing risks and costs; recording tasks details in line with requirements

Working effectively in a team including to contribute to tasks and projects e.g. software development

Maintain productive, professional and secure working environment, including in an online setting.

Communication skills:

Verbal and non-verbal, e.g. awareness and use of body language, voice tone and pace on audience; openness and responsiveness, formal and informal dialogue and feedback to a range of different stakeholders; academic and professional report writing, use of IT to enhance communication; use of source information to undertake research; contributing in meetings; presenting complex information including software solutions to technical and non-technical audiences

Consideration for inclusion and diversity, adapting communication methods to difference audiences.

Problem solving:

Effective problem solving, e.g. initiative, resourceful and responsible for solving problems, applies structured techniques, (if relevant) creative solutions and methods, ability to adapt to changing contexts within the scope of problem scenario, accurately implement solution to meet requirements

Identify issues quickly, investigate and solve complex problems and apply appropriate solutions ensuring true root cause of problem is found and a solution is identified which prevents recurrence.

LO4 **Review ways in which feedback can be used to support professional development planning and role in the workplace.**

Professional development planning:

Writing and designing development plans: SMART planning, contextualised design, appropriate formats for practical application

Cohesive personal and professional development, e.g. developing combinations of skills and competences such as hard skills, soft skills, technical skills, personal demeanour/conduct, appearance and presentation.

Proactive learning and evaluation:

Being proactive, e.g. applies logical thinking, taking ownership, requesting advice/guidance, showing initiative in developmental processes and recording learning

Employer involvement including seeking management support, appropriate notification and consent, agreed monitoring and guidance

Display curiosity and creativity in problem solving to improve performance including seeking a range of solutions and overcoming obstacles.

Feedback:

Different sources of feedback, e.g. informal, formal, peer, customer, manager

Different types of feedback and feed-forward, e.g. constructive (positive and negative), praise and criticism

Encouraging questions in both oral and written communications

Evaluate the importance of progress and seeking feedback on your work

Making suggestions, improvements and giving feedback on others' work

Respond to feedback positively, make refinements as requested

Individual vs. team performance appraisals.

Role responsibilities:

Own responsibilities, e.g. personal responsibility, direct and indirect relationships and adaptability, decision-making processes and skills, ability to learn and develop within the work role; moral code and ethical behaviour and conduct; other, e.g. employment legislation, employment rights and responsibilities

Working to meet or exceed requirements and expectations e.g. customers, clients, manager

Setting and monitoring performance objectives, measurement tools for success and achievement

Commitment to continued professional development planning to include: current performance; future needs; opportunities and threats to career progression; aims and objectives; achievement dates; review dates; learning programme/activities; action plans

Acting with integrity with respect to ethical, legal and regulatory ensuring the protection of personal data, safety and security.

Working with peers and colleagues:

Build and maintain positive relationships with a range of people in different roles, internally and externally, with a positive attitude to inclusion and diversity; team player

Ability to explain job role within the business context to stakeholders to enable a clear understanding of remit and convey technical information

Awareness of wider business environment and own contribution to objectives

Role and responsibilities as part of wider team, department, and organisation

Selecting team members, e.g. specialist roles, skill and style/approach mixes; identification of team/work group roles; work to produce products/services

Benefits of working flexibly and effectively as part of a multidisciplinary team

Factors influencing collaboration to support teams, e.g. scale and size of organisation, geographic dispersal, competing objectives and challenges.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Explore the evolution and impact of digital technologies on work environments</td><td rowspan="4">LO1 and LO2
D1 Evaluate the work environment and trends anticipated in the digital sector, making reference to professional development and career success.</td></tr>
<tr><td>P1 Investigate the evolution of digital technologies.
P2 Explain the impact of digital technologies on work environments.</td><td>M1 Analyse digital sector improvements and trends, and how they have been affected by changing work environments.</td></tr>
<tr><td colspan="2">LO2 Examine the importance of professional development for career success</td></tr>
<tr><td>P3 Examine the key benefits of ongoing professional development for different stakeholders in a specific organisation.
P4 Investigate the importance of ongoing professional development for career success.</td><td>M2 Analyse the benefits of professional development for both an individual and organisation.</td></tr>
<tr><td colspan="2">LO3 Demonstrate a range of transferable and communication skills used for effective problem solving</td><td rowspan="4">LO3 and LO4
D2 Evaluate professional development planning and how feedback can be used to improve transferable and communication skills to support own future role in the workplace.</td></tr>
<tr><td>P5 Demonstrate a range of transferable and communications skills to find a solution to a problem.</td><td>M3 Justify the use and application of transferable and communication skills to solve different problems.</td></tr>
<tr><td colspan="2">LO4 Review ways in which feedback can be used to support professional development planning and role in the workplace.</td></tr>
<tr><td>P6 Discuss the importance of feedback and its contribution to own learning.
P7 Produce a professional development plan that outlines responsibilities, performance objectives and required skills for own learning.</td><td>M4 Analyse professional development planning and different types of feedback to make judgements on how they can be used to support own future role in the workplace.</td></tr>
</table>

Recommended Resources

Textbooks

Friedman, A. L. (2012) *Continuing Professional Development: Lifelong Learning of Millions.* Routledge.

Hargie, O. (2018) *The Handbook of Communication Skills.* Taylor & Francis.

Hook, G. S. (2019) *Communication Skills Training: The Ultimate Guide for Public Speaking and Conversation, Persuasion Relationship, Workplace, Interviews.* Amazon Digital Services LLC.

Jordan, T. (2020) *The Digital Economy.* Polity Press.

Roberts, P. (2013) *The Economist Guide to Project Management*, 2nd Edition. Profile Books Ltd.

Schwab, K. (2016) *The Fourth Industrial Revolution.* World Economic Forum.

Tapscott, D. (2014) *The Digital Economy: Rethinking Promise and Peril in the Age of Networked Intelligence*, 2nd Edition. McGraw-Hill Education.

Tindara, A. et al. (2019) *Performance Appraisal in Modern Employment Relations.* Springer International Publishing.

Wentz, F. H. (2013) 10 *Things Employers Expect Their Employees to Know.* CreateSpace Independent Publishing Platform.

Winstanley, D. (2005) *Personal Effectiveness: A guide to action*. Chartered Institute of Personnel and Development.

Journals

Journal of Education and Work.

Journal of Work, Employment & Society.

Websites

ons.gov.uk	Office for National Statistics (General reference)
weforum.org	World Economic Forum (General reference)

Links

This unit links to the following related units:

Unit 19: Business Intelligence

Unit 22: Work-based Learning in the Digital Economy

Unit 42: Pitching and Negotiating Skills.

Unit 2: Innovation & Digital Transformation

Unit code	**K/618/5691**
Unit type	**Core**
Unit level	**4**
Credit value	**15**

Introduction

Many businesses manage to remain competitive by using their ability to adapt strategies and re-think their old operating models in response to fundamental changes in the market. Technology gives these organisations the opportunity to evolve and to increase their value to their customers; modern services are increasingly moving online – making digital transformation a necessity. In 2019, the global spending on digital transformation technologies and services grew around 18%. This unit aims to give students a comprehensive understanding of digital transformation.

Digital transformation constitutes the integration of digital technology into all areas of a business to maximise the Return on Investment (ROI) meaning that there will be fundamental changes to business operations and culture.

In this unit, students will look at a number of tools and techniques that organisations use to transform and become more innovative in their approach. These include frameworks and related elements such as operational agility, culture, leadership, customer experience, and integration of digital technology.

Learning Outcomes

By the end of this unit, a student will be able to:

LO1 Explain the underlying context for digital innovation and market disruption that lead to business transformation

LO2 Explain the different types of digital transformation

LO3 Discuss the requirements for a successful digital transformation

LO4 Evaluate the range of methods for protecting ideas as part of digital transformation strategies and their advantages and disadvantages.

Essential Content

LO1 **Explain the underlying context for digital innovation and market disruption that lead to business transformation**

Contexts:

The application of digital technology to existing business problems

Exponential evolution of technology

Examples of how technology makes the difference

Deconstruction of the value chain

The competitive life cycle

The economics of innovation

Why do organisations need to digitally transform?

Does your organisation need to digitally transform?

Innovation vs invention:

Definition of digital innovation and commercialisation, taking into consideration the challenges this creates for small businesses

Disruptive innovation, e.g. new market, value network, disruption of existing market and value network, displacement of established market leaders

Definition of invention and how invention is created. Turning invention into innovation and sources of digital innovation.

Appreciating benefits for companies that innovate and transform:

Competitive advantage

Streamlined business processes that come as a result of automation, SaaS, and other integrated technology solutions

Digital solutions that cut costs, improve return on investment (ROI) and boost revenue.

Managing digital innovation:

Creating a structure and culture of innovation; getting the organisation to know the difference between invention and innovation

Developing innovation vision and leadership, entrepreneurial teams and innovation networks

Developing a new technology strategy in an existing business context

Choosing to adopt and implement new software or platforms

Decision-making requirements to evolve from analogue to digital processes.

LO2 **Explain the different types of digital transformation**

Processing different types of digital transformation:

Business process transformation

Business model transformation

Domain transformation

Cultural/organisational transformation.

LO3 **Discuss the requirements for a successful digital transformation**

Factors for a successful digital transformation include:

Senior management buy-in, set clear targets, promote Agile ways of working, build capabilities, secure investment, lighthouse projects, nurture digital culture, sequence initiatives.

New operating model or framework:

Identify opportunities for growth, innovation and new sales

Employ the most effective marketing tactics for your business

Understand if and how you can take on your digital competitors

Identify capability gaps

Select or create the right technology to deliver transformation

Data-driven decision making.

Accessing funding and resources:

Why an organisation would want to access funding (e.g. product development, marketing) and the different types of funding sources available

Consideration of the resources a small business may require in commercialising their offering, e.g. office space.

Preparing a business case:

Determine the value the digital transformation project will bring to the business, e.g. revenue, employee retention, increased productivity, creative performance, brand sentiment, customer satisfaction

Plan a digital roadmap, e.g. short- and long-term actions, key milestones

Creation of a dynamic, flexible communication plan. Communicate achievement of key milestones and identification of the best medium to do this

Determine matrices to achieve return on investment (ROI)

Measurement of matrices to identify return on investment (ROI)

Identification of lessons learned and how these lessons can be adopted for future projects.

LO4 **Evaluate the range of methods for protecting ideas as part of digital transformation strategies and their advantages and disadvantages.**

Intellectual property:

The definition of intellectual property (IP)

Exploiting knowledge and intellectual property rights

Overview of key IP tools including copyrights, trademarks, design rights and patents

The role of branding in protecting the innovation and the limitations of IP in an international context

The implications of growth of open source and open innovation platforms on IP.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Explain the underlying context for digital innovation and market disruption that lead to business transformation</td><td rowspan="4">LO1 and LO2

D1 Evaluate how disruptive digital innovation is developed, embedded and measured in an organisational context.</td></tr>
<tr><td>P1 Explain digital innovation and determine its importance to organisations in comparison with digital inventions.

P2 Explain how organisational vision, leadership, culture and teamwork can exploit disruptive digital innovations.</td><td>M1 Analyse different sources of digital innovation, and how organisations can foster and develop an environment and culture of disruptive innovation.</td></tr>
<tr><td colspan="2">LO2 Explain the different types of digital transformation</td></tr>
<tr><td>P3 Explain the different types of digital transformation, with examples.</td><td>M2 Appraise the role of business strategy to apply each type of digital transformation in an organisational context.</td></tr>
<tr><td colspan="2">LO3 Discuss the requirements for a successful digital transformation</td><td rowspan="4">LO3 and LO4

D2 Evaluate the nature of digital transformation and the context in which it is developed, providing evidence-based judgements on how organisations can overcome challenges to develop successful digital transformation frameworks.</td></tr>
<tr><td>P4 Explain the requirements for a successful digital transformation process for an organisation.

P5 Build a transformation business case for an organisation, including ways to access funding.</td><td>M3 Build a detailed digital transformation business case that includes how to measure its overall effectiveness using appropriate techniques available to test, iterate and improve.</td></tr>
<tr><td colspan="2">LO4 Evaluate the range of methods for protecting ideas as part of digital transformation strategies and understand their advantages and disadvantages.</td></tr>
<tr><td>P6 Explain the different tools that organisations can use to develop, retain and protect knowledge and intellectual property.</td><td>M4 Present supported evidence-based evaluation of these different tools in the context of the wider business environment.</td></tr>
</table>

Recommended Resources

Textbooks

Bessant J. and Tidd, J. (2015) *Innovation and Entrepreneurship*. *3rd Ed.* Oxford: Wiley.

Bounfour, A. (2016). *Digital futures, digital transformation. Progress in IS*. Cham: Springer International Publishing.

Drucker, P. (2006) *Innovation and Entrepreneurship.* London: Harper Business.

Matthews, C. and Brueggemann, R. (2015) *Innovation and Entrepreneurship: A Competency Framework*. London: Routledge.

Rogers, D. L. (2016). *The digital transformation playbook: Rethink your business for the digital age*. Columbia University Press.

Trott, P. (2012) *Innovation Management and New Product Development*. Harlow: Pearson.

Ustundag, A. and Cevikcan, E. (2017). *Industry 4.0: managing the digital transformation*. Cham: Springer International Publishing.

Valikangas, L. and Gibbert, M. (2015) *Strategic Innovation: The Definitive Guide to Outlier Strategies*. London: Pearson FT Press.

Links

This unit links to the following related unit:

Unit 21: Emerging Technologies.

Unit 3: Cyber Security

Unit code	**M/618/5661**
Unit level	**4**
Credit value	**15**

Introduction

Digital technologies provide an opportunity for malicious hackers and cyberterrorists to exploit individuals, government, institutions and large organisations. Defending against cyber-attacks, including insider threats, is a priority within the digital technologies sector. Cybercrime techniques and attack vectors are fast growing, taking advantage of the speed, anonymity and convenience of the internet as a facilitator for malicious and criminal activity.

This unit has been designed to develop students' knowledge and understanding in relation to cyber threats and vulnerabilities, cyber defence techniques and incident response. Students will explore fundamental principles as well as leading-edge concepts, terminologies, models and hardening methods. Students will assess the types of malicious activity and potential targets, and the role everyone has in maintaining cyber resilience.

On successful completion of the unit, students will have explored the nature of cybercrime and cyber threat actors, looked into the roles and responsibilities in relation to information assurance, assessed the threats to, and vulnerabilities in, ICT infrastructure and investigated strategic responses to cyber security threats.

Learning Outcomes

By the end of this unit, students will be able to:

LO1 Explore the nature of cybercrime and cyber threat actors

LO2 Investigate cyber security threats and hazards

LO3 Examine the effectiveness of information assurance concepts applied to ICT infrastructure

LO4 Investigate incident response methods to cyber security threats.

Essential Content

LO1 **Explore the nature of cybercrime and cyber threat actors**

Cyber security and the importance to business and society:

Cyber security concepts and why cyber security matters to business and society

Security assurance concepts and how assurance may be achieved in practice including penetration testing and extrinsic assurance methods

Business and society reliance on technology

Why technology is a target for cybercrime including the role of human behaviour and the significance of the 'insider threat' and how attack techniques combine with motive to become a threat

Impact of cyber security on protecting business and society

Use of technology in business and society, e.g. email correspondence, financial transactions, networking, collaborative work documents, global modes/means of communication

Risks of not educating end users in security measures with regular updates to users.

Key definitions:

Cybercrime, cyber security, malicious cyber activity, hacker, malware, phishing, cyber resilience.

Cyber threat actors:

For example cyber terrorists, government-sponsored/state-sponsored actors, organised crime/cybercriminals, 'hacktivists', insiders, internal user errors.

Targets:

For example critical national infrastructure, mainframes, data centres, mobile phones, consumers, individuals, business, websites.

The categorisation of activity:

Active attacks attempt to alter system resources

Passive attacks, attempts to learn or make use of information from the system without affecting the integrity of targeted systems, e.g. wiretapping

Attacks can be initiated from inside or outside the perimeters

Digital systems as ‘target’, e.g. viruses, attacks against hardware and software, malware, ransomware, hacking, distributed denial of service attacks, e.g. malware, mail bombing, pagejacking

Digital systems as a ‘tool’, e.g. cyber-enabled crimes, crimes against children, financial crimes, e.g. fraud, identity theft, information warfare, phishing, spam, propagation of obscene or offensive content.

LO2 **Investigate cyber security threats and hazards**

Threats and hazards:

The significance of identified trends in cyber security threats and the value and risk of analysis

Types of threats and hazards to a system, service, process, e.g. cybercriminals, organised crime groups, states and state-sponsored activity, terrorists, ‘hacktivists’, script kiddies, insiders (knowing and accidental)

Threat behaviour

Missing data encryption

Global threat landscape

Individual and business fraud, extortion, trolling, racketeering, illegal sales, embezzlement, cyberstalking, cyber terrorism, industrial espionage, prostitution, gambling, suicide assistance

Denial-of-service (DoS) and distributed denial-of-service (DDoS) attacks

Man-in-the-middle (MitM) attacks

Phishing and spear phishing attacks

Drive-by attacks

Password attacks; brute-force, factionary etc

SQL injection attacks

Cross-site scripting (XSS) attacks

Eavesdropping attacks

Advanced Persistent Threats (APTs)

Hazards and sources of potential damage, harm, adverse effect, e.g. life, political, military, organisational, critical infrastructure, economy, social group, technology, environmental, legal.

Cyber threat intelligence (CTI):

Importance of threat intelligence

CTI types, including tactical, operational, strategic

Evidence-based CTI

Attribution and signs of accountability

Risk of not acting on intelligence

Acting on threat intelligence.

Emerging threats:

How to deal with emerging attack techniques (including 'zero day'), hazards and vulnerabilities relevant to the digital systems and business environment

Horizon scanning, e.g. increased dependency on technology, increased use of robots, quantum technologies, low-orbiting satellites, Internet of Things (IoT), increased threats from developing countries as computer literacy increases.

LO3 **Examine the effectiveness of information assurance concepts applied to ICT infrastructure**

Information assurance and governance concepts:

Assurance, trustworthy vs trusted, user awareness of security requirements

Achieving assurance in practice, e.g. penetration testing and contribution to assurance, extrinsic assurance methods

Definitions and Information Architecture (IA) principles, data, information and IT governance, Information Governance (IG) roles and responsibilities

Accountability, legal and regulatory applicability and requirements

Recovery, IG strategic planning and best practices, IG policy development, IG business consideration and legal functions

IG standardisation and accepted practices, IG auditing and enforcement, monitoring

Records management and inventorying, IT and data governance frameworks

IG in the cloud, social media and mobile devices, maintain an IG programme (challenges and opportunities).

ICT infrastructure:

ICT infrastructure, e.g. fundamental building blocks and typical architectures

Common vulnerabilities in networks and systems

Hardware, storage, routers/switches, application software, operating systems

Traditional, cloud or hyper converged IT infrastructure

IoT, IIoT and IoMT.

LO4 **Investigate incident response methods to cyber security threats.**

Standards:

International Organization for Standardisation (ISO), e.g. ISO/IEC 27001 Information Security Management, ISO/IEC 27002:2013

Information technology security techniques, code of practice for information security controls

Encryption standards, including AES – Advanced Encryption Standard, RSA – Rivest Shamir Adleman, 3DEA – Triple Data Encryption Algorithm, PGP – Pretty Good Privacy, common international encryption laws and policies, e.g. General Right of Encryption, Mandatory Minimum or Maximum Encryption Strength, Licensing/Regulation Requirements, Import/Export Controls, Obligations on Providers to Assist Authorities, Obligations on Individuals to Assist Authorities.

Legislation:

UK specific laws and policies, e.g. Electronic Communications Act (2000), Electronic Signatures Regulations (2002), Wassenaar Arrangement (1996), Regulation of Investigatory Powers Act (2016), International Traffic in Arms Regulations (ITAR), disclosure laws, e.g. Public Interest Disclosure Act (1998), Freedom of Information Act (2000), Data Protection Act (2018), General Data Protection Regulation (GDPR) (2016), Computer Misuse Act (1990), The Serious Crime Act (2015), Police and Justice Act (2006), Terrorism Act (2000), Human Rights Act (1998), Digital Economy Act (2017), Extradition Act (2003), Crime and Courts Act (2013) (to prevent extradition), Interception of Communication Act (1985).

Incident response methodology:

Preparation, Detection and Analysis including evidence collection and preservation for investigation, Containment, Eradication, and Recovery

Developing a containment strategy, identifying and mitigating the hosts and systems under attack, and having a plan for recovery

Post-incident activity

The principles and elements of incident management

Guidelines for incident responders and computer forensic investigations, together with legal aspects and relevant laws

Intrusion detection and response methods.

Cryptography:

Contemporary use of cryptography, e.g. data encryption in storage, in usage and in transit (disks, network), data hashing (verification of origin, passwords, look-up tables, software verification, MD5)

Future trends in cryptography, e.g. blowfish, twofish, honey encryption, quantum key distribution

Asymmetric and symmetric cryptography.

Organisations:

Organisations involved in preventing cyber security threats, e.g. National Cyber Security Centre (NCSC), police, National Crime Agency (NCA), National Cybercrime Unit (NCCU), Military Cyber Security Operations Centre (MCSOC), Regional Organised Crime Units (ROCUs).

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Explore the nature of cybercrime and cyber threat actors</td><td rowspan="5">LO1 and LO2
D1 Evaluate types of malicious cyber activity and the action that can be taken to neutralise cyber threat actors.</td></tr>
<tr><td>P1 Review types of malicious and/or criminal cyber activity.
P2 Investigate the potential targets of cybercrime.</td><td>M1 Analyse the concept of digital systems as ‘targets’ and ‘tools’ as related to cyber security, giving real-world examples.</td></tr>
<tr><td colspan="2">LO2 Investigate cyber security threats and hazards</td></tr>
<tr><td>P3 Describe security threats and hazards to a system or service or process.
P4 Investigate common attack techniques and recommend how to defend against them.</td><td>M2 Assess the role of threat intelligence when defending against common attack techniques.</td></tr>
<tr><td colspan="2">LO3 Examine the effectiveness of information assurance concepts applied to ICT infrastructure</td><td rowspan="5">LO3 and LO4
D2 Evaluate the responses that have been implemented by different organisations in response to cyber security threats.</td></tr>
<tr><td>P5 Explore how information assurance concepts can mitigate threats and vulnerabilities in ICT infrastructure, giving examples.</td><td>M3 Assess how information assurance could enhance the cyber resilience of ICT infrastructure.</td></tr>
<tr><td colspan="2">LO4 Investigate incident response methods to cyber security threats.</td></tr>
<tr><td>P6 Describe security standards, regulations and their consequences across at least two sectors.
P7 Investigate the types of response that have been implemented in response to cyber security threats.</td><td>M4 Analyse the role of criminal and other law in deterring cybercrime.</td></tr>
</table>

Recommended Resources

Textbooks

Amoroso, E. and Amoroso, M. (2017) *From CIA to APT: An Introduction to Cyber Security.* New York: Independently published.

Gillespie, A. A. (2015) *Cybercrime.* Oxon: Routledge.

Grabosky, P. (2015) *Cybercrime (Keynotes Criminology & Criminal Justice).* New York: Oxford University Press.

Stevens, T. (2015) *Cyber Security and the Politics of Time.* Cambridge: Cambridge University Press.

Sutton, D. (2017) *Cyber Security: A practitioner's guide.* Swindon: BCS, The Chartered Institute for IT.

Websites

interpol.int	Interpol crime areas, cybercrime (General reference)
nationalcrimeagency.gov.uk	National Crime Agency – crime threats, cybercrime (General reference)
ncsc.gov.uk	National Cyber Security Centre (General reference)

Links

This unit links to the following related units:

Unit 8: Security

Unit 19: Business Intelligence

Unit 23: Applied Security in the Cloud

Unit 24: Applied Cryptography in the Cloud.

Unit 4: Programming

Unit code	**H/618/7388**
Unit level	**4**
Credit value	**15**

Introduction

Programming involves describing processes and procedures that are derived from algorithms. The ability to program is what sets apart a developer from an end user. Typically, the role of the developer is to instruct a device (such as a computer) to carry out instructions; the instructions are known as source code and are written in a language that is converted into something the device can understand. The device executes the instructions it is given.

Algorithms help to describe the solution to a problem or task by identifying the data and the process needed to represent the problem or task *and* the set of steps needed to produce the desired result. Programming languages typically provide the representation of both the data and the process; they provide control constructs and data types (which can be numbers, words and objects, and be constant or variable). The control constructs are used to represent the steps of an algorithm in a convenient yet unambiguous fashion. Algorithms require constructs that can perform sequential processing, selection for decision making and iteration for repetitive control. Any programming language that provides these basic features can be used for algorithm representation.

This unit introduces students to the core concepts of programming, along with an introduction to algorithms and the characteristics of programming paradigms. Among the topics included in this unit are: introduction to algorithms, procedural, object-orientated and event-driven programming, security considerations, the integrated development environment and the debugging process.

On successful completion of this unit, students will be able to design and implement algorithms in a chosen language in a suitable Integrated Development Environment (IDE). This IDE will be used to develop and help track any issues with the code. As a result, students will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

By the end of this unit students will be able to:

LO1 Define basic algorithms to carry out an operation and outline the process of programming an application

LO2 Explain the characteristics of procedural, object-orientated and event-driven programming

LO3 Implement basic algorithms in code using an IDE

LO4 Determine the debugging process and explain the importance of a coding standard.

Essential Content

LO1 Define basic algorithms to carry out an operation and outline the process of programming an application

Algorithm definition:

Writing algorithms to carry out an operation, e.g. Bubble sort

The relationship between algorithms and code

The generation process of code; the roles of the pre-processor, compiler and linker, interpreter.

LO2 Explain the characteristics of procedural, object-orientated and event-driven programming

Characteristics of code:

Definitions of data types (the role of constants/variables), data structures, e.g. arrays, stacks, queues, methods (including input/output), control structures, iteration, scope, parameter passing, classes, inheritance and events

Key components of an IDE, with a brief explanation of each component

Use of addition of advanced text editors to view code, such as Notepad++, Atom, Sublime Text etc.

LO3 Implement basic algorithms in code using an IDE

Implementation:

Develop simple applications that implement basic algorithms, including the features of a suitable language and IDE

Create logical and maintainable codes

Consideration of security concerns and how they could be solved

Build, manage and deploy code to the relevant environment to solve the identified problems.

LO4 **Determine the debugging process and explain the importance of a coding standard.**

Review and reflection:

Documentation of the debugging process in the IDE, with reference to watch lists, breakpoints and tracing

Use of debugging the process to help developers fix vulnerabilities, defects and bugs in code

Apply structured techniques to problem solving and debugging code and consider structure of programmes to identify and resolve issues

Understand coding standards and their benefits when writing code.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Define basic algorithms to carry out an operation and outline the process of programming an application		
P1 Define an algorithm and outline the process in building an application. **P2** Determine the steps taken from writing code to execution.	**M1** Analyse the process of writing code, including the potential challenges faced.	**D1** Evaluate the implementation of an algorithm in a suitable language and the relationship between the written algorithm and the code variant.
LO2 Explain the characteristics of procedural, object-orientated and event-driven programming		
P3 Discuss what procedural, object-orientated and event-driven paradigms are; their characteristics and the relationship between them.	**M2** Compare the procedural, object-orientated and event-driven paradigms used in given source code of an application.	**D2** Critically evaluate the source code of an application that implements the procedural, object-orientated and event-driven paradigms, in terms of the code structure and characteristics.
LO3 Implement basic algorithms in code using an IDE		
P4 Write a program that implements an algorithm using an IDE.	**M3** Enhance the algorithm written, using the features of the IDE to manage the development process.	**D3** Evaluate the use of an IDE for development of applications contrasted with not using an IDE.
LO4 Determine the debugging process and explain the importance of a coding standard.		
P5 Explain the debugging process and the debugging facilities available in the IDE. **P6** Explain the coding standard you have used in your code.	**M4** Examine how the debugging process can be used to help develop more secure, robust applications.	**D4** Evaluate the role and purpose of a coding standard and why it is necessary in a team as well as for the individual.

Recommended Resources

This unit does not specify which programme language should be used to deliver the content – this decision can be made by the tutor.

Examples of languages that are used in industry are C#, Python, Ruby and Java, but any language that will allow students to achieve the Learning Outcomes is acceptable.

Textbooks

Aho, A. V. et al. (1987) *Data Structures and Algorithms*. 1st Ed. Addison-Wesley.

Hunt, A. et al. (2000) *The Pragmatic Programmer: From Journeyman to Master.* 1st Ed. Addison-Wesley.

McConnell, S. (2004) *Code Complete: A Practical Handbook of Software Construction*. 2nd Ed. Microsoft Press

Links

This unit links to the following related units:

Unit 26: Data Structures & Algorithms

Unit 27: Advanced Programming

Unit 36: Application Development.

Unit 5: Big Data & Visualisation

Unit code	**J/618/6251**
Unit level	**4**
Credit value	**15**

Introduction

Exploring and analysing big data translates information into insight. The purposeful, systematic exploitation of big data, coupled with analytics, reveals opportunities for improved decision making and better business outcomes. All this data is useful when processed but requires visualisation to bring to life. Data visualisation makes big data easier for the human brain to understand and detect patterns, trends and meaning in complicated data sets. With such rapid advancement in this area, there have been considerable challenges for data specialists to develop the skills, experience and growth required to maintain innovation in the sector. Similarly, the public and private sectors have struggled to keep up with progress, meaning that the introduction of legislation and community norms have been retrospective and, at times, reactive. As data continues to be the fuel for the digital economy, this area remains a constant topic of conversation for organisations and governments, and the public who share an interest in its growing commercial use, manipulation and presentation.

This unit introduces students to the concepts of big data and visualisation and how this is used for decision making. Students will explore the industry software solutions available for investigating and presenting data, before assessing the role and responsibility of data specialists in the current environment. Students will examine topics including data-driven decision making, manipulating data and automation, and building ethics into a data-driven culture. Students will demonstrate their use of tools and software to manipulate and prepare a visual presentation for a given data set. They will also assess how data specialists are responsible for adhering to legislation and ensuring data compliance.

On successful completion of this unit, students will be able to investigate the value of data for decision making to both end-users and organisations; compare how different industry leading tools and software solutions are used to analyse and visualise data; carry out queries to summarise and group a given data set, and analyse the challenges faced when building ethics into a data-driven culture. Students will have the opportunity to progress to a range of roles in the digital sector and will develop industry-led skills, analysis, and interpretation, which are crucial for developing practical experiences with big data and for gaining employment.

Learning Outcomes

By the end of this unit, students will be able to:

LO1 Examine big data and visualisation for decision making

LO2 Investigate statistical and graphical techniques, tools and industry software solutions for big data and visualisation

LO3 Demonstrate the use of industry software to manipulate data and prepare visual presentations for a given data set

LO4 Assess the role, responsibilities and challenges for data specialists.

Essential Content

LO1 **Examine big data and visualisation for decision making**

Big data:

The value of data to an organisation, and how data needs are considered in business improvement including principles of data, including open and public data, administrative data, and research data

Explore common fundamental concepts, e.g. Doug Laney's Three Vs of Big Data (volume, velocity and variety), an extension of Vs (variability, veracity, visualisation and value)

Big data lifecycle to include purpose, capturing data, searching and filtering, retrieving data for processing, validation and cleansing, visualisation, analysis and querying, utilisation and storage, obsolete and deleted data

Organisation-led big data strategies such as data lake vs data warehouse

Principal approaches to defining customer requirements for data analysis.

Visualisation:

Understanding the target audience needs, e.g. principles of user experience, domain context, reporting, dissemination, accessibility, breadth of data, depth of analysis and using this to plan outputs

Phases of data visualisation design process to include: formulating the brief, working with data, establishing editorial thinking and developing design solution

Applying principles of good design to data visualisation, e.g. Dieter Rams' Ten Principles for Good Design, Gestalt principles of visual perception, use of storytelling for presenting data

Effective visual elements, e.g. charts, graphs, plots, tables, points, lines, bars, area, maps, narratives, and aesthetics, e.g. position, size, shape, colour and transparency.

Data for decision making:

Process of data-driven decision making (DDDM) and steps to include: define an objective, establish a hypothesis, identify data need, build data process, sampling methods, collect data, analyse data, interpret results and make a decision

Advantages of data-driven decision-making, e.g. continuous improvement and planning, collaborative decisions, reduce costs, real-time insights and new opportunities, digital literacy and data-driven cultures and challenges, e.g. inconsistent and unstandardised data, aligning decision making with business strategy, bias and discrimination, descriptive vs predictive trends and probabilities.

LO2 **Investigate statistical and graphical techniques, tools and industry software solutions for big data and visualisation**

Statistical and graphical techniques for big data analysis and visualisation:

Popular big data techniques and analysis to include: business intelligence, cluster analysis, data mining, A/B testing, textual analysis, sentiment analysis, predictive, optimisation and prescriptive modelling

Understanding and organising semi-structured and unstructured data variety, e.g. word-cloud visuals to display frequency, data catalogue, taxonomies and ontologies

Forecasting estimates of future values, e.g. applied forecasting and decision tree algorithms.

Industry leading tools and software solutions to analyse data:

e.g. SQL, MySQL, Node XL, Oracle Analytics, Qlik Analytics Platform, Google Fusion Tables, Open Refine, Python, R Programming, Apache Spark/Hadoop, SAS Sentiment Analysis, Microsoft Azure, AWS, MATLAB.

Industry-leading tools and software solutions to visualise data:

e.g. Microsoft Excel, Power BI and Azure, AWS, Oracle Visual Analyzer, Qlikview, Google Chart, Canvas, Tableau, SAS Visual Analytics.

LO3 **Demonstrate the use of industry software to manipulate data and prepare visual presentations for a given data set**

Software and tools:

Select and apply the most appropriate software or data tools to achieve the best outcome.

Manipulating data:

General activities when using industry software to manipulate data to include: importing datasets, data cleansing, data frame manipulation, testing and training a model, summarising analysis process and steps taken

Query basics, e.g. prepare reports using commands including unions and subqueries, calculate aggregate statistics during a query, create queries against multiple data sources by using join commands, transform the output format of queries using built-in functions, perform queries across a group of rows using windowing functions, summarising and grouping data

Explore advanced data manipulation and automation concepts, e.g. generalised linear models and regression, multilevel modelling and techniques, data pipelines, machine learning, 4-bit deep learning and deep reinforcement learning (DRL).

Prepare visual presentations:

General activities when using industry software to prepare visual presentations to include: selecting a visual element and aesthetic design, use insight analysis to understand data in context, find and filter content in dashboards, view and export data from dashboards to create a report, presentation and/or infographic

Big data visualisation, e.g. onemilliontweetmap.com, the internet in real time (betfy.co.uk/internet-realtime), earth wind map (earth.nullschool.net), and data breaches (informationisbeautiful.net).

Data set requirements:

The data and its topic/context; summary of data collection, sampling procedures and data type; stakeholder requirements, interests and needs.

LO4 **Assess the role, responsibilities and challenges for data specialists.**

Roles and responsibilities:

Roles in a data-driven industry, e.g. data analyst, data scientist, data engineer, visualisation specialist, data administrator, business analyst, middle managers and senior management teams

Responsibilities of a data specialist to include preparing, analysing, modelling, managing and visualising data, storage and access rights e.g. a chief data specialist will be expected to establish and enforce data policies and standards

Identify and escalate quality risks in data analysis with suggested mitigation and resolutions as appropriate, including challenges to combining data from different sources.

Strategies to ensure data compliance:

The importance of managing information and data in line with legislation and organisational policies

Organisational data architecture, policies, standards and rules, e.g. how data is stored, managed, used and disseminated

Data protection, informed consent and privacy issues for compliance to include: personally identifiable information, protected health information, General Data Protection Regulation (GDPR) rights and obligations, enforcement and regulatory legal penalties

Consider Privacy by Design principles to conform to organisational and legislative requirements

Choice of industry-leading compliance management software and tools, e.g. Microsoft Compliance Manager, Amazon Web Services (AWS) Compliance, IBM DataOps.

Challenges for data specialists:

Identifying suitable data sources and the challenges of combining data in an analysis activity

Data governance framework to ensure the value of outcomes, accountability, trust, collaboration, transparency, risks and security, and role of the data steward

Maintain a productive, professional and secure work environment that guards against poor practice, e.g. cherry picking, disclosure of assumptions, conflict of interest, bias from a single view and/or choice of technique

Building ethics into a data-driven culture and joining community of good practice, e.g. Data for Good Exchange (D4GX); Fairness, Accountability and Transparency in Machine Learning group (FAT/ML), Data Ethics Framework (gov.uk).

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Examine big data and visualisation for decision making</td><td rowspan="2">D1 Evaluate the potential impact of data on both users and organisations when using data for decision making.</td></tr>
<tr><td>P1 Explain the fundamental concepts of big data.
P2 Investigate the value of data for decision making to both end users and organisations.</td><td>M1 Analyse the advantages and challenges of data-driven decision making to an organisation.</td></tr>
<tr><td colspan="2">LO2 Investigate statistical and graphical techniques, tools and industry software solutions for big data and visualisation</td><td rowspan="5">LO2 and LO3
D2 Evaluate own data preparation and manipulation, justifying your choice of statistical techniques, to show how this meets the needs of stakeholders for a given data set.</td></tr>
<tr><td>P3 Describe statistical and graphical techniques for big data and visualisation used in industry.
P4 Review different industry-leading tools and software solutions available for analysing and visualising data.</td><td>M2 Compare how different industry-leading tools and software solutions are used to analyse and visualise data, with examples.</td></tr>
<tr><td colspan="2">LO3 Demonstrate the use of industry software to manipulate data and prepare visual presentations for a given data set</td></tr>
<tr><td>P5 Select an industry-leading tool and software solution to manipulate data for a given data set.
P6 Demonstrate the use of queries to summarise and group data for a given data set.</td><td>M3 Prepare a visual presentation to summarise data for a given data set.</td></tr>
<tr><td colspan="2">LO4 Assess the role, responsibilities and challenges for data specialists.</td></tr>
<tr><td>P7 Explain the different roles, responsibilities and challenges faced by data specialists.</td><td>M4 Review the different strategies used by data specialists to ensure data compliance.</td><td>D3 Analyse the role, responsibilities and challenges faced by data specialists when building ethics into a data-driven culture.</td></tr>
</table>

Recommended Resources

Textbooks

Dietel, P. (2020) *Intro to Python for Computer Science and Data Science: Learning to Program with AI, Big Data and The Cloud*. London: Pearson.

Franks, B. (2020) *97 Things About Ethics Everyone in Data Science Should Know*. USA: O'Reilly Media.

Freeman, M., Ross, J. (2019) *Data Science Foundations Tools and Techniques: Core Skills for Quantitative Analysis with R and Git*. London: Addison-Wesley Professional.

Graesser, L. and Keng, W. L. (2020) *Foundations of Deep Reinforcement Learning: Theory and Practice in Python*. London: Addison-Wesley Professional.

Kirk, A. (2019) *Data Visualisation: A Handbook for Data Driven Design*. London: Sage Publications.

Knaflic, C. N. (2015) *Storytelling with Data: A Data Visualization Guide for Business Professionals*. USA: John Wiley & Sons.

Loukides, M., Mason, H. and Patil, D. J. (2018) *Ethics in Health Data Science*. USA: O'Reilly Media.

Marr, B. (2017) *Data Strategy: How to Profit from a World of Big Data, Analytics and the Internet of Things*. London: Kogan Page.

McCormick, K. and Salcedo, J. (2017) *SPSS Statistics for Data Analysis and Visualization*. USA: John Wiley & Sons.

Viescas, J. L. (2018) *SQL Queries for Mere Mortals: A Hands-On Guide to Data Manipulation in SQL*. 4th Edition. London: Addison-Wesley Professional.

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

Journals

Big Data & Society, SAGE Journals.

International Journal of Computer Applications (IJCA).

Journal of Big Data, SpringerOpen.

Journal of Data Science, Statistics and Visualisation, International Association for Statistical Computing (IASC).

Websites

gov.uk	UK government (Data Ethics Framework)
ukdataservice.ac.uk	UK Data Service (General reference)

Links

This unit links to the following related units:

Unit 12: Data Analytics

Unit 19: Business Intelligence

Unit 29: Applied Analytical Models.

Unit 6: Networking in the Cloud

Unit code	**A/618/4884**
Unit level	**4**
Credit value	**15**

Introduction

Complex computer networking has connected the world via groups of smaller, linked networks to support global communications. These can be situated within 'the cloud', at home, with your employer or elsewhere. As a cloud computing professional, a question that must always be asked is 'What remote and local networking infrastructure is supporting our cloud communication?'. The evolution of cloud computing is driven by all forms of network infrastructure allowing users to access data, hardware and services regardless of location. Being knowledgeable about the underlying principles of networking is of vital importance to all cloud professionals, whether they work in cloud support roles, cyber security or cloud software development.

The aim of this unit is to give students a wider background knowledge of cloud networking principles, operational principles, protocols, standards, security considerations and the systems associated with a range of networking technologies. This unit gives students the underpinning knowledge of the principles of networks and supports a range of other units in the qualification.

Students will explore a range of cloud solutions and will configure them to gain knowledge of networking systems. A range of networking technologies will be explored so that students gain a fundamental knowledge of Local Area Networking (LAN), Wide Area Networking (WAN) and their evolution, to form scalable systems.

On successful completion of this unit, students will have gained knowledge and skills to be able to successfully implement, operate and improve a cloud network and the operation of cloud-based data networks, including router, switching technologies, IP routing technologies, IP services and basic troubleshooting.

Students will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation, all of which are crucial for gaining employment and developing academic competence.

Learning Outcomes

By the end of this unit, students will be able to:

LO1 Examine commonplace networking principles used in a cloud infrastructure to support communication

LO2 Explain the operation of networking technologies within a cloud infrastructure

LO3 Design a networking solution for a cloud-based system for a business use case

LO4 Enhance network performance for a cloud-based system developed for a given business use case.

Essential Content

LO1 Examine commonplace networking principles used in a cloud infrastructure to support communication

Network architectures and standards:

Discuss network architectures, including CSD (Cloud Software Defined), WAN (Wide Area Network), LAN (Local Area Network)

Explore a range of technologies and standards, including TCP/IP model, theoretical OSI model, IEEE dot1q, IEEE 802.3

Understanding and application of routing protocols, routed protocols, application layer protocols

Awareness of security standards impacting on networks.

Network communication:

Operation and function of cloud-based routing, cloud-based switching, VLANs, network segmentation, access control lists, TCP/IP stack, IP (internet protocol) addressing (v4 and v6), NAT (network address translation), DHCP (dynamic host configuration protocol), transmission standards, physical layer security (on premises, within cloud).

Implementation solutions:

Understand the differences between on premises vs in-cloud vs hybrid systems

Application of NaaS (Network as a Service) used in conjunction with PaaS (platform as a service), aPaaS (application PaaS) and SaaS (software as a service), VPN (virtual private network) solutions, BoD (bandwidth on demand) and virtualisation resources.

LO2 Explain the operation of networking technologies within a cloud infrastructure

Remote operating system services:

Explain application and implementation of Windows™-based resources, Linux-based resources, server solutions, desktop solutions, mobile applications, serverless lambda, web servers, application servers, storage servers, database servers and licencing constraints.

Operating system optimisation:

Optimisation techniques, including time utilisation, storage resource, processor resource, memory resource, up time, down time, capacity for service being provided, interfaces required, addressing resources and security resources.

Remote clients:

Utilisation of web clients, API interactions, remote desktop solutions, bespoke applications and storage-based integrations for a cloud-based system.

LO3 **Design a networking solution for a cloud-based system for a business use case**

Networked solution:

Establishing a purpose to support a cloud-based resource for a specific customer need, e.g. cloud-based application, cloud-based service, remote deployment, remote backup

Create a WAN-based infrastructure, including combination hosted (hybrid), local hosted (private), public hosted (remote clouded)

Establishing a provisioning level, including understanding of cost, response, redundancy, location

Setting up a LAN-based infrastructure, including addressing, scale, hosts, services, security, firewall and access control.

Design:

Contents of design documentation, e.g. network diagram showing key infrastructure, addressing and routing methodology.

Performance and scalability:

Setting performance metrics, including speed, bandwidth, resilience, throughput, adaption, failover, automation

Setting scalability for number of hosts (clients), number of servers and services, address availability, resource availability, bandwidth, elastic storage, automation APIs.

LO4 **Enhance network performance for a cloud-based system developed for a given business use case.**

Testing methodology:

Establishing testing methodology, including divide and conquer, bottom up, top down, from the middle, load testing, resilience testing, penetration testing, vulnerability analysis, connectivity and reliability testing.

Network enhancements:

Agreeing improvements, including speed, bandwidth, security, scalability, performance, storage, response time, services, applications, features

Network performance measurement parameters, to include latency, packet loss, jitter (ping spikes), throughput and bandwidth

Use of tools for network monitoring, e.g. Amazon CloudWatch.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Examine commonplace networking principles used in a cloud infrastructure to support communication		
P1 Discuss the benefits and constraints of different network architectures and standards within the cloud. **P2** Describe how network communication operates within the cloud.	**M1** Compare common networking standards and how they facilitate cloud computing.	**LO1 and LO2** **D1** Review how creating a cloud environment affects network implementation and overall performance.
LO2 Explain the operation of networking technologies within a cloud infrastructure		
P3 Explain how remote operating system services are deployed within the cloud. **P4** Explain how remote clients interact with cloud services.	**M2** Explore the impact of remote operating system optimisation within the cloud on performance.	
LO3 Design a networking solution for a cloud-based system for a business use case		
P5 Design a networked solution for a cloud-based system for a given business use case. **P6** Implement the networking solution designed for a cloud system.	**M3** Test the cloud-based network, for performance and scalability.	**D2** Justify the effectiveness of your design, based on performance and scalability results from testing.
LO4 Enhance network performance for a cloud-based system developed for a given business use case.		
P7 Recommend network enhancements based on cloud test results. **P8** Implement network enhancements for a cloud system.	**M4** Test network enhancements for further performance and scalability improvements.	**D3** Justify the resulting networking improvements against the original network design.

Recommended Resources

Textbooks

DUTT, D. (2019) *Cloud Native Data-Center Networking: Architecture, Protocols, and Tools*. Sebastopol: O'Reilly

KUROSE, J., ROSS, K. (2016) *Computer Networking: A Top-Down Approach*. Harlow, Pearson

STALLINGS, W. (2015) *Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud*. Boston: Addison Wesley

Journals

IEEE/ACM Transactions on Networking.

IEEE xPlore.

Websites

aws.amazon.com	Training AWS Academy AWS (Amazon Web Services) Academy (General reference and academic resources)
NetAcad.com	Cisco Networking Academy – resources for general networking principles reference

Links

This unit links to the following related units:

Unit 7: Cloud Fundamentals

Unit 9: Networking

Unit 23: Applied Security in the Cloud.

Unit 7: Cloud Fundamentals

Unit code	**T/618/4883**
Unit level	**4**
Credit value	**15**

Introduction

The phrase 'it's in the cloud' has become ubiquitous in computing over the last few years and has revolutionised the way we use computer services. The ability to store both data and services in a remote location on the internet has meant that availability has widened considerably as virtual services have proliferated. The growth in cloud adoption presents challenges for companies to source cloud expertise to support their business, particularly small- and medium-sized enterprises with limited resources, which means that people skilled in cloud technologies are in high demand.

The ability to access applications, storage, printing, server functions and data from almost anywhere on almost any type of device has become the expectation rather than the exception. The ability to scale computing resources in direct relation to demand has reduced the need to purchase and maintain central computing resources significantly.

This unit is designed to develop an understanding of the fundamental concepts of cloud computing and cloud deployment models, and the need for cloud computing. Students will develop an appreciation of the issues associated with managing cloud service architecture and develop critical awareness of the ramifications of cloud-computing-based projects.

Topics included in the unit are: the paradigms of networking, fundamentals of cloud computing, cloud computing architecture and frameworks, deployment models, service models, security, cloud specific technology, and review of Cloud Service Providers (CSPs).

On successful completion of this unit, students will understand the concept, architecture, and services of cloud computing. As a result, they will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation, which are crucial for gaining employment and developing academic competence.

This unit is designed to be studied as the first unit in the Cloud Computing qualifications as it explains the fundamentals of cloud computing and its infrastructure.

Learning Outcomes

By the end of this unit, students will be able to:

LO1 Examine the fundamentals of cloud computing in relation to areas of application, architecture and platform

LO2 Design a deployment model to be hosted in the cloud for a given scenario

LO3 Explain different Cloud Service Providers' (CSPs) approaches to providing a cloud architecture framework for business use

LO4 Assess the technical challenges and risks inherent in moving IT systems to the cloud.

Essential Content

LO1 **Examine the fundamentals of cloud computing in relation to areas of application, architecture and platform**

Cloud fundamentals:

Discuss cloud computing and cloud infrastructure

Understanding of the Shared Responsibility Model, including virtualisation, hypervisors and security

Email, social media, office applications, multiplayer games, entertainment, government services, backups, data storage, iCloud, OneDrive, Dropbox

Describe total cost of ownership and general cloud benefits, e.g. trading capital for variable.

Processing (Compute in USA), storage and network environments:

Explain how to use virtual machines, cloud connectivity and availability, user data, meta data

Understand different types of architecture and platforms Linux Windows, e.g. x86, ARM, Mac, cloud platforms, client-server

Block storage and object storage

Define virtual private networks and public networks, including routing, subnetting, network isolation, CIDR (Classless Inter-Domain Routing).

Migrating to the cloud:

Investigate service migration to the cloud by considering the management of cloud services, range of cloud service providers, cloud architecture, applications in the cloud and ascertaining if a service is a cloud service

Identifying services to be migrated to the cloud, including email, office applications, data storage, data processing, backup, file sharing, security, server functions

Benefits to end users, e.g. access from anywhere, multi-platform access

Benefits to organisations, including cost, removal of data centre and requirement for excess capacity, availability on demand of storage and processing

Disadvantages to end users, e.g. network access requirements, availability of service

Disadvantages to organisations, e.g. legal aspects of different locations, control, levels of auditing and security concerns.

LO2 **Design a deployment model to be hosted in the cloud for a given scenario**

Cloud computing models:

Understanding cloud deployment models, including Infrastructure as a Service, (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS)

Differentiate between On-Premise, SaaS, PaaS, IaaS with a view to understanding when and how they are deployed.

Cloud deployment models:

Interpret the differences between public, private, hybrid and permutations of each

Design of simple deployment model to include the application to be hosted, selection of IaaS, SaaS, PaaS, platform hosting option, management options.

LO3 **Explain different Cloud Service Providers' (CSPs) approaches to providing a cloud architecture framework for business use**

Cloud Service Providers (CSPs):

Review different CSP frameworks, including best practices, implementation recommendations and products and services offered

Compare CSPs services in terms of cost, service management and availability

CSPs, e.g. Amazon Web Services, Microsoft Azure, VMware, Digital Ocean, Kamatera, IBM Cloud, Oracle Cloud, Liquid Web.

Additional services and tools:

Review of platforms, e.g. Amazon Web Services for students

Microsoft Azure for students, Google Cloud for Education and the support offered, e.g. free credits for students

Consideration of tools provided by service providers for improving system performance, cost saving, threat detection, closing security gaps, managing storage, data analysis and identity and access management

Review of open source directories, e.g. Docker, Kubernetes.

LO4 **Assess the technical challenges and risks inherent in moving IT systems to the cloud.**

Security aspects:

Understand the security risks and ways of minimising them, including data security, network access security, permissions, encryption, control and management, type of enforcement, layered security, service management in relation to security.

Legal requirements:

Identify different legal factors involved in commissioning a cloud system, including GDPR, data protection, data storage location, data storage access, governance and compliance

Review of ISO standards, e.g. ISO/IEC 9126 standard, ISO/IEC 27017 Security controls for cloud services.

Technical aspects:

Explain scalability, availability, fault tolerance and disaster recovery, security threats.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Examine the fundamentals of cloud computing in relation to areas of application, architecture and platform</td><td rowspan="5">LO1 and LO2
D1 Evaluate the potential impact of cloud computing on both users and organisations when considering a migration to the cloud.</td></tr>
<tr><td>P1 Explain the fundamental aspects of cloud computing services.
P2 Investigate the value of cloud computing to both end users and organisations.</td><td>M1 Analyse the advantages and disadvantages to an organisation of migrating to a wholly cloud-based system.</td></tr>
<tr><td colspan="2">LO2 Design a deployment model to be hosted in the cloud for a given scenario</td></tr>
<tr><td>P3 Investigate the relationships necessary between different service models and cloud deployment models for them to be effective.
P4 Design a simple deployment to include service models and technologies of cloud computing for a given scenario.</td><td>M2 Review how different deployment models, service models and technologies work together in a design for a given scenario.</td></tr>
<tr><td colspan="2">LO3 Explain different Cloud Service Providers' (CSP) approaches to providing a cloud architecture framework for business use</td><td rowspan="2">D2 Critically analyse the advantages and disadvantages of developing cloud applications with CSP tools.</td></tr>
<tr><td>P5 Compare the services offered by a range of Cloud Service Providers (CSPs).
P6 Explain cloud architecture frameworks and the tools offered by different CSPs.</td><td>M3 Analyse the relative cost of moving an application to the cloud in terms of service level, management and level of availability.</td></tr>
</table>

Pass	Merit	Distinction
LO4 Assess the technical challenges and risks inherent in moving IT systems to the cloud.		
P7 Investigate the security options available for cloud computing solutions. **P8** Assess the technical challenges involved in managing and maintaining cloud-based computing solutions.	**M4** Review the legal, security and practical risks to both users and organisations of using cloud-based technologies.	**D3** Analyse the legal and security aspects of cloud-based computing and propose solutions for the risks identified.

Recommended Resources

Textbooks

FAYNBERG I., LU, H., SKULER, D. (2016) *Cloud Computing: Business Trends and Technologies*. UK: John Wiley and Sons

ORBAN, S., JASSY, A., COCKROFT, A., SCHWARTZ, M. (2018) *Ahead in the Cloud. Best Practices for Navigating the Future of Enterprise IT*. South Carolina: CreateSpace Independent Publishing Platform

Websites

https://opensource.com	Opensource.com Resources menu Cloud technology (General reference, research, tutorials)

Links

This unit links to the following related units:

Unit 6: Networking in the Cloud

Unit 21: Emerging Technologies.

Unit 8: Security

Unit code	**D/618/7406**
Unit level	**4**
Credit value	**15**

Introduction

Security is one of the most important challenges modern organisations face. It is about protecting organisational assets, including personnel, data, equipment and networks, from attack through the use of prevention techniques in the form of vulnerability testing/security policies and detection techniques, exposing breaches in security and implementing effective responses.

The aim of this unit is to give students knowledge of security, the associated risks and how it has an impact on business continuity. Students will examine security measures involving access authorisation and regulation of use. They will implement contingency plans and devise security policies and procedures. The unit also introduces students to detection of threats and vulnerabilities in physical and IT security, and how to manage risks relating to organisational security.

This unit includes network security design and operational topics, including address translation, DMZ, VPN, firewalls, AV and intrusion detection systems. Remote access will be covered, as will the need for frequent vulnerability testing as part of organisational and security audit compliance. As a result, students will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

By the end of this unit students will be able to:

LO1 Assess risks to IT security

LO2 Describe IT security solutions

LO3 Review mechanisms to control organisational IT security

LO4 Manage organisational security.

Essential Content

LO1 **Assess risks to IT security**

IT security risks:

Risks of unauthorised use of a system, including unauthorised removal or copying of data or code from a system, damage to or destruction of physical system assets and environment, damage to or destruction of data or code inside or outside the system, naturally occurring risks, internal and external sources of risk

Legal restrictions on the access to data, including UK and international data laws (walled garden laws), e.g. General Data Protection Regulation (UK) (GDPR)

Organisational security, including business continuance, backup/restoration of data, audits, areas of systems to be secured, e.g. data, network, systems (hardware and software), WANs, intranets, wireless access systems, security culture and the approaches to security in the work place, operational impact of security breaches

The concepts, main functions and features of a range of Operating Systems (OS) and their security functions and associated security features.

LO2 **Describe IT security solutions**

IT security solution evaluation:

Network security infrastructure, including evaluation of network address translation (NAT), demilitarized zone (DMZ), static and dynamic IP addresses

Network performance: redundant array of inexpensive disks (RAID), Main/Standby, Dual LAN, web server balancing

Data security, including asset management, image differential/incremental backups, storage area network (SAN) servers, encryption

Data centre, including replica data centres, virtualisation, secure transport protocol, secure MPLS routing, segment routing and remote access methods/ procedures for third-party access, physical mechanisms, e.g. air flow and cooling to prevent overheating

Security vulnerability, including logs, traces, honeypots, data mining algorithms, vulnerability testing, zero-day exploits

Educating staff and customers on IT security issues and prevention methods

Understand how cyber security technology components are typically deployed in digital systems to provide security and functionality, including hardware and software to implement security controls.

LO3 **Review mechanisms to control organisational IT security**

Mechanisms to control organisational IT security:

Risk assessment and integrated enterprise risk management: network change management, audit control, business continuance/disaster recovery plans, potential loss of data/business, intellectual property, hardware and software

Probability of occurrence, e.g. disaster, theft

Staff responsibilities

Legal mechanisms, both UK and international, including Data Protection Act 2018, Computer Misuse Act 1990 and amendments, ISO 31000 Risk Management standards

Company regulations: site or system access criteria for personnel; physical security types, e.g. biometrics, swipe cards, theft prevention

Awareness of common security architectures and methodologies that incorporate hardware and software components, and sources of architecture patterns and guidance

Assess the security culture within an organisation (the approach to security, including how user actions impact on security)

Ensure system defences are informed by the most up-to-date legislation and guidance on best practice from professional bodies.

LO4 **Manage organisational security.**

Manage organisational security:

Organisational security policies, e.g. system access, access to internet email, access to internet browser, development/use of software, physical access and protection, third-party access, business continuity, responsibility matrix

Reviewing and monitoring of security risk assessments and ensuring stakeholder compliance with security procedures and standards

Collect information from various sources (e.g. log files, system monitoring tools, Secure Information and Event Management (SIEM) tools, access control systems, physical security systems) and compare to known threat and vulnerability data to determine a digital system security breach

Using enterprise risk management (as part of system management and lifecycle) for identifying, evaluating, implementing and follow up of security risks according to ISO 31000 standards

Understand appropriate security tools and methods, e.g. user log-on profiles to limit user access to resources, online software to train and update staff

Auditing tools to monitor resource access, security audits and penetration testing

Investigate organisation policy on ethical hacking and bug bounties

Gathering and recording information on security and initiating suitable actions for remediation.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Assess risks to IT security		
P1 Discuss types of security risks to organisations. **P2** Assess organisational security procedures.	**M1** Analyse the benefits of implementing network monitoring systems with supporting reasons.	**LO1 and LO2** **D1** Evaluate a range of physical and virtual security measures that can be employed to ensure the integrity of organisational IT security.
LO2 Describe IT security solutions		
P3 Discuss the potential impact to IT security of incorrect configuration of firewall policies and third-party VPNs. **P4** Discuss, using an example for each, how implementing a DMZ, static IP and NAT in a network can improve network security.	**M2** Propose a method to assess and treat IT security risks.	
LO3 Review mechanisms to control organisational IT security		
P5 Review risk assessment procedures in an organisation. **P6** Explain data protection processes and regulations as applicable to an organisation.	**M3** Summarise an appropriate risk-management approach or ISO standard and its application in IT security. **M4** Analyse possible impacts to organisational security resulting from an IT security audit.	**D2** Recommend how IT security can be aligned with an organisational policy, detailing the security impact of any misalignment.
LO4 Manage organisational security.		
P7 Design a suitable security policy for an organisation, including the main components of an organisational disaster recovery plan. **P8** Discuss the roles of stakeholders in the organisation in implementing security audits.	**M5** Justify the security plan developed giving reasons for the elements selected**.**	**D3** Evaluate the suitability of the tools used in the organisational policy to meet business needs.

Recommended Resources

Alexander, D. et al. (2020) *Information Security Management Principles*. BSC.

Collins, R. (2017) *Network Security Monitoring: Basics for Beginners. A Practical Guide* CreateSpace Independent Publishing Platform.

Sanders, C. Smith, J. (2013) *Applied Network Security Monitoring: Collection, Detection, and Analysis*. Syngress.

Steinberg, R. (2011) *Governance, Risk Management, and Compliance: It Can't Happen to Us – Avoiding Corporate Disaster While Driving Success*. Wiley.

Tipton, H. (2010) *Information Security Management Handbook*. 4th Ed. Auerbach Publications.

Websites

www.bcs.org	BCS, The Chartered Institute for IT (General reference)
www.bsa.org	Software Alliance (General reference)
www.fast.org.uk	Federation Against Software Theft (General reference)
www.ico.org.uk	Information Commissioners Office (General reference)

Links

This unit links to the following related units:

Unit 3: Cyber Security

Unit 23: Applied Security in the Cloud

Unit 24: Applied Cryptography in the Cloud

Unit 25: Information Security Management in the Cloud

Unit 28: Risk Analysis & Systems Testing.

Unit 9: Networking

Unit code	**M/618/7393**
Unit level	**4**
Credit value	**15**

Introduction

Computer networks are the driving force behind the evolution of computer systems and allow users to access data, hardware, and services regardless of their location. Being knowledgeable about the underlying principles of networking is of vital importance to all IT professionals. Networking is an environment that is increasingly complex and under continuous development.

Complex computer networking has connected the world by groups of small networks through internet links to support global communications. It supports access to digital information any time, anywhere, using many applications like email, audio and video transmission, including the World Wide Web, and this has opened the floodgates to availability of information.

The aim of this unit is to give students a wider background knowledge of computer networking essentials, how they operate, protocols, standards, security considerations and the prototypes associated with a range of networking technologies. Students will explore a range of hardware, with related software, and will configure and install these to gain knowledge of networking systems. A range of networking technologies will be explored to deliver a fundamental knowledge of Local Area Networking (LAN), Wide Area Networking (WAN) and their evolution to form large-scale networks. Students will also explore the protocol methodologies related to IP data networks.

On successful completion of this unit, students will have gained the knowledge and skills needed to successfully install, operate and troubleshoot a small network; and the operation of IP data networks, router, switching technologies, IP routing technologies, IP services and basic troubleshooting. Supporting a range of units in the Higher National suite, this unit underpins the principles of networks for all and enables students to work towards their studies in vendor units, if applicable. Students will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

By the end of this unit students will be able to:

LO1 Examine networking principles and their protocols

LO2 Explain networking devices and operations

LO3 Design efficient networked systems

LO4 Implement and diagnose networked systems.

Essential Content

LO1 Examine networking principles and their protocols

Introduction to networks:

Impact of networks on daily lives, the basic requirements of a reliable network, employment opportunities in the networking field, network common network attacks, network trends, e.g. bring your own device (BYOD).

Role of networks:

Purpose, benefits, resource implications, communications, e.g. transmission mediums, working practice, commercial opportunity, information sharing, collaboration.

System types:

Peer-based, client-server, cloud, cluster, centralised, virtualised.

Networking standards:

Conceptual models, e.g. OSI model, TCP/IP model; standards, e.g. IEEE 802.x.

Topology:

Network representation logical, e.g. ethernet, Token Ring; physical, e.g. star, ring, bus, mesh, tree.

Protocols:

Purpose of protocols; adherence, routed protocols, e.g. IPv4 (addressing, subnetting, VLSM), IPv6 (addressing); global unicast, multicast, link local, unique local, EUI 64, auto configuration, ICMP, FTP, HTTP, SMTP, POP3, SSL; management of protocols for addressing.

Wireless networks:

Explore the use and evolution and industry developments in mobile/cellular networks, including key technologies; standards for communications (3G, 4G, 5G); process of accessing and connecting to NB-IoT, GPRS and Wi-Fi networks

Distinguish between NB-IoT and Wi-Fi AT command sets.

LO2 **Explain networking devices and operations**

Networking devices:

Explain the operation of server, hub, routers, switches, multilayer switch (including their operating systems, e.g. CISCO IOS, etc.), firewall, Host-based Intrusion System (HIDS), repeaters, bridges, wireless devices, access point (wireless/wired), content filter, load balancer, modem, packet shaper, VPN concentrator

Explore the basic concepts, features and key technologies of IoT gateways, including IoT gateway solutions, industrial IoT gateway positioning, edge computing, network topologies, RF mesh, Smart Home networks, acceleration, Wi-Fi coverage and intelligent services and serial data transmission (binary data).

Networking software:

Client software, server software, client operating system, server operating system, firewall.

Server type:

Web, file, database, combination, virtualisation, terminal services server.

Server selection:

Cost, purpose, operating system requirement.

Workstation:

Hardware, e.g. network card, cabling

System bus and local-system architecture, e.g. memory, processor, I/O devices

Permissions.

LO3 **Design efficient networked systems**

Bandwidth:

Expected average load, anticipated peak load, local internet availability, cost constraints, throughput.

Users:

Quality expectations, concept of system growth

Consider what the network will be used for (purpose) according to the scenario.

Networking services and applications:

DHCP, including static vs dynamic IP addressing, reservations, scopes, leases, options (DNS servers, Suffixes), IP helper, DHCP relay, DNS records, Dynamic DNS, static and dynamic routing between multiple subnets

Calculate IP subnet address ranges in dotted decimal and binary

Calculate subnet masks.

Communications:

Ensuring communications are suited to devices, suited to users, supportive of lifestyle desires, supportive of commercial requirements, security requirements, quality of service needs.

Scalability:

Ability to support device growth, able to support addition of communication devices, able to cope with bandwidth use and trend changes, protocol utilisation, addressing, multiple subnets, dynamic, static routing protocols.

Selection of components:

Supporting infrastructure needs; supporting connectivity requirements.

Security:

The concept of 'secure by design' and its application to infrastructure

Security considerations when designing a network for an identified scenario, e.g. shared data, network access, remote workers, public facing systems, internal policy.

LO4 **Implement and diagnose networked systems.**

Devices:

Installation of communication devices, allocation of addresses, local client configuration, server configuration, server installation, security considerations.

Verification of configuration and connectivity:

Installation of internet work communication medium, ping, extended ping, traceroute, telnet, SSH

Evidence the system meets design requirements, including security controls as required by the scenario, have been implemented.

System monitoring:

Utilisation, bandwidth needs, monitoring user productivity and security of the system

Factors affecting network performance

Identify typical failure modes in protocols and approaches to error control

Review network monitoring data to optimise performance and undertake root cause analysis of events and make recommendations to reduce false positives and false negatives.

Network automation:

Process of setting up software to automatically manage, configure, test, deploy, and operate network devices (physical or virtual).

Maintenance schedule:

Backups, upgrades, security, auditing.

Diagnose and resolve layer 1 problems:

Explore the E2E integrated development and testing process

Framing, CRC, runts, giants, dropped packets, late collisions, input/output errors.

Policy review:

Bandwidth, resource availability.

Service level agreements (SLAs):

Conditions of service availability, time window for each level of service (prime time and non-prime time), responsibilities of each party, escalation procedures, and cost/service trade-offs

Organise and prioritise clients/stakeholders' requests in line with SLAs and organisation processes.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Examine networking principles and their protocols</td><td rowspan="4">LO1 and LO2
D1 Evaluate the topology and protocol suite selected for a given scenario and how it demonstrates the efficient utilisation of a networking system.</td></tr>
<tr><td>P1 Discuss the benefits and constraints of different network types and standards.
P2 Explain the impact network topologies have on communication and bandwidth requirements.</td><td>M1 Assess common networking principles and how protocols enable the effectiveness of networked systems.</td></tr>
<tr><td colspan="2">LO2 Explain networking devices and operations</td></tr>
<tr><td>P3 Discuss the operating principles of networking devices and server types.
P4 Discuss the interdependence of workstation hardware and relevant networking software.</td><td>M2 Explore a range of server types and justify the selection of a server for a given scenario, regarding cost and performance optimisation.</td></tr>
<tr><td colspan="2">LO3 Design efficient networked systems</td><td rowspan="4">LO3 and LO4
D2 Critically reflect on the implemented network, including the design and decisions made to enhance the system.</td></tr>
<tr><td>P5 Design a networked system to meet a given specification.
P6 Design a maintenance schedule to support the networked system.</td><td>M3 Analyse user feedback on your designs with the aim of optimising your design and improving efficiency.</td></tr>
<tr><td colspan="2">LO4 Implement and diagnose networked systems.</td></tr>
<tr><td>P7 Implement a networked system based on a prepared design.
P8 Document and analyse test results against expected results.</td><td>M4 Recommend potential enhancements for the networked systems.</td></tr>
</table>

Recommended Resources

Textbooks

Burgess, M. (2003) *Principles of Network and System Administration*. 2nd Ed. John Wiley and Sons Ltd.

Hallberg, B. (2005) *Networking: A Beginner's Guide*. 4th Ed. Osborne/McGraw-Hill US.

Limoncelli, T. and Hogan, C. (2001) *The Practice of System and Network Administration*. Addison-Wesley.

Lowe, D. (2005) *Networking All-in-One Desk Reference for Dummies*. 2nd Ed. Hungry Minds Inc.

Olifer, N. and Olifer, V. (2005) *Computer Networks: Principles, Technologies and Protocols for Network Design*. John Wiley and Sons Ltd.

Stallings, W. (2003) *Data and Computer Communications*. 7th Ed. Prentice Hall

Subramanian, M. (2000) *Network Management: An Introduction to Principles and Practice.* Addison-Wesley.

Tanenbaum, A. (2002) *Computer Networks*. Prentice Hall PTR.

Journals

The Institute of Engineering and Technology.

Links

This unit links to the following related units:

Unit 6: Networking in the Cloud

Unit 7: Cloud Fundamentals

Unit 31: Network Management.

Unit 10: Database Design & Development

Unit code	**A/618/7400**
Unit level	**4**
Credit value	**15**

Introduction

Organisations depend on their databases for providing information that is essential for their day-to-day operations and to help them take advantage of today's rapidly growing and maturing e-commerce opportunities. An understanding of database tools and technologies is an essential skill for designing and developing systems to support them.

As applications get increasingly more sophisticated, database systems continue to demand more complex data structures and interfaces. Most organisations collect and store large volumes of data, either on their own systems or in the cloud, and this data is used not just for the operational running of their business but is also mined for other more intelligent and complex applications. Databases stand as the back-end of most systems used by organisations for their operations.

Database design and development is a fundamental and highly beneficial skill for computing students to master, regardless of their specialism.

The aim of this unit is to give students opportunities to develop an understanding of the concepts and issues relating to database design and development. It will also provide the practical skills needed to be able to translate that understanding into the design and creation of complex databases.

Topics covered in this unit are: examination of different design tools and techniques; examination of different development software options; consideration of the development features of a fully-functional robust solution covering data integrity, data validation, data consistency, data security and advanced database querying facilities across multiple tables; appropriate user interfaces for databases and for other externally linked systems; creating complex reports/dashboards, testing the system against the user and system requirements; and elements of complete system documentation.

On successful completion of the unit, students will be able to use appropriate tools to design and develop a relational database system for a substantial problem. They will be able to test the system to ensure that it meets user and system requirements, and fully document the system by providing technical and user documentation.
For practical purposes, this unit covers relational databases and related tools and techniques. A brief overview of object-oriented databases will also be covered. As a result, students will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

By the end of this unit students will be able to:

LO1 Use an appropriate design tool to design a relational database system for a substantial problem

LO2 Develop a fully functional relational database system, based on an existing system design

LO3 Test the system against user and system requirements

LO4 Produce technical and user documentation.

Essential Content

LO1 Use an appropriate design tool to design a relational database system for a substantial problem

Database design:

Principles and uses of relational and non-relational databases

The role of database systems, e.g. as back-end systems, in e-commerce, for data mining applications, blockchain

Determining user and system requirements

Design tools and techniques for a relational database system

Logical design for relational databases, including structured data in tables, data elements, data types, indexes, primary and foreign keys, entity relationship modelling, referential integrity, data normalisation to third normal form

Designs for data integrity, data validations, data security and data controls

User interface design

Output designs for user requirements

Overview of object-oriented databases and their design tools.

LO2 Develop a fully functional relational database system, based on an existing system design

Implementation:

Consideration of database and platform options for system development

Examination of different software development options for developing the relational database system

Implementation of the physical data model, based on the logical model and linking code to data sets

Data stores, internal storage and external storage, e.g. the cloud

Implementation of security elements in databases

Relational databases with controls like data validation using; input masks, dropdown lists, option buttons

Consideration of user interface requirements looking at functionality, reliability, consistency, performance and accessibility for a range of different users

Develop effective user interfaces linked with other systems, e.g. internet-based applications

Data manipulation using appropriate query tools, including complex queries to query across multiple tables and using functions and formulae

Database maintenance and data manipulation: inserts, updates, amendments, deletions, data backup and recovery

System reports using report-writing tools and report generators, dashboards

Implementation of security elements in a database, including consideration of permissions, access rights, network vulnerabilities, physical location of data, multi-tenancy and data separation, encryption

Consideration of GDPR issues, including data crossing borders and other nations' data protection regulations.

LO3 **Test the system against user and system requirements**

Testing methodologies:

Identify elements of the system that need to be tested. Consider data that should be used to fully test the system

Match tests against user and system requirements

Test procedures to be used: test plans, test models, e.g. structural testing, functional testing; testing documentation

Functional and system testing and testing the robustness of the system, including help menus, pop-ups, hot-spots, data validation checks.

LO4 **Produce technical and user documentation.**

Structure and functionality documentation:

Technical and user documentation and their contents

Technical documentation to include diagrams showing movement of data through the system and flowcharts describing how the system works

User documentation, including how to use the system, outputs produced by the system, menu operations and other functions.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Use an appropriate design tool to design a relational database system for a substantial problem</td><td rowspan="2"></td></tr>
<tr><td>P1 Design a relational database system using appropriate design tools and techniques, containing at least four interrelated tables, with clear statements of user and system requirements.</td><td>M1 Produce a comprehensive design for a fully-functional system, which includes interface and output designs, data validations and data normalisation.</td></tr>
<tr><td colspan="2">LO2 Develop a fully-functional relational database system, based on an existing system design</td><td rowspan="5">LO2 and LO3
D2 Evaluate the effectiveness of the database solution in relation to user and system requirements and suggest improvements.</td></tr>
<tr><td>P2 Develop the database system with evidence of user interface, output and data validations, and querying across multiple tables.
P3 Implement a query language into the relational database system.</td><td>M2 Implement a fully-functional database system, which includes system security and database maintenance.
M3 Assess whether meaningful data has been extracted through the use of query tools to produce appropriate management information.</td></tr>
<tr><td colspan="2">LO3 Test the system against user and system requirements</td></tr>
<tr><td>P4 Test the system against user and system requirements.</td><td>M4 Assess the effectiveness of the testing, including an explanation of the choice of test data use.</td></tr>
<tr><td colspan="2">LO4 Produce technical and user documentation.</td><td rowspan="2">D3 Evaluate the database in terms of improvements needed to ensure the continued effectiveness of the system.</td></tr>
<tr><td>P5 Produce technical and user documentation.</td><td>M5 Produce technical and user documentation for a fully-functional system, including data flow diagrams and flowcharts, describing how the system works.</td></tr>
</table>

Recommended Resources

Textbooks

Churcher, C. (2012) B*eginning Database Design: From Novice to Professional*. 2nd Ed. Apress.

Connolly, T. and Begg, C. (2014) *Database Systems: A Practical Approach to Design, Implementation and Management.* 6th Ed. Global Edition. Pearson.

Flejoles, R. P. (2018) *Database Theory and Application*. Arcler Press.

Karwin, B. (2017) *SQL Antipatterns: Avoiding the Pitfalls of Database Programming* Pragmatic Programmers, LLC, The.

Kroemke, D. and Auer, D. (2012) *Database Concepts: International Edition*. 6th Ed. Pearson.

Journals

The Computer Journal – Oxford Academic.

International Journal of Database Management (IJDMS).

Journal of Emerging Trends in Computing and Information Sciences.

Journal of Systems Analysis and Software Engineering.

Systems Journal of Database Management.

Websites

http://docs.microsoft.com/	Microsoft Virtual Academy Database Development (Training)
http://docs.microsoft.com/	Microsoft Virtual Academy Microsoft Press (E-books)
linked.com/	Linkedin Learning (Training)

Links

This unit links to the following related units:

Unit 26: Data Structures & Algorithms

Unit 29: Applied Analytical Models.

Unit 11: Software Development Lifecycles

Unit code	**K/618/7408**
Unit level	**4**
Credit value	**15**

Introduction

The software development lifecycle is an integrated process that promotes building good quality, secure software throughout the entire development process. The aim of this unit is to give students the knowledge and skills needed to understand software development lifecycles so that they can demonstrate their knowledge by implementing a software development lifecycle with a suitable methodology.

The unit introduces students to lifecycle decision making at different stages of the software development process. They will examine various lifecycle models and learn to appreciate their particular characteristics in order to understand for which project environments they are most appropriate. Theoretical understanding will be translated into practical skills through an actual software development lifecycle project. Students will become confident in the use of particular tools and techniques relevant to a chosen methodology.

Among the topics included in this unit are iterative and sequential models of software development lifecycles and reference frameworks for initially capturing conceptual data and information through a feasibility study, and requirement gathering techniques through to analysis, design and software implementation activities.

Students will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

By the end of this unit students will be able to:

LO1 Describe different software development lifecycles

LO2 Explain the importance of a feasibility study

LO3 Undertake a software development lifecycle

LO4 Discuss the suitability of software behavioural design techniques.

Essential Content

LO1 Describe different software development lifecycles

Software development lifecycles:

Describe different software development lifecycles

Understand and use different lifecycle models, including predictive (Waterfall, Prototyping, RAD), adaptive (Spiral, Agile, DSDM), sequential and iterative software development models

Lifecycle stage and connectivity, including feasibility study, analysis, design, implementation, testing, review or analysis, design, implementation, maintenance, planning, requirements traceability

Testing and integration, including relationship between test activities and software development activities, levels of testing, building test environments, developing test harnesses, functional and structural testing, incremental testing, system testing, acceptance test and integration approaches, changeover strategies, trials and Go-Live prerequisites.

Understand the role and utilisation of analysis artefacts:

The creation of analysis artefacts in a software development project, e.g. software requirements specification, use case or user stories, user profiles, workflow model, wireframes, logical data model, data dictionary etc

The purpose and activities of the gap analysis process.

Roles and responsibilities in a large-scale software project development lifecycle:

Identify the different individuals in a project, e.g. project manager, business analyst, systems analyst, programmer, DevOps engineer, testing engineer etc

Contributions, including quality assurance, common core skills, tools and behaviours

Explore how the psychology and mindset of testing differs to that development mindset and their possible influence on the overall success of a software project.

LO2 **Explain the importance of a feasibility study**

Requirement gathering:

Requirement gathering techniques, including how to categorise, validate and prioritise, e.g. MosCow method, functional requirements, non-functional requirements, users and constraints

Interviews, observation, investigation.

Importance of feasibility study:

Feasibility criteria considerations, e.g. legal, social, economic, technical, timescales, organisational constraints

Components of feasibility study, including purpose, structure, intended audience, outcomes

The purpose of process modelling and the importance of an organisational view of business processes

Key drivers for change, including performance and efficiency, legacy systems upgrade, automation, elimination of human error.

LO3 **Undertake a software development lifecycle**

Carry out software development lifecycle:

Follow company, team or client approaches to continuous integration, version and source control

Apply an appropriate software development approach according to the relevant paradigm, e.g. object oriented, event driven or procedural

Identify stakeholder requirements

Scope of project, including inputs, outputs, processes and process descriptors, consideration of alternate solutions and security considerations, required quality assurance and testing

Constraints specific to activity, e.g. costs, organisational policies, legacy systems, hardware requirements

Create simple software designs to effectively communicate understanding of the program

Follow agreed software designs and technical and functional specifications

Follow organisational policies and procedures relating to the tasks being undertaken, e.g. the storage and treatment of GDPR sensitive data

Report documentation, including structure, e.g. background information, problem statements, data collection process and summary, recommendations and appendices

Use of appropriate systems analysis terminology and tools, including data stores and entities, data flows, process representation techniques relationships (1:1, 1:M and M:M)

Investigation, e.g. upgrading computer systems, designing new systems

Techniques and documents for documenting business requirements and processes relevant to selected methodology, e.g. Context Diagrams, Data Flow Diagrams (DFDs), Entity Relationship Diagrams (ERDs), Business Systems Options (BSOs), Technical Systems Options (TSOs) and requirements traceability

Analyse documented requirements to remove duplication, conflict and overlap

Quality considerations, e.g. Total Quality Management (TQM).

LO4 **Discuss the suitability of software behavioural design techniques.**

Evaluate suitability of software behavioural design techniques:

Flowcharts, pseudocode, formal specification methods, event/state/data driven, finite state machines extended-FSM/FSP

Problem of e-FSM state explosion, reachability analysis, safety, liveness properties

Automatic analysis and animation tools

Understand the characteristics of software architecture that impact on software testing in the development lifecycle.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Describe different software development lifecycles		
P1 Describe two iterative and two sequential software lifecycle models. **P2** Explain how risk is managed in software lifecycle models.	**M1** Discuss using an example, why a particular lifecycle model is selected for a development environment.	**D1** Assess the merits of applying the Waterfall lifecycle model to a large software development project.
LO2 Explain the importance of a feasibility study		
P3 Explain the purpose of a feasibility report. **P4** Describe how technical solutions can be compared.	**M2** Discuss the components of a feasibility report.	**D2** Assess the impact of different feasibility criteria on a software investigation.
LO3 Undertake a software development lifecycle		
P5 Undertake a software investigation to meet a business need. **P6** Use appropriate software analysis tools/techniques to carry out a software investigation and create supporting documentation.	**M3** Analyse how software requirements can be traced throughout the software lifecycle. **M4** Discuss two approaches to improving software quality.	**D3** Evaluate the process of undertaking a systems investigation with regard to its effectiveness in improving a software quality.
LO4 Discuss the suitability of software behavioural design techniques.		
P7 Discuss, using examples, the suitability of software behavioural design techniques.	**M5** Analyse a range of software behavioural tools and techniques. **M6** Differentiate between a finite state machine (FSM) and an extended FSM, providing an application of use for both.	**D4** Present justifications of how data-driven software can improve the reliability and effectiveness of software.

Recommended Resources

Textbooks

Dennis, A. and Haley, W. (2009) *Systems Analysis and Design*. John Wiley & Sons Ltd.

Lejk, M. and Deeks, D. (2002) *An Introduction to System Analysis Techniques*. 2nd Ed. Addison-Wesley.

Murch, R. (2012) *The Software Development Lifecycle: A Complete Guide*. Kindle.

Smart, J. F. (2014) *BDD in Action: Behavior-driven development for the whole software lifecycle*. Manning.

Websites

www.freetutes.com	FreeTutes *Systems Analysis and Design – Complete Introductory Tutorial for Software Engineering* (Tutorial)
www.ijcsi.org	*IJCSI International Journal of Computer Science* Vol. 7, Issue 5, September 2010 *A Comparison Between Five Models Of Software Engineering* (Research)
www.ijcsi.org	*IJCSI International Journal of Computer Science* Vol. 6, Issue 1, 2015 *Software Development Life Cycle Models – Comparison, Consequences* (Research)

Links

This unit links to the following related units:

Unit 28: Risk Analysis & Systems Testing.

Unit 12: Data Analytics

Unit code	**F/618/7415**
Unit level	**4**
Credit value	**15**

Introduction

Like the physical universe, the digital universe is enormous and is doubling in size every two years. By 2020, the digital universe – the data we create and copy annually – is projected to reach 44 zettabytes or 44 trillion gigabytes.

Data is everywhere in the world. Without knowing how to interpret this data it would be difficult to understand its meaning or make use of the data to increase the productivity of an organisation. Data analytics is a range of processes that converts data into actionable insight using a range of statistical techniques. Data analytics is a relatively new term – it is an overarching term for all decision support and problem-solving techniques. Most of the time the terms 'data analytics' and 'business analytics' are used interchangeably.

This unit introduces students to the theoretical foundation of data analytics and a range of data analytic processes and techniques to provide hands-on experience to enhance their skills. Topics included in this unit are data analytic terminologies, types of data analytics, data exploration and visualisation, understanding data with descriptive, predictive and prescriptive analytics.

On successful completion of this unit, students will understand the theoretical foundation of data analytics, data analytic processes and techniques. They will also gain hands-on experience of implementing data analytic processes and techniques using a programming language such as Python, R, or a tool such as Weka, KNIME, Power BI, Excel etc. As a result, students will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

By the end of this unit students will be able to:

LO1 Discuss the theoretical foundation of data analytics that determine decision-making processes in management or business environments

LO2 Apply a range of descriptive analytic techniques to convert data into actionable insight using a range of statistical techniques

LO3 Investigate a range of predictive analytic techniques to discover new knowledge for forecasting future events

LO4 Demonstrate prescriptive analytic methods for finding the best course of action for a situation.

Essential Content

LO1 **Discuss the theoretical foundation of data analytics that determine decision-making processes in management or business environments**

Data analytics terminologies:

Population, sample, categorical data, nominal data, ordinal data, continuous data, discrete data.

Types of data analytics:

Descriptive data analytics, predictive data analytics and prescriptive data analytics.

Exploratory data analysis (EDA):

Variable identification, univariate and bi-variate analysis, missing values treatment

Data visualisation, e.g. graphs, charts, plots.

LO2 **Apply a range of descriptive analytic techniques to convert data into actionable insight using a range of statistical techniques**

Data analysis lifecycle:

Implement the stages of the data analysis lifecycle, including discovery, data preparation, model planning, model building, operationalise, communicate results.

Descriptive statistics:

Measures of central tendency, measure of position and measures of dispersion.

Probability distribution:

Cumulate distribution, discrete distribution, continuous distribution.

Sampling and estimation:

Random sampling, systematic sampling, point estimate, interval estimate.

Statistical inferences:

Models and assumptions.

LO3 **Investigate a range of predictive analytic techniques to discover new knowledge for forecasting future events**

Regression analytics:

Linear regression, multiple linear regression and logistic regression.

Forecasting techniques:

Qualitative, average approach, naïve approach, time series methods, causal relationship etc.

LO4 **Demonstrate prescriptive analytic methods for finding the best course of action for a situation.**

Optimisation:

Classical optimisation, linear programming techniques, nonlinear programming techniques, dynamic programming.

Decision analysis:

Models, justifiable decisions and defensible decisions.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Discuss the theoretical foundation of data analytics that determine decision-making processes in management or business environments</td><td rowspan="5">LO1 and LO2
D1 Evaluate the importance of data analytical techniques to the decision-making process.</td></tr>
<tr><td>P1 Identify data analytic activities, techniques, and tools.
P2 Demonstrate an ability to use a popular programming language or tool used in the data analytics industry.</td><td>M1 Investigate the three types of data analytic methods and their use in industry.</td></tr>
<tr><td colspan="2">LO2 Apply a range of descriptive analytic techniques to convert data into actionable insight using a range of statistical techniques</td></tr>
<tr><td>P3 Investigate descriptive analytic techniques and explain with appropriate examples.
P4 Apply an appropriate tool or programming language to demonstrate these descriptive analytics techniques.</td><td>M2 Show how these descriptive analytic techniques contribute to decision making.</td></tr>
<tr><td colspan="2">LO3 Investigate a range of predictive analytic techniques to discover new knowledge for forecasting future events</td></tr>
<tr><td>P5 Identify predictive analytic techniques and describe these techniques with examples.
P6 Apply an appropriate tool or programming language to demonstrate these predictive analytic techniques.</td><td>M3 Compare a range of predictive analytical techniques for forecasting purposes.</td><td>D2 Evaluate how predictive analytic techniques can be used for forecasting purposes.</td></tr>
</table>

Pass	Merit	Distinction
LO4 Demonstrate prescriptive analytic methods for finding the best course of action for a situation.		
P7 Analyse prescriptive analytic techniques with appropriate examples. **P8** Demonstrate these techniques using an appropriate programming language or tool.	**M4** Describe how these prescriptive analytic techniques are used to find the best course of action in a situation.	**D3** Apply an appropriate programming language or tool to demonstrate how these prescriptive analytic techniques are used to find the best course of action in a situation.

Recommended Resources

Textbooks

Evans, J. (2016) *Business Analytics.* 2nd Ed. Pearson.

Runkler, T. (2016) *Data Analytics: Models and Algorithms for Intelligent Data Analysis*. 2nd Ed. Vieweg+Teubner Verlag.

Websites

archive.ics.uci.edu/ml	University of California, Irvine "Machine Learning Repository" (Data sets)
lfd.uci.edu	University of California, Irvine – Laboratory for Fluorescence Dynamics "Binaries for Python Extension Packages" (Development tool)
cran.r-project.org	The R Project for Statistical Computing "R Archive Network" (Development tool)
cs.waikato.ac.nz	University of Waikato – Machine Learning Group "Data Mining Software in Java" (Development tool)
knime.org	Konstanz Information Miner "KNIME" (Development tool)
powerbi.microsoft.com	Microsoft Power BI "Power BI Desktop" (Development tool)

Links

This unit links to the following related units:

Unit 5: Big Data and Visualisation

Unit 29: Applied Analytical Models.

Unit 15: Fundamentals of Artificial Intelligence (AI) & Intelligent Systems

Unit code	**K/618/5660**
Unit level	**4**
Credit value	**15**

This unit is aligned to the Microsoft Azure AI Fundamentals Certification. See section 3.1.5 for further guidance on claiming certification.

Introduction

Intelligent Systems are revolutionising industry and changing the way we accomplish daily routines. They help to introduce flexibility, quality and energy efficiency, to name just a few, to an increasing range of applications, for example transportation, healthcare, education, the defence sector. Intelligent Systems are enabled by various underpinning technologies, especially Artificial Intelligence (AI). AI offers opportunities to gain insights from data or to perceive the environment in order to take intelligent actions that maximise the chances of performing a task faster or one that was not possible previously. The growth in AI potential offers companies opportunities to reduce costs, increase productivity and introduce new products to the market. Therefore, people skilled in AI and its applications are in high demand.

This unit is designed to introduce the science behind machine intelligence and the philosophical debate around the ambitions of simulating human intelligence to solve real-world problems. Students will be guided to appreciate AI types and applications and develop a better understanding of aspects related to intelligent agents. Other topics included in the unit cover Artificial Narrow Intelligence (ANI), Artificial General Intelligence (AGI), Ambient Intelligence, the major differences between top-down and bottom-up approaches to AI and understanding Machine Learning (ML) algorithms (for example SVM, Naïve Bayes, Random Forest and KNN) and processes, including dataset preparation.

On successful completion of this unit, students will be able to investigate AI fundamentals, including data gathering, validation, and processing, and how the results can be visualised and explained. Students will also develop their skillset to study deployed Intelligent Systems and evaluate technical and ethical challenges and opportunities.

Learning Outcomes

By the end of this unit, students will be able to:

LO1 Discuss the theoretical foundation of Artificial Intelligence and its impact on users and organisations

LO2 Analyse the approaches, techniques and tools to deploy Intelligent Systems in an organisation

LO3 Modify an AI-based system to improve how it exhibits intelligence in response to a real-world problem

LO4 Evaluate the technical and ethical challenges and opportunities of Intelligent Systems.

Essential Content

LO1 **Discuss the theoretical foundation of Artificial Intelligence and its impact on users and organisations**

AI fundamentals:

Understanding what defines Artificial/Machine Intelligence; philosophical debates around the ambitions of simulating human intelligence; and the phenomenon of the 'AI effect'

AI and the phenomenon of combinatorial explosion

The requirements of the underlying data and its influence on AI outcomes

How to handle large (big data) versus small datasets

Understanding what 'learning from experience' means for Intelligent Agents and Intelligent Systems

Appreciating the difference between AI and its subfields, such as machine learning and related interdisciplinary research areas such as robotics

How AI leverages other disciplines such as computer science, mathematics, psychology, software engineering and linguistics

Recognising traditional problems (goals) of AI such as reasoning, planning, learning, natural language processing, perception, prediction/forecasting, anomaly detection, computer vision, knowledge mining and conversational AI

Decision making, including basics of utility theory, sequential decision problems, elementary game theory, decision theory

Understanding Intelligent Agents: reactive, deliberative, goal-driven, utility-driven, and Learning Agents.

AI types:

The difference between weak AI and strong AI

Artificial Narrow Intelligence (ANI), also referred to as weak AI with applications focused on singular tasks, e.g. Alexa, Siri, prediction tools, spam filters

Artificial General Intelligence (AGI), also known as strong AI or deep AI, e.g. Recognition, Recall, Hypothesis testing, Imagination, Analogy, Implication

Artificial Super-intelligence (ASI), a hypothetical concept.

AI applications:

The role of AI in the principles of a Universal Design

Ambient Intelligence enabling electronic environments that are sensitive and responsive to the presence and preferences of people

Finance, e.g. to detect anomalies in charges outside of the norm, flagging these for human investigation

Agriculture, e.g. predicting the time it takes for a crop to be ripe and ready for picking, harvesting robot, predicting and extending storage and shelf life

Business and eCommerce, e.g. chatbots, visual searches, intelligent virtual assistants

Engineering, e.g. Computer Aided Design (CAD) and automation in factories

Healthcare, e.g. care of the elderly, heart beats analysis, computer-aided interpretation of medical images, drug discovery

Cybersecurity, e.g. profiling anomalous user behaviour, automating response against large-scale attacks

Logistics and supply chain, e.g. autonomous trucks and robotic picking systems

Other examples include any application which exhibits intelligence via AI techniques, such as strategy games, autopilot in autonomous cars, intelligent routing in computer networks and military simulations.

LO2 **Analyse the approaches, techniques and tools to deploy Intelligent Systems in an organisation**

Approaches:

The major differences between top-down and bottom-up approaches to AI.

Explainable AI (XAI).

Statistical methods, computational intelligence and traditional symbolic AI.

AI tools, libraries, platforms and frameworks:

Options include but are not limited to Tensorflow, Torch, Theano, Azure Machine Learning, Azure Cognitive Services, Azure Bot Service, MathWorks Matlab (plus Simulink), CNTK (Computational Network Toolkit), Deeplearning4j, Scikit-Learn, Swift AI IBM Watson, Keras, Pybrain, Google ML kit, Caffe, H20: open source AI platform.

Algorithms and techniques:

Understanding Machine Learning algorithms and processes, including dataset preparation, feature engineering and selection, training and validating datasets, model training, selecting and interpreting model evaluation metrics and model deployment and management

Linear regression, logistic regression, decision tree, SVM (Support Vector Machine), Naïve Bayes, KNN (K-Nearest Neighbors), K-Means, random forest, Dimensionality Reduction Algorithms, gradient boosting and AdaBoost

Tools and required relationships for testing, e.g. accurate and clear documentation, role of static testing and review in early defect detection, the need to follow specific industry standards (e.g. GDPR, health informatics, safety critical) and psychology mindset of tester-developer relationship.

LO3 **Modify an AI-based system to improve how it exhibits intelligence in response to a real-world problem**

AI-based system:

Common types of computer vision solution, including image classification, object detection solutions, optical character recognition, facial detection, recognition and analysis

Common types of natural language processing, including key phrase extraction, entity recognition, language modelling, speech recognition and synthesis, translation

Common types of conversational AI, e.g. webchat bots.

Modification:

Modify existing AI-based system using cloud-based solutions, e.g. Azure Machine Learning studio, Azure Cognitive Services and Azure Bot service

Identifying the need to make modifications

Modifying commands

Impact of modification on cost and quality

Improvement identification, e.g. accuracy, efficiency, speed.

Application selection:

Criteria for AI-based application selection, e.g. any application software, system or agent that exhibits intelligence as part of its problem-solving approach, e.g. open-source projects from Google and GitHub.

AI analysis:

Overfitting, underfitting

Data collection, data sources and assessment of data reliability to modify AI-based system.

LO4 **Evaluate the technical and ethical challenges and opportunities of Intelligent Systems.**

Ethics in the use of AI:

Identify guiding principles for responsible AI, e.g. fairness, reliability, safety, privacy, security, inclusiveness, transparency, accountability

Use of deep learning in recruiting new employees, e.g. Deepfake

AI bias and the ethical dilemma, e.g. potential to widen socio-economic inequality, AI-powered hiring processes (employment opportunities), access to skilling, health/life extension, algorithmic quantitative trading

Autonomous weapons (mass casualties), AI arms race, ethical implications of autonomous weapons.

Challenges:

Overfitting, AI lack of reasoning, e.g. naïve physics, folk psychology

The impact of data quality and quantity, e.g. on the accuracy of an AI algorithm

Job automation, risks of mass unemployment

Intelligent Systems and Intelligent Agents have no emotions or out-of-the-box thinking

Limited understanding of the AI decision-making process, e.g. deep learning

Challenges related to the lack of compliance frameworks while considering legal and emerging legal factors, e.g. GDPR, Data Protection and governance

Risks; privacy and security, e.g. Deepfake technology, emerging technology, aligning AI goals with objective(s)

Challenges related to readiness, e.g. lack of understanding of AI (and the value of data) among non-technical employees, lack of business alignment, robust testing, alignment of AI goals with defined objectives

AI and Intelligent Systems are emerging technologies, not fully tested

The environmental footprint of AI, e.g. the carbon impact of AI

Myth and fiction around AI, e.g. mythical worry of 'AI turning conscious' vs actual worry, 'AI turning competence with objectives misaligned with ours'.

Opportunities:

Artificial cognitive abilities could make faster and more accurate decisions, e.g. intelligence advice in health care

Enabling affordability of services, e.g. automation reduces operational costs

Meeting demand, e.g. the optimisation of routine processes increases productivity

Inform strategic decision making, e.g. profiling and risk assessment based on large datasets to predict high-risk events/actors

Mitigate physical harm, e.g. an AI-driven robot replaces a human in a dangerous location

Availability an AI system can work 24 × 7

Introducing new innovations, e.g. AI as a competitor advantage (AI is an emerging technology with growing potential enabled by increasing processing power)

Collaborative work with human input, e.g. AI and humans work together to reduce false positives.

Collaborative Robots (Cobots) and use in industry, healthcare, etc.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Discuss the theoretical foundation of Artificial Intelligence and its impact on users and organisations</td><td rowspan="5">LO1 and LO2
D1 Evaluate the potential impact of deploying several types, approaches and tools of AI and Intelligent Systems on both users and organisations.</td></tr>
<tr><td>P1 Describe the fundamental aspects of Artificial Intelligence.
P2 Describe the types and areas of application to solve current real-world problems.</td><td>M1 Analyse the advantages and disadvantages of using Artificial Intelligence to an area of application.</td></tr>
<tr><td colspan="2">LO2 Analyse the approaches, techniques and tools to deploy Intelligent Systems in an organisation</td></tr>
<tr><td>P3 Investigate options around the approaches, techniques and tools used for the deployment of modern Intelligent Systems.
P4 Compare the advantages and challenges of several tools and techniques used for the development of Intelligent Systems.</td><td>M2 Demonstrate how different approaches and tools work together for the deployment of Intelligent Systems.</td></tr>
<tr><td colspan="2">LO3 Modify an AI-based system to improve how it exhibits intelligence in response to a real-world problem</td><td rowspan="2">D2 Evaluate your own role to improve the performance of an AI-based system.</td></tr>
<tr><td>P5 Investigate the technical implementation of an AI-based system.
P6 Explore the technical options to enhance the performance of an AI-based system.
P7 Modify an AI-based system to enhance performance.</td><td>M3 Demonstrate a technical modification to an existing deployment of an AI-based system, using benchmarking to enhance its performance.</td></tr>
</table>

Pass	Merit	Distinction
LO4 Evaluate the technical and ethical challenges and opportunities of Intelligent Systems.		
P8 Investigate the security and ethical issues with Intelligent Systems. **P9** Discuss the technical challenges involved in managing and maintaining Intelligent Systems.	**M4** Review the legal implications and security risks to both users and organisations of using Intelligent Systems.	**D3** Analyse the technical and ethical challenges while appreciating the opportunities of Intelligent Systems.

Recommended Resources

Textbooks

Géron, A. (2019). *Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems*. O'Reilly Media.

Lauterbach, A. and Bonime-Blanc, A. (2018). *The Artificial Intelligence Imperative: A Practical Roadmap for Business*. ABC-CLIO.

Liu, Yuxi (Hayden) (2020). *Python Machine Learning By Example: Implement machine learning algorithms and techniques to build intelligent systems*. Packt Publishing Ltd.

Marcus, G., & Davis, E. (2019). *Rebooting AI: Building Artificial Intelligence We Can Trust*. New York, USA: Pantheon.

Russell, S. and Norvig, P. (2021). *Artificial Intelligence: A Modern Approach*. 4th Edition. Pearson.

Zaccone, G. and Karim, M. R. (2018). *Deep Learning with TensorFlow: Explore neural networks and build intelligent systems with Python*. 2nd Edition. Packt Publishing Ltd.

Websites

journals.elsevier.com	*Artificial Intelligence*. Elsevier (Journal)
cis.ieee.org/publications	*IEEE Transactions on Artificial Intelligence* (Journal)
ieeexplore.ieee.org	*IEEE Intelligent Systems* (Journal)
mdpi.com	AI, MDPI (Journal)
dl.acm.org	*ACM Transactions on Intelligent Systems and Technology* (Journal)
opensource.google	Google's Open-source Machine Learning projects (Reference)

Links

This unit links to the following related units:

Unit 20: Internet of Things

Unit 36: Application Development

Unit 37: Applications Program Interfaces.

Unit 16: Website Design & Development

Unit code	**Y/618/7419**
Unit level	**4**
Credit value	**15**

Introduction

Wireless, public hotspot, mobile broadband and unlimited network connections mean that accessing and using the internet to request, use and post information has never been so easy, or so important. As public, organisational and business demand increases so does user expectation. Designers need to use technology successfully to deliver high-quality and consistent User Experiences (UX) through friendly and functional User Interfaces (UI). However, as the software and hardware evolve so does the challenge of design.

This unit introduces students to the underpinning services required to host, manage and access a secure website. Students will then be introduced to and explore the methods used by designers and developers to blend back-end technologies (server-side) with front-end technologies (client-side). To help ensure that new designers are able to design and deliver a site that offers an outstanding User Experience (UX) supported by an innovative User Interface (UI), students will discuss the reasons, requirements, relationships, capabilities and features of the systems they will be using. This gives them an opportunity to explore various tools, techniques and technologies with 'good design' principles in order to plan, design and review a multipage website.

Among the topics included in this unit are: domain structure, domain name systems, web protocols, database servers, development frameworks, website publishing, content management, search engine optimisation, web browsers, HTML standards, CSS and CSS pre-processing (LESS, SASS), presentation models, responsive design, integrated development environments, user requirements, interface design, user experience, branding, navigation, optimisation and validation.

On successful completion of the unit, students will be able to explain the server technologies and management services associated with hosting and management of secure websites, categorise website technologies, tools and software used to develop websites, utilise website technologies, tools and techniques with good design principles to create a multipage website, and create and use a Test Plan to review the performance and design of a multipage website. As a result, students will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

By the end of this unit students will be able to:

LO1 Explain server technologies and management services associated with hosting and managing websites

LO2 Categorise website technologies, tools and software used to develop websites

LO3 Utilise website technologies, tools and techniques with good design principles to create a multipage website

LO4 Create and use a Test Plan to review the performance and design of a multipage website.

Essential Content

LO1 Explain server technologies and management services associated with hosting and managing websites

Hosting and website management:

Relationships between domain names, Domain Name System (DNS) services and communication protocols used to access a website

Overview of publishing and managing secure websites, including search engine indexing and ranking.

Different server technologies:

Differences between web server hardware, software and host operating systems

Advantages of an integrated database system with regard to expanding website capability

Common web development technologies and frameworks.

LO2 Categorise website technologies, tools and software used to develop websites

Website technologies:

Using front-end technologies, presentation layers and client-side programming to build a User Interface (UI) and effect User Experience (UX)

How back-end technologies, application layers and server-side programming can be used to enable personalisation and deliver dynamic content

Tools, techniques and software used to develop websites, e.g. integrated development environments, code repositories, low code environments, front-end and back-end processing

Improving User Experience (UX) through Rich Internet Application (RIA) design using JavaScript and CSS frameworks and packages

Overview of online content management systems, including possible advantages and limitations with regard to design

Using web design and development software to design and build a secure website.

LO3 **Utilise website technologies, tools and techniques with good design principles to create a multipage website**

Establish the client and user requirements:

Differentiate client and user requirements from behaviours

Consider how audience and purpose could influence the look and feel of a website

Review accessibility and inclusivity standards and guidelines, e.g. World Wide Web Consortium (W3C), Equality Act 2010 and other relevant legislation, and their possible impact on design and aesthetics.

Research and create good content, combined with good design principles to create a multipage website:

Introduce and use recognised design principles, incorporating accessibility and inclusivity guidelines to implement an appropriately branded, multipage site

Guidelines and recommended good practice to ensure the website and associated data is 'secure by design'

Discuss why and how the quality of content can affect the performance of a website.

LO4 **Create and use a Test Plan to review the performance and design of a multipage website.**

Consider factors that influence website performance:

Review how intuitive interfaces and actions, user-friendly designs, appropriate graphics, effective navigation and good-quality content can help establish user trust and deliver an improved User Experience (UX)

Consider the effects of good and bad search engine optimisation (SEO) and indexing on the performance of a website

W3C Validation (HTML and CSS) and how it influences website design and performance.

Establish a Test Plan and use it to assess the performance of a website:

Assess the impact of poorly optimised website graphics

Research and conduct Quality Assurance (QA) and usability testing on a multipage website.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Explain server technologies and management services associated with hosting and managing websites</td><td rowspan="5">LO1 and LO2

D1 Justify the technologies, management services, tools and software chosen to realise a custom-built website.</td></tr>
<tr><td>P1 Identify the purpose and types of DNS, including explanations on how domain names are organised and managed.

P2 Explain the purpose of and relationships between communication protocols, server hardware, operating systems and web server software, with regard to designing, publishing and accessing a website.</td><td>M1 Analyse the impact of common web development technologies and frameworks with regard to website design, functionality and management.

M2 Review the influence of search engines on website performance and provide evidence-based support for improving a site's index value and rank through search engine optimisation.</td></tr>
<tr><td colspan="2">LO2 Categorise website technologies, tools and software used to develop websites</td></tr>
<tr><td>P3 Discuss the capabilities and relationships between front-end and back-end website technologies and explain how they relate to presentation and application layers.

P4 Discuss the differences between online website creation tools and custom-built sites with regard to design flexibility, performance, functionality, User Experience (UX) and User Interface (UI).</td><td>M3 Analyse a range of tools and techniques available to design and develop a custom-built website.</td></tr>
</table>

Pass	Merit	Distinction
LO3 Utilise website technologies, tools and techniques with good design principles to create a multipage website		
P5 Create a design document for a branded, multipage website, supported with medium fidelity wireframes and a full set of client and user requirements. **P6** Use the design document with appropriate principles, standards and guidelines to produce a branded, multipage website supported with realistic content.	**M4** Justify the multipage website implementation decisions against the design document.	**D2** Evaluate the design and development process of the multipage website against the design document including any technical challenges faced.
LO4 Create and use a Test Plan to review the performance and design of a multipage website.		
P7 Create a suitable test plan, identifying key performance areas to review the functionality and performance of the multipage website developed.	**M5** Analyse the Quality Assurance (QA) process and review how it was implemented during the multipage website design and development stages.	**D3** Evaluate the results of the Test Plan and the overall success of the multipage website, with recommendations for improvement.

Recommended Resources

Textbooks

Frain, B. (2012) *Responsive Web Design with HTML5 and CSS3*. UK: Packt Publishing.

Krug, S. (2013) *Don't Make Me Think: A Common Sense Approach to Web Usability.* USA: New Riders.

Lidwell, W., Holden, K. and Butler, J. (2010) *Universal Principles of Design, Revised and Updated: 115 Ways to Enhance Usability, Influence Perception, Increase Appeal, Make Better Design Decisions and Teach Through Design*. USA: Rockport Publishers.

Websites

developers.google.com/web/tools	Google web development tools (General reference)
getbootstrap.com	Open source web development tool kit (General reference)
www.w3.org	World Wide Web Consortium (General reference)

Links

This unit links to the following related unit:

Unit 32: Digital Technologies as a Catalyst for Change

Unit 40 Customer Value Management.

Unit 17: Management in the Digital Economy

Unit code	**H/618/5690**
Unit level	**4**
Credit value	**15**

Introduction

The internet creates a borderless economy and over the last few decades has taken shape resulting from billions of everyday connections between people, business, data and processes. As the digital economy continues to evolve, each day it destabilises traditional norms and practices in organisations, therefore requiring managers to reinvent and consider new ways of working. The way in which an organisation structures and organises its workforce will affect the culture that develops within it. Its system of shared values and beliefs will determine and shape the accepted pattern of behaviour within the organisation. This structure and culture, along with the way that managers approach the workforce and motivate their staff, will directly affect performance. The management of structure and culture in digital sector organisations is now quite different to those in other sectors.

This unit introduces students to the concept of organisational behaviour and encourages them to apply this to the digital sector, developing an awareness of how organisations in the digital economy are organised and formed. Students will explore topics including structures, culture, and the impact and influence that stakeholders can have on digital organisations. Students will consider the use of communication and media channels to understand different stakeholders and discover a range of digital-led management styles and leadership skills to assess those most appropriate, before applying theories of motivation to digital teams.

On successful completion of this unit, students will have discussed different types of organisational structure and culture; evaluated the impact of stakeholders in a digital sector organisation; investigated digital-led approaches to management and leadership; and assessed the relationship between motivation, organisational behaviour, performance and reflection. Students will have the opportunity to progress to a range of roles within the digital sector, which could include, for example, the role of IT Manager, Team Leader, Digital Community Manager, or working in project management.

Learning Outcomes

By the end of this unit, students will be able to:

LO1 Investigate types of organisational structures and cultures in the digital economy sector

LO2 Explore the role, impact and influence of stakeholders in a digital economy organisation

LO3 Investigate digital-led approaches to management and leadership

LO4 Assess the relationship between motivation, organisational behaviour, performance and reflection in a digital team.

Essential Content

LO1 Investigate types of organisational structures and cultures in the digital economy Sector

Digital economy organisations:

ICT-goods-producing and supporting infrastructure, i.e. hardware, software, telecoms and ICT-service-producing, e-commerce and e-business, i.e. trading of goods or services

Existing sectors increased use of digital products or services to include: government, retail, transport and logistics, financial services, manufacturing and agriculture, education, healthcare, broadcasting and media

Supporting organisations, e.g. charities, social enterprises; and voluntary groups, e.g. third sector role in supporting delivery of services.

Key terminology and organisational structures:

Organisational terms, e.g. hierarchy, span of control, chain of command, line management, authority, delegation, empowerment, lines of communication, delayering, centralisation and decentralisation, collaboration and cross-collaboration, examples of organisational charts

Structures including functional, product-based, geographically based, divisional, multifunctional and multidivisional, matrix, project, tall, flat, holistic, bureaucratic and post-bureaucratic, parent, strategic business units (SBUs)

Archetypes of digital teams, e.g. centralised, hybrid, independent, informal.

Organisational culture:

Types of organisational culture, e.g. forward-looking, backward-looking, innovation, customer-centric, digital transformation

Shared drivers of organisational culture to include: behaviours, e.g. assumptions, vision, norms, values and beliefs, systems ,e.g. processes, decision making, renumeration, and symbols, e.g. observations, language, stories

Theories, e.g. Hofstede's Cultural Dimensions (6D's), Handy's Model of Organisational Culture (power, role, task and person), Schien's Model of Organisational Culture, Lewin's Force Field Analysis for change; and digital-led trends, e.g. social connectivity, communication speed, learning, automation.

LO2 **Explore the role, impact and influence of stakeholders in a digital economy organisation**

Size and scope of organisations in the digital sector:

Differences between small-, medium- and large-sized organisations, including objectives and goals, market share, profit share, growth and sustainability

Global digital growth and developments of transnational, international and global organisations.

Role and community impact of stakeholders:

Examples of organisational stakeholders, e.g. employees, communities, shareholders, creditors, investors, government, customers, owners, managers, suppliers, competitors, unions, trade groups, analysts and media

Stakeholders and responsibilities of organisation to engage with different internal and external stakeholder interests, perspectives and expectations

Importance of corporate communication strategy alignment to support business objectives, brand loyalty and community relationships

Stakeholder communication and media channels, e.g. corporate website, online communities and forums, publications, meetings and visits, to communicate technical information to both technical and non-technical audiences

The relationship with stakeholders and meeting stakeholder expectations in the context of encouraging, developing and sustaining community; sharing and delivering welcomed and unwelcomed information; conflict management techniques and understanding of community management best practice relevant in the industry.

Influence of stakeholders in the digital sector:

The importance of effective communication and engagement with a range of stakeholders in relation to business analysis assignments

Central government, e.g. legislation, budget and spending review, economic growth, education and social welfare

Private and public sector, e.g. digital innovation and change (new technologies, business processes, business models, domains and people development), labour force (elimination and creation of jobs) and transparency of business habits

Customer, clients and users, e.g. law of supply-demand, accessibility of data and content, surveillance capitalism, consumer rights and brand reputation.

LO3 **Investigate digital-led approaches to management and leadership**

Digital-led approaches to management:

Quantitative or mathematical approach, i.e. management science

Systems approach, i.e. systems management

Contingency or situational approach, i.e. empirical case study

Administrative or management process, i.e. 'traditional' or 'universalist'

Human relations, i.e. social and psychological factors

Behavioural science, i.e. interpersonal behaviour

Decision-theory, i.e. decision-making

IT-led management, i.e. operational and management process.

Types of management styles:

Methods used by managers to organise people, e.g. directive, authoritative, visionary, affiliative, participative, pacesetting, autocratic, consultative, servant, persuasive, democratic, chaotic, laissez-faire, paternalistic or maternalistic, transactional, results-based, transformational

Roles and responsibilities of managers, e.g. interpersonal, informational, decisional, planning, leading, organising, commanding, coordinating, coaching, controlling, decision making, conflict resolution, managing change, delegation, contingency planning

Identify ways that managers elicit information from stakeholders to process information, identify business needs, validate requirements and document areas of interest and influence.

Digital-led leadership skills:

Adopted roles and characteristics, i.e. digital champions, digital investors, digital pioneers, digital transformers

Leader capabilities, i.e. cognitive transformation, behaviour transformation and emotional transformation.

LO4 **Assess the relationship between motivation, organisational behaviour, performance and reflection in a digital team.**

Motivation and performance:

Motivational theories including content theories, e.g. Maslow, Herzberg, Alderfer, process theories, e.g. Vroom, Adams, Latham and Locke, and applications of motivational theory on management and leadership

The use of rewards and incentives (monetary and non-monetary), effective management, performance standards (goal setting, appraisals) and staff morale on digital team's performance management.

Organisational behaviour and reflective practice:

Organisational psychology, personality and work behaviour, self and self-image, personality traits and types, e.g. Myers Briggs Type Indicator (MBTI), group dynamics and inter-group behaviour, e.g. Belbin Team Roles

Benefits of reflective practice on individual and organisation performance, recognition of paradigms, i.e. assumptions, frameworks, patterns of thought and behaviour, thinking and action

Organisational learning, monitoring and evaluation

Addressing issues of position, conflict, resistance and power relationships

Reflective theory and models, e.g. Dewey, Schön, Gibbs' reflective cycle, Lawrence-Wilkes' REFLECT model, Rolfe et al's reflective model.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Investigate types of organisational structures and cultures in the digital economy sector</td><td rowspan="5">LO1 and LO2
D1 Evaluate the structure, culture, role, impact of communication and influence of stakeholders in a digital sector organisation.</td></tr>
<tr><td>P1 Explain different types of organisational structures in the digital economy.
P2 Describe the concept of culture as it applies to digital sector organisations.</td><td>M1 Discuss the different structures and cultures used in the digital economy, providing specific examples.</td></tr>
<tr><td colspan="2">LO2 Explore the role, impact and influence of stakeholders in a digital economy organisation</td></tr>
<tr><td>P3 Explain the role of stakeholders, providing specific examples, in the digital sector.
P4 Review stakeholder communication and media channels to identify a threat or opportunity in a digital sector organisation.</td><td>M2 Analyse how different stakeholders and choice of communication and media channels can impact on and influence a digital sector organisation.</td></tr>
<tr><td colspan="2">LO3 Investigate digital-led approaches to management and leadership</td><td rowspan="5">LO3 and LO4
D2 Assess the management approach and leadership skills in response to motivation theory and organisational behaviour to improve performance of a digital team.</td></tr>
<tr><td>P5 Discuss different approaches to management styles, providing specific examples.</td><td>M3 Analyse the roles, characteristics and capabilities of digital-led leaders.</td></tr>
<tr><td colspan="2">LO4 Assess the relationship between motivation, organisational behaviour, performance and reflection in a digital team.</td></tr>
<tr><td>P6 Describe the relationship between motivation, organisational behaviour and reflection on performance.</td><td>M4 Compare advantages and disadvantages of using motivation and reflection theories when applied to a digital team.</td></tr>
</table>

Recommended Resources

Textbooks

Beames, C. (2019) *How to Manage Your Workforce in the Digital Age*. Online: Blurb.

Garfield, S.A. (2020) *Handbook of Community Management: A Guide to Leading Communities of Practice.* Berlin: Walter de Gruyter.

Hill, A. (2016) *Leadership in the Headlines: Insider insights into how leaders lead*. London: Financial Times Publishing.

Huczynski, A. and Buchanan, D. (2013) *Organisational Behaviour*. 8th Ed. Harlow: Pearson.

Mullins, L. J. (2016) *Management and Organisational Behaviour*. 11th Ed. Harlow: Pearson.

O'Brien, J. (2017) *The Power of Purpose: Inspire teams, engage customers, transform business*. Online: Pearson Business.

Raskino, M. and Waller, G. (2015) *Digital to the Core: Remastering Leadership for Your Industry, Your Enterprise and Yourself*. Oxon: Taylor & Francis.

Rollinson, D. (2008) *Organisational Behaviour and Analysis: An Integrated Approach*. 4th Ed. Harlow: Prentice Hall.

Schedlitzki, D. and Edwards, G. (2014) *Studying Leadership: Traditional and Critical Approaches*. London: SAGE.

Stokes, P. et al (2016) *Organizational Management: Approaches and Solutions*. London: Kogan Page.

Szczepanska-Woszczyna, K. (2020) *Management Theory, Innovation, and Organisation: A Model of Managerial Competencies*. Oxon: Taylor & Francis.

Yuki, G. and Gardener, W. L. (2019) *Leadership in Organizations, Global Edition*. 9th Ed. Online: Pearson.

Journals

Journal of Leadership and Organizational Studies. Sage Online.

Journal of Management (online). Sage Online.

Journal of Occupational and Organizational Psychology (online). The British Psychological Society Online.

Websites

belbin.com	The Nine Belbin Team Roles (General reference)
myersbriggs.org	The Myers & Briggs Foundation (General reference)

Links

This unit links to the following related unit:

Unit 32: Digital Technologies as a Catalyst for Change

Unit 40: Customer Value Management.

Unit 18: Project Management

Unit code	**K/618/5688**
Unit level	**4**
Credit value	**15**

Introduction

Skilled project managers are expert in bringing together people, materials and processes in the right order, at the best possible time. Projects can be complex and highly technical or straightforward and simple but the aim of achieving a clearly defined output for a project in the most effective and economical way is the same.

This unit introduces students to the elements that constitute a project, the tools available to help achieve the specified outcome and the role of the project team and the project manager in the process. Students will examine the criteria for the success or failure of a project, evaluate project management systems and consider the reflective and analytical processes involved in the appraisal of the finished project. They will also look at the need for structured organisation and responsibility, effective control, coordination and reporting; and communication and leadership in the project team.

On successful completion of the unit, students will be able to define a project, create project plans, set up the delivery of the project, execute and review the outputs, and understand the outcomes – how the project fits into the wider business planning strategy of the organisation.

Learning Outcomes

By the end of this unit a student will be able to:

LO1 Explain the key stages of the project lifecycle that should be considered when project managing

LO2 Describe the principles of project management and the tools available to assist the process

LO3 Create a project plan for a digital technologies project and implement it

LO4 Reflect on value gained from implementing the project and the project management process.

LO1 **Explain the key stages of the project lifecycle that should be considered when project managing**

Project management: defining project management:

The project lifecycle and the stages of the project lifecycle, e.g. initiation, planning, execution and closure

The advantages of using project management and why it is important

Roles in project managing, e.g. assistant project manager, junior project manager, project team leader and responsibilities to drive through the project and achieve required outcomes

Project management skills, including good planning, organising, leadership and communication skills

Organisational approaches to project management.

Project management plans:

Scoping a project − defining objectives, scope, purpose and deliverables to be produced

Developing the project plan, including planning for timescales and time management, cost, quality, change, risk, stakeholder communication.

LO2 **Describe the principles of project management and the tools available to assist the process**

Project management tools:

Different types of software and application used to support project management, e.g. Microsoft Project for tracking, managing and analysing projects and Asana for holistic project management and integration of workload, inbox, calendars and tasks. Use of project-planning tasks and tracking tools, e.g. Trello, Smartsheet and Excel spreadsheets. Tools and techniques used to create activity plans, work breakdown structure (WBS) and Gantt charts for effective planning.

Consolidated planning:

Purpose and formats for consolidated plan to support overall management

Support the establishment of requirements traceability

Plan fundamental components of scope, schedule, resources, budgets, risks and quality

Approaches to conducting internal and external environmental analysis of an industry domain.

Project management life cycle:

e.g. initiate, plan, execute, monitor, control, close

Methodologies and key principles, features and differences, e.g. Waterfall, Agile, Hybrid, Critical Path, Critical Chain, Six Sigma, Scrum.

Organisational structure:

Functional, project and matrix organisational structures

Consideration of cultural and environmental influences

Organisational evolution during the project lifecycle

Job descriptions and key roles in the project team

Influence of the project sponsor or owner, champion, manager, integrators, users and stakeholders.

Roles and responsibilities:

Planning, scheduling and resourcing techniques

Preparation of project plans

Operator training/re-certification

Monitoring and control.

Control and coordination:

Use of work breakdown structures to develop monitoring and control systems

Performance monitoring and progress measurement against established targets and plans

Project reporting

Changes in control procedures, documentation version control Importance of cascading, communications briefing, instilling trust and confidence in others.

Communication:

Key contexts of a project communication plan, effectiveness in managing different stakeholders

Factors that can affect communications such as cultural and physical barriers.

Leadership:

Vision and values of the project and its links to objectives; the ways in which these can be effectively communicated and reinforced to team members and stakeholders, e.g. stages of team development; Belbin's team roles; motivation and team building

Project leadership styles, qualities and attributes

Importance of motivation on team performance

Delegation of work and responsibility

Techniques for dealing with conflict; negotiation skills; chairing meetings

Characteristics of the working environment which encourage and sustain high performance.

Stakeholders:

Project stakeholder management, e.g. their perspectives, different interests and levels of influence on project outcomes

Stakeholder engagement, e.g. challenges, complexities, limitations.

Human resources and requirements:

Calculation, specification and optimisation of human resource requirements, job descriptions

Formation of project teams

Project initiation and start-up procedures.

Project risk and issue management:

Need for and implementation of a risk management plan

Risk management methods and techniques to identify and prioritise threats or opportunities

Mitigation actions to minimise risk impacts

Optimise benefits by managing opportunities.

LO3 **Create a project plan for a digital technologies project and implement it**

Project management plans:

The 'why, what, how, when, where and by whom' of project management

Contract terms and document distribution schedules

Procurement

Establishing the baseline for the project.

Scheduling techniques:

Scheduling and estimating for project activities and quality assurance of project activities

Relationship between schedules

Progress monitoring and metrics to assess work performed against the schedule, e.g. Organisational Breakdown Structure (OBS) and Work Breakdown Structure (WBS); bar charts; milestone schedules; network techniques; resourcing techniques; computer-based scheduling and resourcing packages; project progress measurement and reporting techniques; staff-hours earned value and progress, 'S' curves; critical path analysis and reporting; milestone trending

Schedule management methods to evaluate and revise activities to improve confidence in delivery.

Cost control techniques:

Cost breakdown structure, resources needed, e.g. funding, estimating, overheads, direct costs, indirect costs, fixed costs, variable costs and overall budget for a project

Tracking systems for actual costs, accruals and committed costs

Alternative cost breakdowns to provide for graphical representations and performance management

Types of project estimate, estimating techniques, estimating accuracy, contingency and estimation, bid estimates, whole-life cost estimates; computer-based estimating

Sources of information, sensitivity of cost information

Allocation of budgets to packages of work, committed costs, actual costs, cash flow; contingency management.

Performance:

Cost–performance analysis; budgeted cost for work scheduled (BCWS)

Budgeted cost for work performed (BCWP)

Concept of earned value

Actual cost of work performed (ACWP)

Cost–performance indicators.

Termination of the project:

Audit trails, close-out reports.

Project impact evaluation:

Achievement, e.g. expected financial and non-financial impact, investment and strategic decision, monitoring, change/social change

Impact on society, the environment, economy.

Post-project appraisals:

Comparison of project output/outcome with business objectives

Process of self-reflection on project process and outputs/outcomes.

LO4 **Reflect on value gained from implementing the project and the project management process.**

Reflection for learning and practice:

Differences between reflecting on performance and evaluating a project – the former considers the research process, information gathering and data collection, the latter the quality of the research argument and use of evidence. The cycle of reflection and using reflection to inform future behaviour.

Reflective writing:

Writing to avoid generalisation, focusing on personal development and the research journey in a critical and objective way.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Explain the key stages of the project lifecycle that should be considered when project managing		
P1 Explain the stages of the project lifecycle and their importance to the success of a project. **P2** Examine the factors to be considered when compiling a project management plan (PMP).	**M1** Analyse the stages of the project lifecycle and the factors, (deliverables, quality, risk, communication and resources) to be considered in a PMP.	**D1** Evaluate the project management process.
LO2 Describe the principles of project management and the tools available to assist the process		
P3 Explain the principles of project management. **P4** Detail the importance of scheduling techniques in a project plan.	**M2** Analyse the role of control and coordination in the delivery of a project plan.	**D2** Evaluate the importance of leadership in the role of the project team.
LO3 Create a project plan for a digital technologies project and implement it		
P5 Produce a project plan for a digital technologies project that covers the aims, objectives, deliverables, quality, risk, communication approach(es) and resources. **P6** Implement the project plan.	**M3** Produce a detailed project plan for a digital technologies project and schedule for monitoring and completing the aims and objectives of the project.	**D3** Justify the choices made in the design of the project plan for a digital technologies project for completing the aims and objectives of the project.
LO4 Reflect on value gained from implementing the project and the project management process.		
P7 Reflect on the value of undertaking the digital technologies project to meet stated objectives, own learning and performance.	**M4** Analyse the project management tools selected to assist with the delivery and monitoring of the project plan.	**D4** Evaluate the effectiveness of the project plan produced in the light of expert and peer group feedback.

Recommended Resources

Textbooks

Banfield, R. (2017) *Product Leadership: How Top Product Managers Launch Awesome Products and Build Successful Teams*. Sebastopol, CA: O'Reilly Media.

Broughton, P. (2013) *Life's a Pitch*. London: Portfolio Penguin.

Ess, C. (2015) *Digital Media Ethics*. 2nd Edition. Cambridge, UK: Polity.

Harrin, E. (2016) *Collaboration Tools for Project Managers: How to Choose, Get Started and Collaborate with Technology*. Newton Square, PA: Project Management Institute.

Kersten, M. (2019) *Project to Product: How Value Stream Networks Will Transform IT and Business: How to Survive and Thrive in the Age of Digital Disruption with the Flow Framework*. Portland: IT Revolution.

Newton, R. (2016) *Project Management Step by Step*. 2nd Edition.
Harlow: Pearson Education. SMITH.

Thompson, S. (2018) *The Critically Reflective Practitioner*. New York: Palgrave Macmillan.

Websites

apm.org	Association of Project Management (General reference)
cipmglobal.org	Chartered Institute of Project Management (General reference)
institute.pm	Institute of Project Management (General reference)
mindtools.com	Resources to support the development of management, leadership and personal effectiveness skills. (General reference)
skillsyouneed.com	Life skill improvement. (General reference)
thedigitalprojectmanager.com	Project management resources, training and membership. (General reference)

Links

This unit links to the following related unit:

Unit 30: Business Information Technology Systems.

Unit 19: Business Intelligence

Unit code	**M/615/1641**
Unit type	**Core**
Unit level	**5**
Credit value	**15**

Introduction

Modern business intelligence focuses on having a comprehensive view of an organisation's data and to then use that data to drive change, eliminate inefficiencies, and quickly adapt to market or supply changes. The necessity of having meaningful information is the key driver for effective decision-making and problem-solving. Business intelligence can help companies make better decisions by showing present and historical data within their business context. Business intelligence has evolved from technologies such as decision support systems (DSS) to include tools and methods associated with data mining, data integration, data quality and data warehousing in conjunction with other information management systems and applications.

This unit introduces students to a range of tools, techniques and technologies for acquiring data and processing this into meaningful information that can be used to support business functions and processes.

Within this unit students will examine the concept of business processing in terms of data capture, conversion and information output. Students will also be required to define the tools and technologies associated with business intelligence functionality. They will develop a business intelligence tool and demonstrate techniques to understand a given problem. Finally, students will be expected to evaluate the impact of business intelligence for effective decision-making.

On successful completion of this unit students will be able to appreciate the importance of business intelligence in terms of optimising decision-making and performance. By exploring the tools, techniques and systems that support business intelligence students will have an awareness of the role and contribution that these technologies and methodologies have and their importance to organisations.

As a result students will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

By the end of this unit students will be able to:

LO1 Discuss business processes and the mechanisms used to support business decision-making

LO2 Compare the tools and technologies associated with business intelligence functionality

LO3 Demonstrate the use of business intelligence tools and technologies

LO4 Discuss the impact of business intelligence tools and technologies for effective decision-making purposes and the legal/regulatory context in which they are used.

Essential Content

LO1 Discuss business processes and the mechanisms used to support business decision-making

Business process model:

The definition of Business Analysis and the range of activities that constitute it

The role of the Business Analyst in facilitating business acceptance of changes, and its relationship with other roles on a business change initiative, including those with system development responsibility

The value of Business Analysis in enabling business improvement

Eliciting process information from stakeholders

The purpose and activities of the gap analysis process and the advantages and disadvantages of a range of investigative techniques for business analysis

The different phases of testing of business and system changes

Data input and capture, data processing/conversion and information output, security considerations; unstructured and semi-structured data

Tactical and operational decisions, the business process model, business intelligence functionality

Analyse and compare the systems and technologies associated with business intelligence including the purpose of business process models for an organisational view and to help identify opportunities for improvement.

Mechanisms:

Application software, databases, which are used to collect and store intelligence, including the principles and uses of relational and non-relational databases

Systems that are used to manage, analyse and display business intelligence to support the decision-making process; the importance of reliable data; impacts of reliable data in businesses.

Business processes:

Different approaches to document business processes including when it is most appropriate to use each

The different phases of testing of business and system changes

Management e.g. supporting decision-making, problem-solving; operational e.g. sales, purchasing and marketing; support e.g. accounting, technical supporting processes; improving the efficiency of a business process e.g. forecasting, decision-making, predictive reasoning; automating processes e.g. print runs, salary slips etc.

LO2 **Compare the tools and technologies associated with business intelligence functionality**

Support for business decisions:

Operational tactical and strategic. Operational examples could include product positioning or pricing. Tactical decisions could include financial outlays to gain competitive advantage. Strategic business decisions could include priorities, goals setting and forecasting for the future, global diversification etc.

Business intelligence functionality:

Analysing data, decision-making, problem-solving, designing more intuitive/innovative systems.

Systems and technologies:

Information systems at an operational, tactical and strategic level. Transaction processing, management information systems, decision support systems, expert systems.

LO3 **Demonstrate the use of business intelligence tools and technologies**

Tools and techniques:

Techniques to elicit requirements, including when it is most appropriate to use each, rather than gathering solution descriptions, applying appropriate approaches to scope, plan and perform Business Analysis

Approaches to categorise, validate and prioritise requirements including requirements management and change control

A broad range of non-functional requirement areas, and the importance of including these within requirements engineering

Descriptive and predictive analysis, predictive modelling e.g. forecasting, use of statistical models to predict and identify trends. Data mining techniques to find anomalies, cluster patterns and/or relationships between data sets. Converting data into visual information using charts, graphs, histograms and other visual mediums.

Solutions:

Supporting a business process e.g. end user requirements, systems requirement, application to automate procedures

Designing a tool, program or package that can perform a specific task to support problem-solving or decision-making at an advanced level.

Uses:

For example, designing an application to solve a specific user need or system requirement. Create an e-commerce function for a website to support a specific business process, design a program for a specific end user that will support another application or process.

Design considerations:

Business change and system development life cycles, including the use of appropriate methodologies and the impact of organisational culture and context

Elicit user or system requirement from stakeholders to identify needs and analyse to remove duplication, conflict and overlap

Document functional and non-functional needs in line with local standards

Design a user-friendly and functional interface including user engagement and interaction with the designed solution and customisation of the solution to satisfy the user and system requirements

Support the establishment of requirements traceability

Assess the impact on user experience and domain context of the data analysis activity.

LO4 **Discuss the impact of business intelligence tools and technologies for effective decision-making purposes and the legal/regulatory context in which they are used.**

Legal and regulatory understanding:

Recognise the legal, social, ethical and professional issues involved in the exploitation of computer technology.

Cybersecurity management:

Understanding the personal, organisational and legal/regulatory context in which business intelligence (BI) tools could be used including in cybersecurity management

The risks of use of BI tools and the constraints (such as time, finance and people) that may affect how cybersecurity is implemented

Ethical principles and codes of good practice of a cyber security professional body

Ethical responsibilities of a cyber security professional in relation to business intelligence gathering.

Evaluation criteria for effective business intelligence:

Enhanced or improved operations e.g. more efficient, faster results, more user-friendly, higher productivity, extended target audience, more competitive, more profitable, improved customer service.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Discuss business processes and the mechanisms used to support business decision-making</td><td rowspan="4">LO1 and LO2

D1 Evaluate a range of information systems and technologies that can be used to support organisations at operational, tactical and strategic levels.</td></tr>
<tr><td>P1 Examine, using examples, the terms ‘business processes’ and ‘supporting processes’.</td><td>M1 Differentiate between unstructured and semi-structured data within an organisation.</td></tr>
<tr><td colspan="2">LO2 Compare the tools and technologies associated with business intelligence functionality</td></tr>
<tr><td>P2 Compare the types of support available for business decision-making at varying levels within an organisation.

P3 Determine, with examples, what business intelligence is and the tools and techniques associated with it.</td><td>M2 Justify, with specific examples, the key features of business intelligence functionality.</td></tr>
<tr><td colspan="2">LO3 Demonstrate the use of business intelligence tools and technologies.</td><td rowspan="2">D2 Critically review the design in terms of how it meets a specific user or business requirement and identify the customisation that has been integrated into the design.</td></tr>
<tr><td>P4 Design and implement a business intelligence tool, application or interface that can perform a specific task to support problem-solving or decision-making at an advanced level.

P5 Improve the business intelligence tool by gathering feedback and refining it.</td><td>M3 Customise the solution to ensure that it is user-friendly and has a functional interface.</td></tr>
</table>

Pass	Merit	Distinction
LO4 Discuss the impact of business intelligence tools and technologies for effective decision-making purposes and the legal/regulatory context in which they are used.		
P6 Discuss how business intelligence tools can contribute to effective decision-making. **P7** Explore the legal issues involved in the secure exploitation of business intelligence tools.	**M4** Research with specific examples organisations that have used business intelligence tools to enhance or improve operations.	**D3** Evaluate how organisations could use business intelligence to extend their target audience and make them more competitive within the market, taking security legislation into consideration.

Recommended Resources

Textbooks

Boyer, J. (2010) *Business Intelligence Strategy*. MC Press (US).

Jeston, J. and Nelis, J. (2014) *Business Process Management*. 3rd Ed. Routledge.

Kolb, J. (2013) *Business Intelligence in Plain Language: A practical guide to Data Mining and Business Analytics*. CreateSpace Independent Publishing Platform.

Marr, B. (2015) Big Data: *Using Smart Big Data, Analytics and Metrics to Make Better Decisions and Improve Performance*. 1st Ed. John Wiley & Sons, Ltd.

Journals

International Journal of Business Intelligence and Data Mining.

International Journal of Business Intelligence Research (IJBIR).

Websites

businessintelligence.com	Business Intelligence (General Reference)
business-intelligence.ac.uk	Business Intelligence Project for HE (General Reference)

Links

This unit links to the following related units:

Unit 3: Cyber Security

Unit 5: Big Data and Visualisation

Unit 21: Emerging Technologies

Unit 29: Applied Analytical Models

Unit 32: Digital Technology as a Catalyst for Change.

Unit 20: Internet of Things

Unit code	**J/618/7481**
Unit type	**Core**
Unit level	**5**
Credit value	**15**

Introduction

The Internet of Things (IoT) is a network of physical objects – devices, vehicles, drones and other objects embedded with electronics, software, sensors and network connectivity – that enables those objects to collect and exchange data. The objective of the IoT is to enable almost any object to become smart, accessible and data capable, thereby benefitting from advances in communications, computation and interconnectivity. IoT explores the mixture of hardware, software, data, platforms and services that can be combined to create innovative opportunities for more direct integration of the physical world and objects into computer-based systems, resulting in improved efficiency, accuracy and social and economic benefits.

This unit introduces students to the role, basic concepts and benefits of IoT in the design and development process of computer applications. The aim of the unit is to enhance understanding of the methodology, terminology and benefits of IoT in the design and development of software applications.

Among the topics included in this unit are: classification and terminology of IoT; the hardware, software, data, platforms and services used to enable IoT; common architecture, frameworks, tools, hardware and APIs that can be utilised to design IoT-enabled objects; problems and solutions resulting from widespread deployment and adoption of IoT; software application methodology for IoT-specific software application design and development; data models; network complexity; security; privacy; enabling technologies; and how to simulate and test an IoT concept.

On successful completion of this unit, students will be able to: explain the basic concepts of IoT; design, build and simulate an IoT application using any combination of hardware, software, data, platforms and services; discuss the problems that IoT applications solve; the potential impact on society, business and the end user; and the problems encountered when integrating into the wider IoT ecosystem. As a result, students will develop skills such as communication literacy, design thinking, team working, critical thinking, analysis, reasoning and interpretation, and computer software literacy, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

By the end of this unit students will be able to:

LO1 Analyse what aspects of IoT are necessary and appropriate when designing software applications

LO2 Outline a plan for an appropriate IoT application using common architecture, frameworks, tools, hardware and APIs

LO3 Develop an IoT application using any combination of hardware, software, data, platforms and services

LO4 Evaluate your IoT application and the problems it might encounter when integrating into the wider IoT ecosystem.

Essential Content

LO1 **Analyse what aspects of IoT are necessary and appropriate when designing software applications**

Identify role, formats and characteristics of IoT:

Present an overview of IoT and its appropriate use in software development

Investigate what IoT is by researching its role, purpose, terminology and methodology

Explore NB-IoT and eLTE-IoT, including standards evolution and industry development, related technologies, differences, and similarities between NB-IoT and eLTE-IoT

Appropriateness of various architecture, frameworks, tools, hardware and APIs for different problem-solving requirements, including architecture of NB-IoT solution and eLTE-IoT solutions, NB-IoT physical Layer, key NB-IoT Features, open modules for integration, E2E Ecosystems, lightweight devices

Describe application scenarios of NB-IoT and eLTE-IoT

Recognise the various forms of IoT by researching its history, current trends and use in relation to, and in conjunction with, traditional computer-based systems and networks

Define the characteristics of IoT by investigating how it can be used and how it can interact with existing computer-based networks and the physical world

Recognise the use of appropriate IoT applications to solve specific problems.

Research specific forms of IoT functionality:

Explore various forms of IoT functionality

Research, debate and agree current functionality, technology and trends for IoT. Investigate the advantages and disadvantages of using IoT

Common problems in smart campuses and cities, pain points, corresponding solutions

Requirements of IoT technologies, including ensuring appropriate functionality; the need to reduce power consumption of the smart grid and how this achieved

Driving forces of IoT development and corresponding solutions.

Define standard architecture, frameworks, tools, hardware and APIs available for use in IoT application development:

Review architecture, frameworks, tools, hardware and APIs available to develop IoT applications including security architectures and methodologies

The advantages and disadvantages of IoT architecture, frameworks, tools, hardware and APIs

How various architecture, frameworks, tools, hardware and APIs can be used to create IoT applications

Explore key technologies that enable and support mobile/cellular communications, e.g. 3G, 4G, 5G.

LO2 **Outline a plan for an appropriate IoT application, using common architecture, frameworks, tools, hardware and APIs**

Identify a problem to be solved and select appropriate IoT techniques to solve a problem:

Evaluate the benefits, features, advantages and disadvantages of IoT to solve a specific problem

Review the different architecture, frameworks, tools, hardware and API techniques that can be used

Select the most appropriate IoT architecture, frameworks, tools, hardware and API techniques to include in an application.

Describe a plan for an IoT application to solve a problem:

Outline the problem to solve, including how IoT and a planned application address this problem

Select an appropriate IoT application to achieve desired results

Apply IoT architecture, frameworks, tools, hardware and API techniques appropriate to the problem identified

Use selected techniques to create an IoT application development plan.

LO3 **Develop an IoT application using any combination of hardware, software, data, platforms and services**

Utilise appropriate tools and techniques to develop an IoT application:

Employ an appropriate set of tools to develop plan into an IoT application

Run end user experiments and examine feedback

Reconcile and evaluate end user feedback and determine advantages and disadvantages of chosen IoT techniques.

LO4 **Evaluate your IoT application and the problems it might encounter when integrating into the wider IoT ecosystem.**

Assess the success of an IoT application:

Assemble and appraise end-user feedback from IoT application

Undertake a critical review and compare final application with the original plan

Evaluate the advantages, disadvantages, strengths and weaknesses of IoT techniques

Critique the overall success of an IoT application, including how well it solved problem, potential impact on people, business, society and the end user, possible problems when integrating into the wider IoT ecosystem.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Analyse what aspects of IoT are necessary and appropriate when designing software applications</td><td rowspan="2">D1 Evaluate specific forms of IoT architecture and justify their use when designing software applications.</td></tr>
<tr><td>P1 Explore various forms of IoT functionality.
P2 Review standard architecture, frameworks, tools, hardware and APIs available for use in IoT development.</td><td>M1 Analyse the impact of common IoT architecture, frameworks, tools, hardware and APIs in the software development lifecycle.
M2 Examine specific forms of IoT architecture, frameworks, tools, hardware and APIs for different problem-solving requirements.</td></tr>
<tr><td colspan="2">LO2 Outline a plan for an appropriate IoT application, using common architecture, frameworks, tools, hardware and APIs</td><td rowspan="4">LO2 and LO3
D2 Make multiple iterations of the IoT application and modify each iteration with enhancements gathered from user feedback and experimentation.</td></tr>
<tr><td>P3 Investigate the architecture, frameworks, tools, hardware and API techniques available to develop IoT applications.
P4 Discuss a specific problem to solve using IoT.</td><td>M3 Plan the most appropriate IoT architecture, frameworks, tools, hardware and API techniques to include in an application to solve a problem.
M4 Apply selected techniques to create an IoT application development plan.</td></tr>
<tr><td colspan="2">LO3 Develop an IoT application using any combination of hardware, software, data, platforms and services</td></tr>
<tr><td>P5 Employ an appropriate set of tools to develop a plan into an IoT application.
P6 Create a detailed test plan and examine feedback.</td><td>M5 Reconcile end-user feedback and determine advantages and disadvantages of chosen IoT techniques.</td></tr>
</table>

Pass	Merit	Distinction
LO4 Evaluate your IoT application and the problems it might encounter when integrating into the wider IoT ecosystem.		
P7 Review the IoT application, detailing the problems it solves. **P8** Investigate the potential problems the IoT application might encounter when integrating into the wider system.	**M6** Compare the final application with the original plan.	**D3** Critically evaluate the overall success of the application, including the potential impact of the IoT application on people, business and society, and the end user.

Recommended Resources

Textbooks

Bahga, A. and Madisetti, V. (2014) *Internet of Things: A Hands-On Approach*. 1st Ed. VPT.

McEwen, A. (2013) *Designing the Internet of Things.* 1st Ed. John Wiley and Sons.

Links

This unit links to the following related units:

Unit 15: Fundamentals of Artificial Intelligent (AI) and Intelligent Systems

Unit 21: Emerging Technologies.

Unit 21: Emerging Technologies

Unit code	**R/618/7483**
Unit type	**Core**
Unit level	**5**
Credit value	**15**

Introduction

Emerging technologies have the ability to disrupt industries, radically change the progress and thinking of humankind, affect society at large and solve huge problems. Computing underpins many emerging technologies, it allows rapid development and the sharing of ideas, products and scientific understanding across multiple fields in shorter and shorter timeframes. The objective and effect of emerging technologies is usually to change the status quo. This change might be to solve problems, increase performance, improve efficiency, or to create entirely new scientific fields and novel technologies by converging different systems, technology, thinking and disciplines. Emerging technologies include changing technologies that display radical novelty, have the potential for significant commercial or social impact and fast growth and scalability, and which affect the future in uncertain ways.

This unit introduces students to the role, benefits, disadvantages and potential outcomes that emerging technologies have in the development of software applications and business practices. The aim of the unit is to enhance students' understanding of the current types, terminology, advantages, disadvantages, potential impact and benefits of emerging technologies.

Among the topics included in this unit are: classification and terminology of emerging technologies; review of the most promising and impactful emerging technologies; trends of convergence; the impact of emerging technologies on software development; and an understanding of the scale and scope that emerging technologies may have on organisations and their employees, and the individuals served by them.

On successful completion of this unit, students will be able to explain some of the most promising and impactful emerging technologies and their advantages and disadvantages. Students will understand the impact that emerging technologies have on the development of software applications. As a result, they will develop skills such as communication literacy, design thinking, team working, critical thinking, analysis, reasoning, interpretation and computer software literacy, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

By the end of this unit students will be able to:

LO1 Review which emerging technologies are necessary and appropriate when designing software applications for the future

LO2 Research an emerging technology and its impact on a given end-user group

LO3 Develop multiple iterations of an emerging technology solution based on requirements

LO4 Consider the ethical, social, economic and legal factors that play a role in the success of emerging technologies.

Essential Content

LO1 Review which emerging technologies are necessary and appropriate when designing software applications for the future

Formats, characteristics and trends of emerging technologies:

Overview of emerging technologies and their appropriate use in software development

Emerging technology role, purpose and terminology

Recognise the various forms of emerging technology, e.g. educational technology, information technology, nanotechnology, biotechnology, cognitive science, robotics and artificial intelligence

History and current trends in emerging technologies

Characteristics of emerging technologies, how they can be used and how they differ from and converge with developed technology.

Recognise specific emerging technologies:

Current trends in emerging technologies and their use in software development and computing, e.g. AI, blockchain, IoT, Virtual Reality (VR), Augmented Reality (AR)

Advantages of emerging technologies, e.g. efficiency gains, increased effectiveness, new and innovative approach

Risks of emerging technologies, e.g. security and data breach risks, fairness and equity due to bias, costs could be high, ethical and legal compliance

Emerging technologies vs disruptive technologies

Appropriateness of using emerging technologies to disrupt the status quo in industries, markets, user adoption and established practices.

LO2 Research an emerging technology and its impact on a given end-user group

Emerging technology impact:

Investigate the specific emerging technology that will have the most impact on software application design and development

Selection of a specific industry and end-user group that will be the most influenced by emerging technology, e.g. doctors in a diagnostic health setting, bankers in finance and predictive modelling.

Features of selected emerging technology:

Examination of features based on a specifically selected emerging technology, to include key characteristics, area(s) of application, impact on user group and working practices, e.g. change of job roles, automation, use of systems, working policies

Contrast the features, advantages and disadvantages of chosen emerging technology.

Convergence:

Technologies cohabiting in a single device, sharing resources and interacting, creating new technology and convenience

How chosen emerging technology can converge with existing technologies or replace them, e.g. blend of the mobile telephone and the internet, design of hybrid vehicles.

LO3 **Develop multiple iterations of an emerging technology solution based on requirements**

Emerging technology solution:

Small-scale prototype solution for a specific user need, e.g. AI chatbot, VR video experience, IoT smart solution, 3D printing solution

Consider the importance of user experience, accessibility and usability requirements in the design of the solution.

Iteration:

Understand end-user requirements by conducting a needs analysis

Developing an initial prototype based on end-user needs

Iteration based on user feedback and testing.

LO4 **Consider the ethical, social, economic and legal factors that play a role in the success of emerging technologies.**

Social, economic and legal factors:

Understanding that emerging technologies can produce unintended consequences

Ability of emerging technologies to transform cultural mores and traditions, economic trends and structures, political behaviour, legal processes and principles, environmental systems and conditions

The governance challenges associated with emerging technologies, e.g. regulations, policies, laws, and constitutions, staying abreast of technological advances

Organisational decision-making process behind technological implementation, including the choice between human capital and technology

Balancing technology risks and rewards, including achieving tangible benefits from emerging technologies and predicting threats associated with new innovations.

Replacing existing technologies or change ways of working:

Changes in practice, e.g. AI and deep learning replacing traditional medical diagnosis methods, predictive maintenance in IT and industry vs scheduled processes, autonomous or self-driving vehicles replacing human drivers.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Review which emerging technologies are necessary and appropriate when designing software applications for the future</td><td rowspan="2">D1 Evaluate emerging technologies and justify their use when designing software applications for the future.</td></tr>
<tr><td>P1 Review various forms of emerging technologies, focusing on their relevance to software development and computing.
P2 Explore the benefits and risks of emerging technologies.</td><td>M1 Assess formats, characteristics and trends of emerging technologies.
M2 Justify the ability of emerging technologies to disrupt the status quo in industries, markets, user adoption and established practices.</td></tr>
<tr><td colspan="2">LO2 Research an emerging technology and its impact on a given end-user group</td><td rowspan="4">LO2 and LO3
D2 Evaluate the solution developed, including its impact on a given end user group and their current systems and working practices.</td></tr>
<tr><td>P3 Research a specific industry and end-user group that will be the most influenced by a selected emerging technology.</td><td>M3 Examine the features, of the selected emerging technology.</td></tr>
<tr><td colspan="2">LO3 Develop multiple iterations of an emerging technology solution based on requirements</td></tr>
<tr><td>P4 Develop a solution using an emerging technology for a given end-user group.</td><td>M4 Make multiple iterations of a solution based on feedback gathered from a given end-user group.</td></tr>
<tr><td colspan="2">LO4 Consider the ethical, social, economic and legal factors that play a role in the success of emerging technologies.</td><td rowspan="2">D3 Defend the adoption of emerging technologies, despite the ethical, social, economic and legal challenges.</td></tr>
<tr><td>P5 Summarise the importance of considering ethics in the development of emerging technologies.
P6 Discuss the influence of social, economic and legal factors on the development and deployment of emerging technologies.</td><td>M5 Analyse the regulatory challenges in keeping up with the pace of development of emerging technologies.</td></tr>
</table>

Recommended Resources

Textbooks

Christensen, C. M. (2015) *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail (Management of Innovation and Change)*. Harvard Business Review Press.

Schwab, K. (2016) *The Fourth Industrial Revolution*. World Economic Forum.

Thiel, P. and Masters, B. (2014) *Zero to One: Notes on Startups, or How to Build the Future.* Virgin Digital.

Websites

cipd.co.uk	CIPD – The Professional Body for HR and People Development *The impact of emerging technologies on work* (Article)
frontiersin.org	Frontiers *Politics of Technology – Specialty Grand Challenge* (Article)

Links

This unit links to the following related units:

Unit 2: Innovation and Digital Transformation

Unit 7: Cloud Fundamentals

Unit 19: Business Intelligence

Unit 20: Internet of Things

Unit 41: Digital Sustainability.

Unit 22: Work-based Learning in the Digital Economy

Unit code	**M/618/5692**
Unit level	**5**
Credit value	**15**

Introduction

As a professional, learning is a continuous and lifelong process. In the digital industries, there is constant change in technology, materials, processes, legislation, and practice. In order for organisations to remain up to date, they need to recognise the potential of both structured, formal based learning and learning gained through professional activities in the studio, office, workshop or on site.

Whether through a traditional industry placement, a freelance opportunity, or a simulated industry situation, it is important for students to recognise key industry structures and their related employment patterns and characteristics. Effective workplace learning requires both the application of a skillset and the implementation of appropriate attitudes and behaviours.

This unit provides a framework in which students have the opportunity to reflect on and contextualise the learning they gain from working in the industry. In coordination with tutors and an employer, students will define the scope, duration, and content of their expected work-based learning experience. Throughout the period of their work-based learning experience, students will be expected to record their experience and reflect on their learning.

Learning Outcomes

By the end of this unit a student will be able to:

LO1 Explore a range of digital technology working environments and culture

LO2 Prepare a work-based learning and development plan that enables monitoring and reflection

LO3 Review work-based learning and development in a digital role

LO4 Reflect on own skills and knowledge developed through work-based learning experience in a digital environment and plan for the future.

LO1 **Explore a range of digital technology working environments and culture**

Industry roles and responsibilities in digital economy:

Range of industries that use digital technologies

Identification of opportunities for work-based learning in appropriate sector(s)

Review career profiles in digital fields, including roles and responsibilities, e.g. cyber security, software development, data analytics, network engineering, digital animation, software testing, project management, business analysis

Required skillsets and qualifications for different roles.

Sector work patterns:

Work patterns, e.g. full-time (FT), part-time (PT), freelance, contractual, remote/virtual.

Core skills and competencies:

Value and importance of core skills and competencies, e.g. working as part of a team, team dynamics, cultural awareness, independent working, leadership, communication (verbal, written, visual), networking and collaboration, negotiation skills.

Organisational culture:

Importance of a positive and collaborative organisational culture

Achievement of a positive organisational culture, e.g. leadership, values, traditions and beliefs, behaviours and attitudes

Benefits of a collaborative workplace culture, e.g. improve retention, increase performance, increase morale, productivity and wellbeing

Impact of digital emerging technologies on workplace practices and culture, e.g. remote working, virtual teams, networking and collaborative working, social distancing measures

Globalisation and development of multicultural and diverse workforces, meeting needs and expectations

Diversity of the workforce and meeting needs of individualism, equality and inclusion and social responsibility

Impact of improving educational standards in the workplace

Organisational/employer expectations.

LO2 **Prepare a work based learning and development plan that enables monitoring and reflection**

Self-evaluation of learning needs for development and career planning:

Competencies comparison against job specifications and required personal and professional skills

Self-assessment of skills, e.g. skills audit

Identification of strengths and weaknesses, e.g. analysis of strengths, weaknesses, opportunities, threats (SWOT)

Setting specific, measurable, attainable, relevant, time bound (SMART) development plans, goals and objectives

Identification of learning and development needs

Achievement of learning and career plans via short-, medium- and long-term career planning.

Learning and development plan:

Define learning and development vision, goals and matrices

Develop an inventory of learning and development needs

Undertake a gap analysis of learning and development to identify needs

Identify modes of learning and development to achieve vision, goals and matrices

Identify priorities for learning and development.

Undertake work experience:

Experience a range of work, e.g. different patterns/types of work experience opportunities – voluntary, placement, contract-based, apprenticeships, internships and externships

Experience a range of organisations, e.g. types, size and scope

Use of a skills audit for matching opportunities for work experience with gaps in own experience of skills

Importance of developing interpersonal communication skills to support personal and professional development, e.g. body language, tone of voice (written, electronic and verbal)

Impact of appearance and professional conduct

Professionalism and resilience

Working within own remit.

Feedback and review systems during work-based learning:

Developmental opportunities – formal training, on-job training, shadowing, buddying, self-directed study, secondment, coaching and mentoring, job rotation, workshops, conferences, social learning and networking

Reviewing performance, behaviours and interactions via informal, e.g. in-the-moment, casual conversation and formal mechanisms of feedback, e.g. rag rating, performance review, 360-degree feedback

Different forms of feedback, e.g. formative and summative

Exit interview.

Meeting employer objectives and key performance indicators (KPIs):

Employer use of key performance indicators (KPIs) to measure and evaluate the performance of an organisation against its strategic objectives

Personal contribution and responsibilities to meet employer objectives

Use of key performance indicators (KPIs) to measure and increase productivity

Effective and efficient time management skills, e.g. efficient use of own time

Identification of workforce skills and requirement to upskill, e.g. soft/transferable skills, hard skills

Employee development to support objectives, e.g. Continuous Professional Development (CPD), training and development

Key risk indicators, e.g. financial KRIs: economic downturn, regulatory changes, people KPIs: high staff turnover, low staff satisfaction, operational KPIs: system failure, IT security breach.

LO3 **Review work-based learning and development in a digital role**

Work-based learning and development:

Review of structured opportunities for work-based learning and development, e.g. mode – online, distance, peer

Learning and development that supports the digital role

Identification of further learning and development

Planning work-based learning and development to enhance career prospects.

Development of skills and knowledge:

Roles and duties undertaken, e.g. practical operation of equipment, software development, analysis, networking, animation, software testing, project management, programming, research, provision of service to internal and external customers, marketing, technical, consultation

Communicating with managers and stakeholders

Reporting/receiving feedback on development and progress

Working as part of a team and supporting team initiative and proactivity

Adapting to and using technology.

Identification of learning and development to progress in a role:

Skills and knowledge required to progress in an identified role and identification of learning and development requirements

Use of formal and informal methods to assess learning and development needs to support progression into identified role

Skills gaps analysis

Prioritising learning and development needs.

LO4 **Reflect on own skills and knowledge developed through work-based learning experience in a digital environment and plan for the future.**

Reflective practice:

Methods of recording reflective practice, e.g. diary, portfolio, reflective log, personal journal

Responding to and adapting to formative feedback

Self-evaluation of work-based learning and experience in all areas; systems, interpersonal skills, problem resolution, incidents and accidents, teamwork and management practices.

Evaluation of performance:

Methods of final evaluation in the workplace, e.g. final skills audit, performance reviews, appraisal, observation feedback, benchmarking to match skills standards, 360-degree feedback process, e.g. client, peer, tutor, employer feedback.

Future development opportunities:

Identifying skills gaps and needs for improvement, future training needs and personal development planning

Developing a lifelong learning plan

Recommendations on how to enhance future development plans, e.g. different work context, alternative roles and titles, locations, preparation methods, time management

Future opportunities to promote development, e.g. coaching and mentoring, seeking new assignments/opportunities, attending conferences and networking events.

Career planning:

Identification of areas for improvement

Lessons learnt and how to enhance performance

Use of experience to enhance career prospects

Development of a career plan.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Explore a range of digital technology working environments and culture.		
P1 Examine work cultures in the digital technology sector. **P2** Profile careers in the digital technology sector and working environments which make use of digital technology.	**M1** Analyse professional conduct and employer expectations of employees.	**LO1 and LO2** **D1** Justify the selection of a work-based learning opportunity in terms of the skills and knowledge to be gained, and how it contributes to future developmental goals.
LO2 Prepare a work-based learning and development plan that enables monitoring and reflection		
P3 Plan a work-based learning plan based on own learning needs, including methods for review. **P4** Devise SMART developmental goals in relation to work-based learning.	**M2** Analyse how work-based learning will contribute to own development and career goals.	

Pass	Merit	Distinction
LO3 Review work-based learning and development in a digital role		
P5 Undertake work-based learning that develops both the subject-specific skills and core competencies required for working in the digital technology sector. **P6** Implement review and performance monitoring methods during work-based learning to assess performance and capabilities.	**M3** Evaluate the specific skills, competencies and knowledge developed through different duties undertaken in the digital technology sector.	**LO3 and LO4** **D2** Critically evaluate own learning and development through consultation and reflection, identifying areas for future development in support of future plans.
LO4 Reflect on own skills and knowledge developed through work-based learning experience in a digital environment and plan for the future.		
P7 Compare 360-degree feedback to identify areas of good practice and areas for improvement. **P8** Assess own development of transferable and employability skills through work-based learning.	**M4** Evaluate own development through reflection and feedback.	

Recommended Resources

Textbooks

Bolton, G. (2014) *Reflective practice: Practice: Writing and Professional Development.* New York: Sage Publications Ltd.

Cottrell, S. (2015) *Skills for Success: The Personal Development Planning Handbook.* New York: Palgrave Macmillan.

Helyer, R. (2015) *The Work-based Learning Student Handbook.* New York: Palgrave Macmillan.

Jordan, T. (2020) *The Digital Economy.* London: Polity.

Kersten, M. (2019) *Project to Product: How Value Stream Networks Will Transform IT and Business: How to Survive and Thrive in the Age of Digital Disruption with the Flow Framework.* Portland: IT Revolution.

Moon, J. A. (2006) *Learning Journals: A Handbook for Reflective Practice and Professional Development*. London: Routledge.

Orme, G. (2019) *Human Intelligence: How curiosity and creativity are your superpowers in the digital economy.* London: Pearson Business.

Tarrant, P. (2013) *Reflective Practice and Professional Development.* New York: SAGE.

Thompson, S. (20018) *The Critically Reflective Practitioner.* New York: Palgrave Macmillan.

Websites

cipd.co.uk	Chartered Institute of Personnel and Development The CPD Cycle (General reference)

Links

This unit links to the following related unit:

Unit 1: Professional Practice in the Digital Economy.

Unit 23: Applied Security in the Cloud

Unit code	**A/618/4898**
Unit level	**5**
Credit value	**15**

Introduction

The challenge of securing systems is ever present regardless of where the system is situated, whether in premises or the cloud the opportunities and threats are the same. This issue affects customers, corporate partnerships, governments and educational institutions. Streaming services, ecommerce solutions and mobile applications rely heavily on cloud provisioning, so a secure solution is essential.

Whilst traditional 'on site' security risks still exist and must be managed, the approach to security in a professional setting must be different. Professional working in this field must adapt to the remote situation and understand how secure cloud services operate and understand the potential behaviours of cybersecurity threat actors. Any security configuration must be responsive and must not impede the functionality and performance of the cloud environment. In the culture of cloud defence there is a need to continually assess and review threats – exploring vulnerabilities and mitigating them whenever feasible.

Many computing and cloud infrastructure professionals require a broad understanding of applied cloud security principles as part of their core skills portfolio. In the context of cyber security, cloud security assures an essential element of end-to-end security in a corporate infrastructure.

This unit gives students the opportunity to implement security in a cloud-based infrastructure. They will explore common threats and how to defend a cloud system. Students will design security policies, ensuring that their cloud-based system has effective security management.

Before taking this unit, students should have experience of security in a cloud or associated context.

It is highly recommended that students complete Unit 3: Security in the Cloud *before studying this unit.*

Learning Outcomes

By the end of this unit, students will be able to:

LO1 Analyse common threats and defence practices with a view to improving security within a cloud infrastructure

LO2 Design defence-based security policies, ensuring effective cloud security management for a business case

LO3 Deploy security solutions to mitigate threats in a cloud environment to meet the needs of the business case

LO4 Evaluate how secured cloud infrastructure mitigates potential vulnerabilities through monitoring strategies.

Essential Content

LO1 **Analyse common threats and defence practices with a view to improving security within a cloud infrastructure**

Common cyber security threats:

Analysis of threats, including an understanding of awareness of how cloud security attacks sit at different levels

Application level attacks, including SQL injection, guest hopping, side channel, malicious insider, traffic based (DDoS, probe and scan)

Network level attacks, including domain name system (DNS), domain hijacking, IP spoofing, denial of service (DoS), database exploits such as data loss and weak back-up method

User level attacks, including phishing, user exploit (employee negligence, social engineering)

Impact of security threats on a cloud infrastructure.

Defence practices:

Apply effective system monitoring, e.g. traffic, service performance, memory, processor utilisation, database performance, establishing responsibilities, managing access control

Develop routine testing methodology, e.g. penetration tests

Continually review access requirements

Maintain and manage data encryption, maintain sufficient data deletion policies

Ensure effective data backup and recovery

Ensure effective border controls, e.g. firewalls, signature management, access control lists, resource visibility, employee training, CERT-UK, OWASP.

LO2 **Design defence-based security policies, ensuring effective cloud security management for a business case**

Scope of the security solutions:

Agreeing scope, including what systems should be protected and are in professional responsibility domain

Tenancy monitoring including who has access to what, where and within what boundaries

Establish and review user rights assuring prompt revocation

Understanding of how to assure confidentiality, setting acceptable use parameters, compliance standards, e.g. meeting national, international, legal and industry regulatory requirements

Managing system breaches and communicating risk

Understand security principles including defence-in-depth, layered security principles, data security.

Cloud security management:

Implement effective user management, e.g. maintain users, use and level of rights according to resource, identity management and access control

Analysis of risk management, compartmentalisation, auditing, logging, monitoring, critical testing, patching systems, evaluating known system vulnerabilities, malware management and system scanning, running cloud-based security APIs.

LO3 **Deploy security solutions to mitigate threats in a cloud environment to meet the needs of the business case**

Benchmark:

Establishing a range of pre-test or pre-configuration system baselines, including penetration testing benchmarks.

Application of security solutions:

Access controls, e.g. authentication, user management, privileged insiders

Data management, e.g. migration, integrity, confidentiality and warehousing methods

Configure networking devices, e.g. routers, switches, firewalls in the cloud to meet service capacity.

Tools:

Cloud Service Provider Tools (CSP) to include intrusion detection and prevention, core reporting tools, configuration rules, identity and access managements (IAM) and troubleshooting.

Measurements of security responsiveness:

Passes penetration testing benchmarks or show improvement against benchmarks

Managing and maintaining optimal data access and retrieval performance, assuring service uptime and availability at 99.91% or better

Service responsiveness, e.g. HTTP request time, remote server latency

Mean time between security issue and resolution, ensuring security solution does not impede performance.

LO4 **Evaluate how secured cloud infrastructure mitigates potential vulnerabilities through monitoring strategies.**

Monitoring strategies:

Consider a range of risk assessment tools offered by Cloud Service Providers (CSPs) for system monitoring

Systematic review of all logged data using risk assessment tools for benchmarking norms, reviewing anomalies, positives, false positives, negatives, false negatives

Taking account of user or customer access feedback, malware scanning results, known system issues, e.g. operating system, hardware, services, servers

Review of database access integrity analysis, e.g. data breaches, account hijack, data loss

Security patching and awareness of commonplace attack stages.

Mitigation:

Using risk assessment tools and applying techniques that will sufficiently resolve any known or discovered vulnerability, domain-based risks of multi-homed systems, working within assigned responsibilities.

Vulnerabilities:

Exploring a range of vulnerabilities, including network based, database based, operating system based, user access based, hardware based, malware based, software, service based.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Analyse common threats and defence practices with a view to improving security within a cloud infrastructure</td><td rowspan="5">LO1 and LO2
D1 Critically justify how the designed security solutions will mitigate common threats and maintain defence practices for the given business case.</td></tr>
<tr><td>P1 Analyse common security threats and their impact on a cloud infrastructure.
P2 Assess how defence practices can improve the security of a cloud infrastructure.</td><td>M1 Evaluate how defence practices can be adapted to mitigate common security threats.</td></tr>
<tr><td colspan="2">LO2 Design defence-based security solutions, ensuring effective cloud security management for a business case</td></tr>
<tr><td>P3 Design a range of security solutions, to support cloud infrastructure management.
P4 Describe how the designed cloud security solutions will affect the management of a cloud infrastructure for the given business case.</td><td>M2 Analyse proposed security solutions against the requirements of the business case.</td></tr>
<tr><td colspan="2">LO3 Deploy security solutions to mitigate threats in a cloud environment to meet the needs of the business case</td></tr>
<tr><td>P5 Develop a range of benchmarks, including penetration benchmarks for the cloud security solutions.
P6 Apply the designed security solutions using a range of custom tools in a cloud-based environment.</td><td>M3 Adapt the security solution based on benchmarked response measurements.</td><td rowspan="3">LO3 and LO4
D2 Justify the effectiveness of the implemented security solutions against the initial requirements of the business case.</td></tr>
<tr><td colspan="2">LO4 Evaluate how secured cloud infrastructure mitigates potential vulnerabilities through monitoring strategies.</td></tr>
<tr><td>P7 Evaluate suitable monitoring strategies for mitigating cloud-based vulnerabilities.
P8 Implement a range of monitoring strategies on a cloud infrastructure.</td><td>M4 Analyse the effectiveness of the monitoring strategies, when implemented on a cloud infrastructure.</td></tr>
</table>

Recommended Resources

Textbooks

ADKINS, H., BEYER, B., BLANKINSHIP, P., LEWANDOWSKI, P., OPREA, A., STUBBLEFIELD, A (2020). *Building Secure and Reliable Systems: Best Practices for Designing, Implementing, and Maintaining Systems*. Sebastopol: O'Reilly

AI, S. (2020) *Building a Future-proof Cloud Infrastructure: A unified architecture for Network, Security and Storage Services*. Boston: Addison Wesley

DOTSON, C (2019): *Practical Cloud Security: A Guide for Secure Design and Deployment*. Sebastopol: O'Reilly

KANIKATHOTTU, H (2020*): AWS Security Cookbook: Practical solutions for managing security policies, monitoring, auditing, and compliance with AWS*. Mumbai: Packt Publishing

Journal

IEEE xPlore.

Websites

aws.amazon.com/training/awsacademy/	AWS (Amazon Web Services) Academy
	(General reference and academic resources)

Links

This unit links to the following related units:

Unit 3: Cyber Security

Unit 6: Networking in the Cloud

Unit 8: Security

Unit 25: Information Security Management in the Cloud.

Unit 24: Applied Cryptography in the Cloud

Unit code	**F/618/4899**
Unit level	**5**
Credit value	**15**

Introduction

Almost every interaction we make with an electronic device will involve cryptography in some form. Cryptography is an indispensable tool for protecting information in computer systems. Applied cryptography for cloud services uses encryption techniques that protect data used, shared and stored in the cloud. Cryptography underpins many aspects of security and is a crucial component in protecting the confidentiality and integrity of information. The dangers of uploading data into this new environment require cryptographers and cryptanalysts to protect the cloud environment using a variety of technologies, processes and forms of encryption. The complexity with how cloud computing manages data secrecy and information security is a reason why people avoid the cloud. As a result, despite the hype surrounding cloud computing, some users remain reluctant to deploy their personal information or to deploy commercial enterprises into the cloud. Understanding cloud security issues, the application of crypto algorithms and ensuring that data is secured are vital to its continued functionality, longevity and sustainability.

This unit introduces students to the applied principles of cryptography and looks at its practical applications and methods, many of which are fundamental to secure data in the cloud. Students are expected to analyse fundamental symmetric, asymmetric and hashing encryption methods, and investigate examples of these in practice. Students are expected to demonstrate the use of cryptography and cryptanalysis tools, methods and their applications. Students are also expected to appraise the inner workings of cryptographic protocols and principles, including transport layer security (TLS) and blockchain, and evaluate how they can be used by organisations to enhance security when considering a move to a cloud environment. Among the topics included in this unit are: the mathematical algorithms used in cryptography, the mechanisms by which cryptographic and cryptanalysis work, hashing and salting, cloud-hosted Public Key Infrastructure (PKI), benefits of encryption techniques, quantum cryptography, secure multi-party computation, security risks and issues with public key encryption, practical applications of cryptography and Cryptography as a Service (CaaS).

On successful completion of this unit, students are expected to understand the differences in the roles and responsibilities of a cryptographer and a cryptanalyst.

They will be able to analyse functions of stream ciphers and block ciphers, produce code implementing ciphers, analyse methods such as KEM, DEM and PKEs to secure data in a cloud environment. Students will design a security case and implement it. As a result, they will develop skills such as critical thinking, analysis and interpretation, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

By the end of this unit, students will be able to:

LO1 Analyse encryption ciphers and algorithms as methods to secure data in a cloud environment

LO2 Discuss security risks and issues related to public key encryption in practice

LO3 Demonstrate the use of cryptographic and cryptoanalysis tools for improving security in a virtual private network

LO4 Evaluate advanced encryption protocols and their application for an organisation considering a move to the cloud.

Essential Content

LO1 Analyse encryption ciphers and algorithms as methods to secure data in a cloud environment

Symmetric encryption:

Use of ciphers for, e.g., secure messages, cloud storage

Symmetric to include Transposition Cipher, Substitution Cipher, Lorenz Cipher

Feistel Cipher, including Data Encryption Standard (DES)

Triple Data Encryption (3DES)

Rijndael Cipher, e.g. Advanced Encryption standard (AES)

Stream cipher, e.g. Rivest Cipher 4

Block Cipher Mode, e.g. Blowfish, Twofish, Rivest Cipher 5

Message Authentication Code (MAC)

One-time pad.

Asymmetric encryption:

Use of algorithms for, e.g., authenticity using digital signatures, website security, withdraw or transfer bitcoin

Asymmetric, to include digital signature algorithm (DSA), public key encryption algorithms such as Rivest Shamir Adleman (RSA) algorithm, e.g. RSA cryptosystem, Diffie-Hellman, El Gamal, Elliptic Curve Cryptography (ECC), ECSTR for Efficient and Compact Subgroup Trace (XTR).

Hashing:

Use of hashing for, e.g., sharing documents, database encryption, safeguarding passwords

Hashing, to include message digest, secure hashing algorithm. Galois/Counter mode (GCM), MD5, Secure Hash Algorithm 1 (SHA-1), Secure Hash Algorithm 2 (SHA-2), RIPE Message Digest (RIPEMD), homomorphic encryption.

LO2 **Discuss security risks and issues related to public key encryption in practice**

Attacks on public key schemes:

Exploring most common attacks on public key encryption schemes using a range of examples, e.g. Wiener's attack on RSA, lattice-based attacks on RSA, partial key exposure attacks, Meet-in-the-Middle (MITM) attack, Distributed Denial of Service (DDoS) bots, and fault analysis.

Different definitions of security:

Examining security of encryption, security of actual encryption algorithms, semantically secure systems, security of signatures

Analysing provable security, explaining random oracles, security of encryption algorithms and encryption algorithms with random oracles

Explaining provable security without random oracles, using examples such as strong RSA assumption, provable security-absolute assurance, signature and encryption schemes

Analysing encryption techniques to include Key Encapsulation Mechanisms (KEMs), Data Encapsulation Mechanisms (DEMs), and hybrid public key encryption (PKE), for security.

LO3 **Demonstrate the use of cryptographic and cryptoanalysis tools for improving security in a virtual private network**

Cryptographic tools, methods and applications:

Secret Key to include secret key distribution, key exchange and signature schemes, Diffie-Hellman key exchange, digital signatures and authenticated key agreement

Public Key to include one-way functions, obtaining authentic public keys, confidentiality and integrity, digital certificates and Public Key Infrastructure (PKI), analysing examples of PKI

Hash functions, to include designing hash functions, using hash functions in signature schemes, analysing hash functions

Cryptographer role, responsibilities and continual professional development.

Cryptanalysis tools, methods and applications:

Attacking methods to include brute force, chosen plaintext, SQL injection, dictionary and rainbow tables

Solving ciphers to include linear (i.e. Fast data Encipherment Algorithm); non-linear (i.e. linear masking), differential (i.e. mixed integer linear programming), block (i.e. simplified Tiny Encryption Algorithm)

Frustrating statistical cryptanalysis, including confusion and diffusion

Impact of high-performance computing and quantum cryptography

Web-based tools, e.g. CrypTool, EverCrack, AlphaPeeler

Cryptanalyst role, responsibilities and continual professional development.

Security case and system response:

Security case to include design of a system at network layer, crypto to meet defined security objectives, key management plan, evidence of system with required security controls, format, e.g. Common Criteria Protection Protocol

System response to include security objectives and common threats, assumptions, functional requirements and security controls, e.g. technical, implementation, policy or process.

LO4 **Evaluate advanced encryption protocols and their application for an organisation considering a move to the cloud.**

Assessing advanced encryption protocols and their applications:

Exploring access structures for secret sharing schemes for cloud security, general secret sharing, Reed-Solomon codes, Shamir sharing scheme

Applying RSA key generation, SecurID and strategy in popular cloud environments

Analysing Zero-Knowledge proofs, Sigma protocols, electronic voting systems

Examining secure multi-party computation, the two-party case, multi-party cases, including honest-but-curious adversaries and malicious adversaries

Evaluating different applications of cryptography and hybrid cryptosystems to include Cryptography as a Service (CaaS), digital cash, bitcoin, Transport Layer Security (TLS) protocol, including configuration such as ciphersuites, Blockchain, Blockcloud and zkSNARKS.

Influencing factors affecting choice of cryptographic techniques for an organisation's move to the cloud:

Cost, e.g. implementing encryption, network support, resourcing

General considerations, including suitability for business needs, infrastructure, scaling, reliability, support, storage capacity, content delivery, protection, user access and training.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Analyse encryption ciphers and algorithms as methods to secure data in a cloud environment		
P1 Analyse the functions of stream cipher and block cipher, using a range of appropriate examples in practice. **P2** Produce code that implements mathematical ciphers and algorithms to encrypt and decrypt data.	**M1** Critically analyse the operational differences between stream cipher and block cipher, using a range of appropriate examples in practice.	**D1** Justify improvements introduced by stream ciphers compared to block ciphers for public and private key encryption.
LO2 Discuss security risks and issues related to public key encryption in practice		
P3 Discuss risks and issues in security of public key encryption schemes, using a range of appropriate examples in practice.	**M2** Analyse key benefits of encryption techniques including KEMs, DEMs and PKEs and the importance of securing public key systems.	**D2** Provide justified recommendations, synthesising different definitions of provable security, suitable for securing public key systems.
LO3 Demonstrate the use of cryptographic and cryptoanalysis tools for improving security in a virtual private network		
P4 Illustrate, using a diagram, encryption and decryption process functions in a PKI environment for a business scenario. **P5** Design a security case, representative of a business scenario, to solve a security threat.	**M3** Assess security risks and challenges of using cloud-hosted PKI in a private network. **M4** Implement the system designed, in response to a security case, using cryptographic and cryptanalysis methods or tools.	**D3** Provide a critical review of the implemented system in terms of how it meets defined security objectives and make suggestions for improvement.

Pass	Merit	Distinction
LO4 Evaluate advanced encryption protocols and their application for an organisation considering a move to the cloud.		
P6 Evaluate the key benefits of using a range of cryptography and hybrid cryptosystems to improve cloud security. **P7** Assess common factors influencing an organisation's choice of cloud solution(s) to improve security.	**M5** Critically analyse the use of selected cryptography and hybrid cryptosystems in protecting data in an organisation.	**D4** Justify the use of different cryptographic applications, for an organisation, that will inform their move to the cloud.

Recommended Resources

Textbooks

BALACHANDRAN, M.J. (2020) *Cloud Engineering and Architecture Design Patterns.* Chennai: Notion Press

CARLET, C. (2020) *Boolean Functions for Cryptography and Coding Theory.* Cambridge: Cambridge University Press

CHAUBEY, N.K., PRAJAPATI, B.B. (2020) *Quantum Cryptography and the Future of Cyber Security.* USA: IGI Global

GOYAL, D., BALAMURUGAN, S., PENG, S.L., VERMA, O.P. (2020) *Design and Analysis of Security Protocol for Communication.* USA: John Wiley & Sons

MENEZES, A.J., VAN OORSHOT, P.C., VANSTONE, S.A. (2018) *Handbook of Applied Cryptography*. 2nd Ed. Boca Raton: CRC Press, Taylor & Francis

NIELSON, S.J., MONSON, C.K. (2019) *Practical Cryptography in Python: Learning Correct Cryptography by Example*. USA: Apress

PACHGHARE, V.K. (2019). *Cryptography and Information Security.* 3rd Ed. Delhi: PHI Learning

SCHMEH, K. (2006) *Cryptography and Public Key Infrastructure on the Internet.* UK: Wiley

STALLINGS, W. (2013) *Cryptography and Network Security: Principles and Practice.* UK: Pearson

STINSON, D.R., PETERSON, M.B. (2018) *Cryptography: Theory and Practice.* 4th Ed. Boca Raton: CRC Press, Taylor & Francis

SWAMMY, S., THOMPSON, R., LOH, M. (2019) *Crypto Uncovered: The Evolution of Bitcoin and the Crypto Currency Marketplace.* (eBook) Palgrave Macmillan

Journals

International Association for Cryptologic Research, Online.

International Journal of Applied Cryptography, Online.

International Journal of Network Security, Online.

Journal of Emerging Trends in Computing and Information Sciences, Online.

Websites

ncsc.gov.uk	National Cyber Security Centre (General reference)

Links

This unit links to the following related units:

Unit 3: Cyber Security

Unit 8: Security

Unit 25: Information Security Management in the Cloud.

Unit 25: Information Security Management in the Cloud

Unit code	**T/618/4897**
Unit level	**5**
Credit value	**15**

Introduction

As organisations move to cloud platforms, an understanding of security is more important than ever. It is often inferred that Cloud Service Providers (CSPs) are solely responsible for security risks. In reality, security risks in the cloud are a shared responsibility with the organisation and its users. The question organisations need to be asking is not 'How secure is the cloud?' but rather 'Are we using the cloud securely?'. Through an understanding of security best practices and requirements, organisations can implement security controls and threat protection in a cloud environment that supports established governance and compliance frameworks. Jobs in cloud security entail the development and execution of the organisation's security initiatives, designing and documenting security solutions in line with standards, work with CSPs to secure best practices, carry out audit activities and identify risk-based needs for decision making.

This unit introduces students to the principles of information security governance and explores key principles of ISO standards for meeting assurance, quality and performance standards. Students are expected to investigate the use of an Information Security Management System (ISMS) and how cloud service providers support solutions for protecting data in organisations. Students are also expected to analyse the challenges of using cloud-based ISMS solutions and design a Security Posture Assessment to use in a cloud environment. Among the topics included in this unit are security threats and risks, ISO 27000 series, risk treatment planning, ISMS and concept of CIA, cloud-based ISMS solutions, Security Posture Assessment, risk assessment methodologies and governance frameworks.

On successful completion of this unit, students will be able to explore security standards and certifications, and the process of establishing and maintaining an ISMS. Students will prepare a business case for a cloud-based ISMS solution and recommend a suitable risk management framework to ensure security governance and compliance in the cloud. As a result, they will develop technical knowledge alongside skills such as communication and decision making, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

By the end of this unit, students will be able to:

LO1 Explore the basic principles of information security governance for meeting assurance, quality and performance standards in the cloud

LO2 Investigate the use of Information Security Management Systems (ISMS) in organisations

LO3 Develop a business case for a cloud-based ISMS solution for a given business scenario

LO4 Design a Security Posture Assessment for a cloud environment, identifying risks.

Essential Content

LO1 **Explore the basic principles of information security governance for meeting assurance, quality and performance standards in the cloud**

Identification of threats that lead to breach of organisational compliance:

Review of threats that can impact security, e.g. malware, botnets, brute force attacks, account hijacking, data loss, insecure application programming interfaces (APIs), denial-of-service attacks (DDoS).

Explore standards for assurance in the cloud:

Rules and etiquette to be followed when adhering to ISO 27000 series with focus on ISO 27002 and 27017

Understand the role of Service Organisation Controls (SOC) report in relation to security, availability, processing integrity, confidentiality and privacy

Expectations and operational requirements of end-user license agreements and service-level agreements

Examination of standards for assurance, i.e. ISO, SOC and client-provider agreements, and their impact on organisational compliance.

Measures of quality and performance of security solutions:

Asset identification of critical components, including type, owner, classification, location and impact levels, for building information asset register

Use of Computer Aided Integration of Requirements and Information Security (CAIRIS) to assess stakeholder requirements

Understand how risk assessment and risk treatment planning (RTP) is used

Understand policy and procedure development in relation to developing security solutions

Senior management buy-in to assure quality and performance

Review of audit process including internal, external, and performance monitoring.

LO2 **Investigate the use of Information Security Management Systems (ISMS) in organisations**

Review of organisational policies:

Policies that consider definition of roles and responsibilities such as segregation of duties and least privilege

Policies that consider operational objectives such as policy enforcement, privacy and acceptable use

Policies that consider information security, including identification of risks, actions to address risk and staff training needs.

Establishing and maintaining an ISMS:

Explain what an ISMS is and why it is important

Apply the CIA triad, confidentiality, integrity and availability to define security aims

Benefits of effective ISMS use in organisations, e.g. reputation, financial, strategic and security

Process of developing ISMS to include Plan Do Check Act (PDCA) cycle

Maintaining of ISMS, including review of risk, monitoring, internal audits, management review and corrective actions.

Business scenario considerations:

Consider the organisation and its context, including stakeholders and expectations of interested parties, determining ISMS scope, leadership commitment, policy and compliance, organisational roles and responsibilities, information security objectives, financial flexibility and cost savings, scalability and ease of access for permitted users

Distinguishing between Cloud Service Provider (CSP) and client responsibilities such as business continuity management, network strategy, security logs and incident reporting

Challenges that lead to increased threat to information security, including access to data and applications, visibility of data, data controls, configuration, disaster recovery, and legal requirements such as data protection act and GDPR.

LO3 **Develop a business case for a cloud-based ISMS solution for a given business scenario**

Cloud-based ISMS solutions:

Explore cloud-based ISMS solutions in the market, e.g. AWS Security Hub, Microsoft Cloud Infrastructure and Operations (MCIO) ISMS, Alliantist ISMS. online and SureCloud ISMS manager

Challenges of using ISMS solution in the cloud, including capturing content from existing systems and new systems, security, privacy, user experience and controls, governance and framework compliance.

Requirements of business case and business impact analysis:

Business case for a cloud-based ISMS solution to include executive summary, identify the business problem or opportunity, define how the project supports the organisation's strategic objectives, description of solution, including alternative options, SWOT analysis, recommendations for a preferred solution and description of implementation approach

Business impact analysis in relation to security solution, e.g. who is involved, interruption costs, cost of failure analyses, worst-case scenario, possibility of new impacts or vulnerabilities.

LO4 **Design a Security Posture Assessment for a cloud environment, identifying risks.**

Design of Security Posture Assessment:

Explain what Security Posture Assessment is and why it is important

Security Posture Assessment to include identifying value of assets, defining threat exposure and risks, evaluating security measures, recommendations for action plan and improving security posture

Process for ensuring security policy management lifecycle

Benefits for implementing and improving security posture, including staff training and awareness, security measures, incident response management and user access.

Risk management principles and governance frameworks:

Measuring risk, including impact, likelihood, quantitative, qualitative, vulnerabilities and threats

Use of risk assessment methodologies to identify the severity of identified risks and prioritise required actions, e.g. asset-based, scenario-based, IT information risk assessment methodology 2 (IRAM2)

Actions to address risks, including measuring, analysis, evaluation, nonconformity, and continual improvement

Risk treatment, including avoid, transfer, accept and mitigate

Governance frameworks to support risk management and compliance in the cloud, e.g. ISO 27000 series, COBIT, ITIL, SOA, Risk IT from IT Governance Institute.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Explore the basic principles of information security governance for meeting assurance, quality and performance standards in the cloud</td><td rowspan="4">LO1 and LO2
D1 Critically evaluate your choice of ISO 27000 series and ISMS solution for an organisation that uses the cloud.</td></tr>
<tr><td>P1 Examine the key principles of ISO 27000 series and the key clauses of ISO 27017.</td><td>M1 Assess the advantages and disadvantages of certification against the ISO standards.</td></tr>
<tr><td colspan="2">LO2 Investigate the use of Information Security Management Systems (ISMS) in organisations</td></tr>
<tr><td>P2 Explore the process of establishing and maintaining an ISMS.
P3 Investigate a specific cloud service provider's ISMS solution and its capabilities for protecting data in organisations.</td><td>M2 Analyse the benefits an effective ISMS can have on organisational security.
M3 Evaluate the strengths and weaknesses of using a specific cloud security provider as a security solution.</td></tr>
<tr><td colspan="2">LO3 Develop a business case for a cloud-based ISMS solution for a given business scenario</td><td rowspan="2">D2 Critically review how the business case provides the most suitable cloud-based ISMS solution for the business scenario.</td></tr>
<tr><td>P4 Prepare a business case, including business impact analysis, for a cloud-based ISMS solution.</td><td>M4 Analyse the challenges of using a cloud-based ISMS solution for the given business scenario.</td></tr>
<tr><td colspan="2">LO4 Design a Security Posture Assessment for a cloud environment, identifying risks.</td><td rowspan="2">D3 Evaluate risk management principles and how they support security governance and compliance in a cloud environment.</td></tr>
<tr><td>P5 Design a Security Posture Assessment to use in a cloud environment.
P6 Summarise the key benefits of using a Security Posture Assessment to identify security risks.</td><td>M5 Recommend a suitable risk management framework, supporting your design of Security Posture Assessment, to ensure governance and compliance.</td></tr>
</table>

Recommended Resources

Textbooks

ALEXANDER, D., FINCH, A., SUTTON, D., TAYLOR, A. (2013) *Information Security Management Principles.* 2nd Ed. UK: BCS The Chartered Institute for IT

BALACHANDRAN, M.J. (2020) *Cloud Engineering and Architecture Design Patterns.* Chennai: Notion Press

CALDER, A., WATKINS, S. (2015) *IT Governance: An International Guide to Data Security and ISO27001/ISO27002.* 5th Ed. UK: Kogan Page

DAVIS, C., SCHILLER, M., WHEELER, K. (2019) *IT Auditing Using Controls to Protect Information Assets.* 3rd Ed. USA: McGraw Hill Professional

GOYAL, D., BALAMURUGAN, S., PENG, S.L., VERMA, O.P. (2020) *Design and Analysis of Security Protocol for Communication.* USA: John Wiley & Sons

SMALLWOOD, R.F. (2019) *Information Governance: Concepts, Strategies and Best Practices.* USA: John Wiley & Sons

VOEHL, C.F. (2017) *Making the Case for Change: Using effective business cases to minimise project and innovation failures.* USA: Productivity Press

WILSON, S., VANDERBURG, E.A. (2018) *CompTIA Cloud+ Certification Study Guide.* 2nd Ed. USA: McGraw Hill Professional

Journals

International Journal of Network Security, Online.

Information Security Journal: A Global Perspective.

Journal of Cloud Computing.

Links

This unit links to the following related units:

Unit 8: Security

Unit 23: Applied Security in the Cloud

Unit 25: Information Security Management in the Cloud.

Unit 26: Data Structures & Algorithms

Unit code	**T/618/7430**
Unit level	**5**
Credit value	**15**

Introduction

Knowing how to implement algorithms and data structures that solve real problems, and knowing the purpose, complexity and use of algorithms is part of an essential toolkit for software engineers. An algorithm is a sequence of instructions used to manipulate data held in a structured form and together with data structures constitute design patterns for solving a diverse range of computer problems, including network analysis, cryptography, data compression and process control.

This unit introduces students to data structures and how they are used in algorithms, enabling them to design and implement data structures. Students are introduced to the specification of abstract data types and will explore their use in concrete data structures. Using this knowledge, students should be able to develop solutions by specifying, designing and implementing data structures and algorithms in a variety of programming paradigms for an identified need.

Among the topics included in this unit are abstract data types specification, formal data notations, data encapsulation, complex data structures, programming language implementations using handles, pointers, classes and methods, algorithm types, data structure libraries, algorithm complexity, asymptotic testing and benchmarking.

On completion of this unit, students should be able to identify program data requirements, specify abstract data types using a formal notation, translate into concrete data structures and be able to develop, using a programming paradigm, different sorting, searching and navigational algorithms that implement complex data structures and evaluate their effectiveness. As a result, students will have developed skills such as communication literacy, critical thinking, analysis, synthesis, reasoning and interpretation, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

By the end of the unit students will be able to:

LO1 Examine abstract data types, concrete data structures and algorithms

LO2 Specify abstract data types and algorithms in a formal notation

LO3 Implement complex data structures and algorithms

LO4 Assess the effectiveness of data structures and algorithms.

Essential Content

LO1 Examine abstract data types, concrete data structures and algorithms

Abstract Data Types (ADTs):

Specification of ADTs with formal notation.

Data structures:

Array, set, stack, queue, list, tree, types, e.g. active, passive, recursive.

Algorithm types:

Recursive, backtracking, dynamic, divide and conquer, branch and bound, greedy, randomised, brute force.

Algorithms:

Sort, insertion, quick, merge, heap, bucket, selection, search linear, binary, binary search tree, recursive, e.g. binary tree traversals, find path, travelling salesman.

LO2 Specify abstract data types and algorithms in a formal notation

Design specification:

Specify ADTs using formal notation, e.g. ASN.1

Use non-executable program specification language, e.g. SDL, VDM

Issues, e.g. complexity in software development, design patterns, parallelism, interfaces, encapsulation, information hiding, efficiency.

Creation:

Pre-conditions, post-conditions, error-conditions.

LO3 Implement complex data structures and algorithms

Implementation:

Apply algorithms, logic and data structures, multidimensional arrays, linked lists, stacks, queues, trees, hash table, heap, graph algorithms, sorting, searching, tree traversal, list traversal, hash functions, string manipulation, scheduling and recursive algorithms, using handle, pointer, class, methods, using an executable programming language

Create logical and maintainable codes.

Testing and debugging:

Testing code to ensure it is secure and can handle user errors, identifying and creating test scenarios, applying structured techniques to problem solving, debugging code, understanding the structure of programmes to identify and resolve issues.

LO4 **Assess the effectiveness of data structures and algorithms.**

Use of data structure libraries (DSL):

Limitations of DSL, manual selection of data structures, theoretical analysis, asymptotic analysis, size of N, Big O notation.

Algorithm effectiveness:

Run time benchmark, compiler/interpreter dependencies, resource usage, degree of parallelism, time, space, power performance, efficiency of garbage collection.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Examine abstract data types, concrete data structures and algorithms		
P1 Create a design specification for data structures, explaining the valid operations that can be carried out on the structures. **P2** Determine the operations of a memory stack and how it is used to implement function calls in a computer.	**M1** Illustrate, with an example, a concrete data structure for a First in First out (FIFO) queue. **M2** Compare the performance of two sorting algorithms.	**D1** Analyse the operation, using illustrations, of two network shortest path algorithms, providing an example of each.
LO2 Specify abstract data types and algorithms in a formal notation		
P3 Specify the abstract data type for a software stack using an imperative definition.	**M3** Examine the advantages of encapsulation and information hiding when using an ADT.	**D2** Discuss the view that imperative ADTs are a basis for object orientation offering a justification for the view.
LO3 Implement complex data structures and algorithms		
P4 Implement a complex ADT and algorithm in an executable programming language to solve a well-defined problem. **P5** Implement error handling and report test results.	**M4** Demonstrate how the implementation of an ADT/algorithm solves a well-defined problem.	**D3** Critically evaluate the complexity of an implemented ADT/algorithm.

Pass	Merit	Distinction
LO4 Assess the effectiveness of data structures and algorithms.		
P6 Discuss how asymptotic analysis can be used to assess the effectiveness of an algorithm. **P7** Determine two ways in which the efficiency of an algorithm can be measured, illustrating your answer with an example.	**M5** Interpret what a trade-off is when specifying an ADT using an example to support your answer.	**D4** Evaluate three benefits of using implementation independent data structures.

Recommended Resources

Textbooks

Cormen, T. (1990) *Introduction to Algorithms*. MIT Labs.

Cormen, T. (2002) *Instructors Manual: Introduction to Algorithms*. MIT Labs.

Heineman, G. (2009) *Algorithms in a Nutshell*. O'Reilly Publishing.

Larmouth, J. (1999) *ASN.1 Complete*. Kaufman Publishing.

Leiss, E. (2007) *A Programmer's Companion to Algorithm Analysis*. Chapman & Hall.

Sedgewick, R. (1983) *Algorithms*. Addison-Wesley.

Wirth, N. (2004) *Algorithms and Data Structures*. Oberon.

Links

This unit links to the following related units:

Unit 4: Programming

Unit 10: Database Design & Development

Unit 27: Advanced Programming.

Unit 27: Advanced Programming

Unit code	**Y/615/1651**
Unit level	**5**
Credit value	**15**

Introduction

Features of programming languages that are considered advanced are used to develop software that is efficient; it can affect the performance of an application as well as the readability and extensibility of the code, improving productivity and therefore reducing cost. Many commercial applications available today, whether for productivity or entertainment, will have used one or more design pattern in their development. A design pattern is a description of how to solve a problem that can be used in many different situations and can help deepen the understanding of object-orientated programming and help improve software design and reusability.

The aim of this unit is to familiarise students with these features and their best practices to ensure that their code is in line with industry standards.

Among the topics included in this unit are: object-orientated programming; polymorphism, encapsulation, class aggregation/association, constructors/destructors, inheritance, abstract classes, interfaces, containers, generics, introduction to design patterns and Unified Modelling Language (UML).

On successful completion of this unit students will be able to write code in an object-orientated fashion using design patterns where necessary and be able to model their code structure in UML class diagrams. As a result they will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

By the end of this unit students will be able to:

LO1 Examine the key components related to the object-orientated programming paradigm, analysing design pattern types

LO2 Design a series of UML class diagrams

LO3 Implement code applying design patterns

LO4 Investigate scenarios with respect to design patterns.

Essential Content

LO1 **Examine the key components related to the object-orientated programming paradigm, analysing design pattern types**

Outline the object-orientated paradigm characteristics:

Encapsulation, polymorphism, constructors/destructors, sub objects, abstract/concrete, interface, method redefinition, generics/templates, containers.

Object-orientated class relationships:

Generalisation/inheritance, realisation, dependency, aggregation, composition.

Design patterns:

Creational, structural and behavioural.

LO2 **Design a series of UML class diagrams**

UML class design:

Analyse a code scenario and utilise a suitable UML tool to develop class diagrams.

LO3 **Implement code applying design patterns**

Implementation:

Using an appropriate language & IDE to develop code that implements design patterns and utilises techniques to produce secure code

Interpret and implement a given design whilst remaining compliant with security and maintainability requirements.

LO4 **Investigate scenarios with respect to design patterns.**

Review the usage of design patterns:

Relating design patterns to a range of given scenarios

Discuss software design approaches and patterns to identify reusable solutions to commonly occurring problems.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Examine the key components related to the object-orientated programming paradigm, analysing design pattern types		
P1 Examine the characteristics of the object-orientated paradigm as well as the various class relationships.	**M1** Determine a design pattern from each of the creational, structural and behavioural pattern types.	**D1** Analyse the relationship between the object-orientated paradigm and design patterns.
LO2 Design a series of UML class diagrams		
P2 Design and build class diagrams using a UML tool.	**M2** Define class diagrams for specific design patterns using a UML tool.	**D2** Analyse how class diagrams can be derived from a given code scenario using a UML tool.
LO3 Implement code applying design patterns		
P3 Build an application derived from UML class diagrams.	**M3** Develop code that implements a design pattern for a given purpose.	**D3** Evaluate the use of design patterns for the given purpose specified in M3.
LO4 Investigate scenarios with respect to design patterns.		
P4 Discuss a range of design patterns with relevant examples of creational, structural and behavioural pattern types.	**M4** Reconcile the most appropriate design pattern from a range with a series of given scenarios.	**D4** Critically evaluate a range of design patterns against the range of given scenarios with justification of your choices.

Recommended Resources

Textbooks

Freeman, E. et al. (2008) *Head First Design Patterns*. 4th Ed. United Stated of America: O'Reilly Media.

Gamma, E. et al. (1995) *Design Patterns: Elements of Reusable Object-Oriented Software.* 1st Ed. New Jersey: Addison-Wesley.

Mclaughlin, B.D. et al. (2007). *Head First Object-Oriented Analysis and Design*. 1st Ed. United States of America: O'Reilly Media.

Links

This unit links to the following related units:

Unit 4: Programming

Unit 26: Data Structures & Algorithms.

Unit 28: Risk Analysis & Systems Testing

Unit code	**D/618/7437**
Unit level	**5**
Credit value	**15**

Introduction

Risk-based testing prioritises tests during the system testing phase, based on the highest impact and probability of system failure.

The aim of this unit is to give students the knowledge and skills they need to use risk-based testing (RBT), using a medium-sized application, developing a full and detailed RBT procedure and documenting the results. They will then be able to evaluate the effectiveness of the application and the testing procedures employed. RBT is used widely in industry to organise software testing and to use test resources more efficiently.

This unit introduces students to prioritising testing software features according to risk of failure, evaluated as a function of criticality or importance and impact of failure.

Risk of software failure determines the priority of tests within a Test Plan, strategically carrying out testing over multiple test cycles. Among the topics included in this unit are how to classify and evaluate software risks using the risk formula, risk matrix, RBT testing and test build strategies, priority test cycles, security testing, coverage analysis and risk reduction reports.

As a result of studying this unit, students will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

By the end of this unit students will be able to:

LO1 Examine risk-based testing and requirements

LO2 Create a customised risk-based test strategy, plans and techniques for a given specification

LO3 Demonstrate a risk-based Test Plan, producing associated outcomes

LO4 Evaluate a risk-based Test Plan and its associated outcomes.

Essential Content

LO1 Examine risk-based testing and requirements

Risk-based testing and requirements:

Understand risk-based testing stage model (ISO/IEC 9126-1)

Define no risk/no test; distinguish risk classifications, business/operational, security, technical, external, apply risk formula r(f) = P(f)*C(f), test risk assessment and criticality, develop risk weighted matrix, develop risk quality matrix, assess risk reduction methods, detail project risks, identify methods of reporting progress

The principles underpinning the psychology of testing, including required mindset and development mindset difference, how this can influence success of software testing activities.

LO2 Create a customised risk-based test strategy, plans and techniques for a given specification

Risk-based test strategy planning:

Identify and create test scenarios, including identification of typical security vulnerabilities to be addressed by different types of testing, e.g. penetration testing for known or unknown software flaws

Develop test risk matrix with selection of risk-based tests, considering latest knowledge of technological developments in software testing

Classification of tools to support testing

Develop risk test plan and build environment rollout plan, including functional testing, structural testing, automated testing as part of the systems development lifecycle and regression testing, sub-system integration (use-case, whole system, interface)

Maintenance following changes or reviews, after length of time or stress/overload

User evaluation, including analysis of requirements, actual outcomes, acceptance, alpha, beta

Ensuring requirements traceability.

Testing plan:

Examine test cycles, prioritising security testing

Example test data, including normal, erroneous and extreme

Define expected outcomes, including valid, invalid and information gained, reporting of risk

Understand the difference between error, defect and failure, including the distinction between the root cause of a defect and its effects

Analyse test coverage and follow up, fault density analysis

Choose appropriate testing methods, e.g. static testing, change related, sequential, iterative and suitable metrics for the defect management process

Prioritisation of further test cycles, changes to specification, changes to analysis, design, amendments to code written, modifications to risk test strategy and plan, create risk reduction reports.

Techniques:

Apply static testing techniques, e.g. review, static analysis visual evaluation

Functional testing, e.g. control flow, data flow

Structural testing, e.g. boundary value, branch condition, validation, verification

Apply a regression strategy, including selection of tests, maintenance of regression suites and identifying tests suitable for automation

Understand the importance of defect management, using defect tracking tools.

LO3 **Demonstrate a risk-based Test Plan, producing associated outcomes**

Outcomes:

Follow software testing frameworks and methodologies, including conforming to appropriate industry standards, e.g. GDPR, health informatics, safety critical

Test code and analyse results to correct errors found using unit testing

Review code coverage results and analysis, analyse cause defects, check fault density results

Conduct a range of test types, e.g. integration, system, user acceptance, non-functional, performance and security testing

Review actual results against expected results, e.g. valid information or action, invalid information, or action, system-generated messages, program-generated messages.

Modifications:

Prioritisation of further test cycles, including changes to specification, changes to analysis, design, amendments to code written, modifications to risk test strategy and plan, create risk reduction reports

Links between the testing and software development lifecycles (sequential and iterative), the role of testing in continuous development and integration, the importance of regression testing, approaches to defect tracking and version control.

LO4 **Evaluate a risk-based Test Plan and its associated outcomes.**

Evaluation:

Evaluation to include developing risk heuristics evaluation criteria (probability, severity, classification), identifying risk-based testing benefits and drawbacks, defining fit for purpose criteria (functionality, accuracy, security effectiveness), alterations to tests carried out, possible improvements, program specification and design, self-reflection, management aspects.

Maintainability:

Perform risk testing and reporting refinement, usefulness to self, usefulness to others

Create analysis artefacts, such as use cases and/or user stories.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Examine risk-based testing and requirements</td><td rowspan="5">LO1 and LO2
D1 Justify test strategy and selection of test cases, based on quantified risk for a given specification.</td></tr>
<tr><td>P1 Investigate the testing stages involved in relation to a risk-based testing model and the key information to be communicated post-testing.
P2 Discuss the type of risks involved in systems testing in relation to the given specification.</td><td>M1 Analyse the advantages and disadvantages of applying risk-based testing by comparing two risk-based test strategies.</td></tr>
<tr><td colspan="2">LO2 Create a customised, risk-based test strategy, plans and techniques for a given specification</td></tr>
<tr><td>P3 Create a risk-based test strategy for the given specification, explaining specifically how security testing will be carried out.
P4 Develop a full and detailed Test Plan relating to the risk-based test strategy.</td><td>M2 Develop a test risk matrix, showing how the risks were evaluated.
M3 Design and apply a suitable risk-based test cycle.</td></tr>
<tr><td colspan="2">LO3 Demonstrate a risk-based Test Plan, producing associated outcomes</td></tr>
<tr><td>P5 Perform the tests identified in the risk-based Test Plan, providing a detailed log of all test results and modifications made.</td><td>M4 Justify the modifications made at each stage of the risk-based test procedure.</td><td>D2 Assess the importance of a suitable build environment to support a risk-based test strategy, including how prioritisation of test cycles can improve testing.</td></tr>
<tr><td colspan="2">LO4 Evaluate a risk-based Test Plan and its associated outcomes.</td><td rowspan="2">D3 Report on how test risk heuristics are identified, evaluated and monitored in a risk-based test strategy, providing justification.</td></tr>
<tr><td>P6 Discuss the effectiveness of the risk-based test strategy, including an assessment of security testing cycles.</td><td>M5 Propose a strategy for designing and building an improved risk-based test environment based on the lessons learned.</td></tr>
</table>

Recommended Resources

Textbooks

DeMarco, T. and Lister, T. (2003) *Waltzing with Bears: Managing Risk on Software Projects.* Dorset House Publishing.

Nettleton, D. (2006) *Risk-based Software Validation: Ten Easy Steps*. Parenteral Drug Association.

Journal

Mottahir, M. and Khan, A. I. (2013) *Risk-based Testing Techniques: A Perspective Study.* International Journal of Computer Applications. Article.

Websites

istqbexamcertification.com	International Software Testing Qualifications Board What is Risk Based testing? (Article)
www.cs.tut.fi	Tampere University of Technology Faculty of Computing and Electrical Engineering – Risk based Testing (Tutorial)

Links

This unit links to the following related unit:

Unit 8: Security

Unit 11: Software Development Lifecycles.

Unit 29: Applied Analytical Models

Unit code	**L/618/7448**
Unit level	**5**
Credit value	**15**

Introduction

Applied analytical modelling has become prevalent in many industries and has developed in terms of the mathematical techniques used and the diversity of modelling tools and techniques. Applied analytical modelling is carried out by a data scientist utilising modelling data, model building and model reporting skills. The aim of this unit is to give students knowledge of skills in analytical modelling skills, using computers to discover and interpret meaningful patterns in data by creating computer models.

This unit introduces students to applied analytical models used in business to discover, interpret and communicate meaningful patterns of data held in silos or data warehouses, and to derive knowledge to gain competitive advantage. Organisations may apply analytical methods and models to predict/prescribe business outcomes and improve performance in diverse areas such as stock control, financial risk and fraud analysis. Analytical models use mathematical algorithms and require extensive computation to process large amounts of data.

Among the topics included in this unit are data preparation, fundamentals of applied analytical models and development of predictive or prescriptive models using a suitable algorithm and operating on a large data set.

Students will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation which are crucial for gaining employment and developing academic competence.

Learning Outcomes

By the end of this unit students will be able to:

LO1 Examine applied analytical modelling methods

LO2 Prepare a large data set for use in an applied analytical model

LO3 Demonstrate the use of an analytical model with a large data set

LO4 Investigate improvements to an applied analytical model.

Essential Content

LO1 Examine applied analytical modelling methods

Decision or descriptive analytics:

Statistical look at data using visualisations, e.g. graphs, charts, reports, dashboards.

Prescriptive analytics:

Confirmatory data analysis (CDA).

Predictive analytics:

Forecasting or classification algorithms, machine learning, scoring, correlation, causation, regression analysis.

Algorithms:

Filtering, sorting clustering

Data visualisation.

Business domains:

Behavioural analytics, cohort analytics, collections analytics, cyber analytics, enterprise optimisation, financial analytics, fraud analytics, marketing analytics, pricing analytics, retail analytics, risk analytics, supply chain analytics, talent analytics, telecoms analytic, transportation analytics.

LO2 Prepare a large data set for use in an applied analytical model

Identify and evaluate applied analytical model data requirements:

Apply principles of data classification within data analysis activity

Data collection and data processing

Semi-structured and unstructured metadata processing and cleaning

Aggregation

Exploratory data analysis (EDA)

Data product

Data visualisation

Information displays

Dashboards.

LO3 **Demonstrate the use of an analytical model with a large data set**

Define analytic model requirements:

Data set selection

Carry out cleaning, aggregation and EDA

Identification of algorithm, selection and configuration of data mining software

Model implementation

Communication of results

Data visualisation

Graphical reports/dashboards.

LO4 **Investigate improvements to an applied analytical model.**

Improvements:

The advantages *and* disadvantages of a range of investigative techniques

Support the development of models for future state business situations

Other considerations including data quality, data assumptions, sampling, segmentation, uplift data modelling, algorithm selection, pattern and relationship discovery, qualitative and quantitative use, validating results, output communication methods and tailoring data visualisation.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Examine applied analytical modelling methods		
P1 Discuss the prescriptive and predictive analytical models, using examples. **P2** Illustrate three analytical methods, describing how they function.	**M1** Compare prescriptive and predictive analytical models, stating their advantages and disadvantages.	**D1** Using a case study example, critically evaluate the derived benefits from the use of an applied analytic model.
LO2 Prepare a large data set for use in an applied analytical model		
P3 Describe the process of analytical model data preparation, describing data cleaning, discretisation, aggregation and data reduction stages. **P4** Suggest two methods to visualise the output from an applied analytical model, using illustrations.	**M2** Analyse three potential issues in preparation of data for use in an applied analytical model.	**D2** Review the primary reasons for carrying out data transformation before input to an applied analytical model.
LO3 Demonstrate the use of an analytical model with a large data set		
P5 Select a suitable algorithm to analyse a large data set to meet a business need. **P6** Use an appropriate analytical modelling tool to carry out an investigation.	**M3** Propose how the data set will be prepared for the analytical model used in the investigation.	**D3** Review the results of the investigation, assessing the quality of the obtained knowledge.

Pass	Merit	Distinction
LO4 Investigate improvements to an applied analytical model.		
P7 Investigate improvements to an applied analytical model.	**M4** Propose three improvements to the approach used in the investigation. **M5** Discuss two ways to increase the performance and limits of the analytical model used in the investigation.	**D4** Present the results of the investigation, promoting the benefits of using applied analytical models in a business.

Recommended Resources

Textbooks

Carlberg, C. (2016) *Predictive Analytics: Microsoft™ Excel*. QUE.

Marr, B. (2015) *Big Data: Using SMART Big Data, Analytics and Metrics To Make Better Decisions and Improve Performance.* Wiley.

Runkler, T. (2020) *Data Analytics: Models and Algorithms for Intelligent Data Analysis.* Springer Vieweg.

Websites

www.ericsson.com	Ericsson white paper *Big Data Analytics – Actionable Insights for the Communication Service Provider* (Research)
aisel.aisnet.org	Association for Information Systems *Big Data Analytics: Concepts, Technologies, and Applications* (Tutorial)
www.fujitsu.com	Fujitsu *The White Book of Big Data* (E-book)

Links

This unit links to the following related units:

Unit 5: Big Data and Visualisation

Unit 10: Database Design & Development

Unit 12: Data Analytics

Unit 19: Business Intelligence.

Unit 30: Business Information Technology Systems

Unit code	**A/618/4934**
Unit level	**5**
Credit value	**15**

Introduction

Information is the most valuable resource that an organisation possesses. The effective gathering, protection, analysis, processing and dissemination of information is vital to the success of any organisation. As globalisation and the 24-hour economy develops and increases, organisations must ensure that their information systems are reliable, efficient and able to cope with rapid change. This unit introduces students to the importance of information to organisations. They will examine how systems can be used to support core business functions and enable organisations to be more productive and competitive in the global marketplace.

The aim of this unit is to enhance students' understanding of contemporary business information technology (IT) systems and how organisations develop and continuously review their IT strategy in order to gain and maintain competitive advantage. Students will explore the areas of business that benefit from the support of IT systems and how organisations are using IT as a driver for business improvement.

By the end of this unit, students will be able to critically analyse the application of current and future technologies and suggest best solutions for an organisation.

Learning Outcomes

By the end of this unit a student will be able to:

LO1 Analyse the role of different IT systems in support of organisational objectives

LO2 Compare flexible and reliable IT systems that respond to organisational requirements in an organisational context

LO3 Evaluate IT systems that support value-added change in organisations

LO4 Recommend practical IT system solutions to given organisational scenarios.

Essential Content

LO1 **Analyse the role of different IT systems in support of organisational objectives**

IT systems:

Definition of IT systems and categories of information systems, e.g. operational, tactical and strategic information systems

Definition of information and data, sources of information, information requirements and the needs for information at different levels within an organisation

Hardware and software for IT systems, e.g. operating systems, computer communications and networks, distributed computing.

Emerging digital technologies and use of digital devices:

Cloud computing for data storage, retrieval and transmission

Mobile devices for database management, stock management, goods tracking and customer service

Distributed ledger technology (DLT), e.g. blockchain for e-commerce

The transformational impact of 5G networks on IT systems for faster and efficient decision making.

The role of IT systems:

The role of IT in knowledge management, data management and customer service management

Storing information and its importance with regard to security, accuracy and relevance

The impact of IT systems and their contribution to decision making and solving business problems

Capabilities and limitations of IT solutions

The impact of IT systems on the functions and structure of organisations to support meeting organisational objectives.

LO2 **Compare flexible and reliable IT systems that respond to organisational requirements within an organisational context**

Types of IT systems:

Use of different types of IT systems and their roles in relation to meeting business objectives and improving operational efficiency

EOPS (End of Point Sales) for transaction processing

CRM systems for customer relationship management, e.g. Salesforce

Database management systems, use of data dashboards, data warehouses and data discovery tools for business intelligence, e.g. Datapine, Clear Analytics and Tableau Online

Knowledge management systems (KMS), e.g. Microsoft Teams, Alfresco, Google for streamlining employee workflows, collaboration, sharing and disseminating data and information

Enterprise Resource Planning (ERP) cloud solutions. e.g. Oracle for integrating different technologies and systems across the business.

Types of information and data:

Layers of information systems, e.g. services, integration, security and analytics

Corporate database management systems, data management and characteristics of data within organisations

Processing Big Data, data warehousing and online databases

Types and flow of data and information in an organisation

Cybersecurity measures for data protection and confidentiality.

Reliability of IT systems and data quality:

The importance of ensuring accurate and appropriate data collection

Quality assurance and control measures used to ensure data quality on entry and after data collection.

LO3 **Evaluate IT systems that support value-added change in organisations**

Project management methodologies and strategies to create value and competitive advantage:

Project management methodology for achieving specific goals

Value creation strategy, competitive advantage, make or buy decisions

Cost and benefit analysis.

IT support for value-added change:

IT for improving knowledge in activities in the value chain, increasing quality, reducing costs

New and existing approaches to improving IT position and impact on other business areas providing value-added services, e.g. solutions for providing real-time performance data, maintenance histories, organic systems for effective data management and cybersecurity solutions

System development tools and techniques, e.g. Agile, Rapid Application Development (RAD), Scrum and Waterfall.

LO4 **Recommend practical IT system solutions to given organisational scenarios.**

IT systems support for problem solving:

Problem solving using decision-making models, e.g. decision support, group decision, artificial intelligence and IT systems application

The use of IT systems to support the storing and managing of data, information sharing, communication, security and gaining a competitive edge

The use of IT systems for a seamless customer experience management.

Monitoring and evaluating IT systems:

Effective monitoring and evaluation of IT systems and their impact on organisations.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Analyse the role of different IT systems in support of organisational objectives		
P1 Analyse the use of IT systems in different functions of an organisation. **P2** Examine how IT systems contribute to the achievement of objectives in a specific organisational context.	**M1** Critically analyse how IT systems are applied in the different functions of an organisation and how they work together to achieve high performance.	**D1** Justify the role and purpose of IT systems in different functions of an organisation, and their contribution to achieving organisational objectives.
LO2 Compare different flexible and reliable IT systems that respond to organisational requirements in an organisational context		
P3 Compare different ways, in an organisational context, that IT systems store and process data for knowledge management, customer relationship management, data management and communication management.	**M2** Evaluate the different ways that IT systems store and process data to meet organisational objectives, giving specific organisational examples.	**D2** Critically evaluate the choices that have been made in specific organisational examples to make recommendations.
LO3 Evaluate IT systems that support value-added change in organisations		
P4 Evaluate how IT systems can be used to support value-added change for improving business operations, performance and sustainability.	**M3** Critically evaluate advantages and disadvantages of different IT systems that support value-added change in an organisational context.	**D3** Provide justified recommendations for improving IT systems in the support of value-added change in an organisational context.
LO4 Recommend practical IT system solutions to given organisational scenarios.		
P5 Recommend practical IT system solutions for organisational scenarios that cover a range of common business problems experienced in the workplace.	**M4** Recommend practical IT system solutions, giving potential consequences and benefits of their implementation.	**D4** Evaluate how IT system solutions support added future value and improve the workplace.

Recommended Resources

Textbooks

BENYON-DAVIES, P. (2019) *Business Information Systems.* 3rd Ed. London: Palgrave Macmillan.

BOCIJ, P. (2018) *Business Information Systems: Technology, Development and Management for the E-Business*. 6th Ed. London: Prentice Hall.

LAUDON, K. C. and LAUDON J. P. (2019) *Management Information Systems*. 16th Ed. Harlow: Pearson.

TURBAN, E. et al (2018) *Information Technology for Management: Advancing Sustainable, Profitable Growth*. 11th Ed. Oxford: Wiley.

Websites

computerweekly.com	*Computer Weekly* (Articles)
computer.org	Institute of Electrical and Electronics Engineers (IEEE) Computer Society Publications Technology news (General reference)

Links

This unit links to the following related units:

Unit 18: Project Management.

Unit 31: Network Management

Unit code	**F/618/7463**
Unit level	**5**
Credit value	**15**

Introduction

Network management has become one of the most sought-after skills for government institutions, commercial organisations, financial institutions and academic institutions as they try to run their IT networks in a more cost-effective, efficient and secure way. The art of network management needs to be perfected by those in charge of networks today and in the future, including multimedia applications such as VoIP, IPTV and mobile network, and virtualised environments.

This unit introduces students to simple network planning, configurations, setup, and management, including LAN, WAN, NAT, PAN, MAN, using a variety of tools and methods for managing networks, including network monitoring, network security such as Snort, firewalls and IPS, network protocols and standards such as Simple Network Management Protocol (SNMP), the Network Configuration Protocol (NETCONF), IEEE, MIBII, Remote Network Monitoring (RMON), MDIB & ANS.1, as well as industry's best practices. Students will also be introduced to virtual networks, network operating systems, risk management and cloud network management.

Among the topics included in this unit are: network planning, network configurations, network setup and network management of LANs, PAN, MAN, WAN, NAT, using several tools and methods; network monitoring, network security, network load balancing, network protocols and standards, best practices, virtualisation, network operating systems, network risk management and cloud network management.

On successful completion of this unit, students will be able to plan a network, configure a network, setup a network, manage a network such as a LAN, PAN, MAN, WAN, and conduct network monitoring, network security, network protocols and standards. Students will also be able to apply industry best practices, manage virtualised networks, work with several operating systems vendors and plan and manage network risks and cloud computing. Students will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation which are crucial for gaining employment and developing academic competence.

Learning Outcomes

By the end of this unit students will be able to:

LO1 Explore the concepts and principles of network management

LO2 Plan, design, setup and configure a network

LO3 Review the protocols and standards related with networking and network management

LO4 Use tools and methods to manage a network, including network security and risk management.

Essential Content

LO1 Explore the concepts and principles of network management

Effective network management activities:

Security, networking technologies, networking topologies, networking protocols, self-learning networks and Service Level Agreements (SLAs).

Automatic management:

Data formats, e.g. JSON (JavaScript Object Notation), YAML (YAML ain't a markup language), XML (eXtensible Markup Language)

Computer to computer communications, e.g. via APIs (Application Programming Interfaces), via REST (Representational State Transfer)

Configuration management tools, e.g. Puppet, Chef, Ansible, SaltStack.

LO2 Plan, design, setup and configure a network

Planning and design:

Planning methodology, topological design, protocols, transmission technologies, hardware, network realisation

Interpret information received from a manager, customer or technical specialist and accurately implement the defined requirements into the design of the network.

Setup and configuration:

Devices, cabling, protocols, ACLs, security and optimisation.

LO3 Review the protocols and standards related with networking and network management

Network protocols and standards:

Protocols, including SNMP, NTP, NETCONF, RMON, TCP/IP, HTTP, DNS, DHCP, SSL, IPSec. Standards: IEEE, ITU, ISO, OSI, IANA

Current legislation which impacts networking and network management and network engineers role.

LO4 **Use tools and methods to manage a network, including network security and risk management.**

Tools and methods:

NETCONF, CISCO, SNMP, RMON.

Network security:

IPSec, GRE (Genetic Routing Encapsulation), HHTPs, FTPs, DNS, firewall, passwords, cryptography.

Risk management:

Approaches to risk assessment, including risk identification, risk mitigation, risk avoidance, risk management and risk grading, e.g. severity, likelihood, impact.

Troubleshooting and maintenance:

Troubleshooting methodologies for network and IT infrastructure

Diagnostic techniques and tools to interrogate and gather information on systems performance

Monitor, identify and implement required maintenance procedures

Implement techniques to monitor and record systems performance in line with defined specifications.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Explore the concepts and principles of network management</td><td rowspan="5">LO1 and LO2
D1 Critically evaluate a comprehensive network configuration for a predefined network specification.</td></tr>
<tr><td>P1 Investigate network management concepts and principles.
P2 Discuss the implications of automatic network management.</td><td>M1 Evaluate the importance of network management.</td></tr>
<tr><td colspan="2">LO2 Plan, design, setup and configure a network</td></tr>
<tr><td>P3 Produce a comprehensive design of a network according to pre-defined network specification.</td><td>M2 Implement a network design according to a predefined network specification.</td></tr>
<tr><td colspan="2">LO3 Review the protocols and standards related with networking and network management</td><td rowspan="2">D2 Evaluate the role and functions of SNMP and RMON.</td></tr>
<tr><td>P4 Assess the following network protocols and standards: SNMP, NETCONF, RMON, TCP/IP, HTTP, DNS, DHCP, SSL, IPSec, IEEE, ITU, ISO, OSI, including IANA and ICANN.</td><td>M3 Analyse the benefits and limitations of two protocols.</td></tr>
<tr><td colspan="2">LO4 Use tools and methods to manage a network, including network security and risk management.</td><td rowspan="2">D3 Critically evaluate the importance of carrying out a risk assessment on a network.</td></tr>
<tr><td>P5 Use tools and methods to manage a network.
P6 Implement network security on a network.
P7 Conduct a risk assessment on a network.</td><td>M4 Justify the importance of network security to a network.</td></tr>
</table>

Recommended Resources

Textbooks

Anderson, A. and Benedetti, R. (2009) *Head First Networking*. O'Reilly Media.

Comer, D. and Droms, R. (2003) *Computer Networks and Internets*. 4th Ed. Upper Saddle River: Prentice Hall.

FitzGerald, J., Dennis, A. and Durcikova, A. (2021) *Business Data Communications and Networking*. 14th Ed. Hoboken. John Wiley.

Hallberg, B. (2013) *Networking: A Beginner's Guide*. 6th Ed. McGraw-Hill Osborne.

Harrington, J. L. (1999) *Ethernet Networking Clearly Explained*. Morgan Kaufman.

Kurose, J. F. and Ross, K. W. (2016) *Computer Networking: A Top-Down Approach Featuring the Internet*. 7th Edition. London: Addison-Wesley.

Lowe, D. (2012) *Networking All-in-One For Dummies*. 5th Ed. John Wiley & Sons.

Olifer, N. and Olifer, V. (2005) *Computer Networks: Principles, Technologies and Protocols for Network Design.* John Wiley and Sons Ltd.

Reid, A. (2006) *WAN Technologies CCNA 4 Companion Guide.* Cisco Press.

Spurgeon, C. and Zimmerman, J. (2014) *Ethernet: The Definitive Guide*. 2nd Ed. O'Reilly Media.

Stallings, W. (2003) *Data and Computer Communications*. 7th International Ed. Upper Saddle River: Prentice Hall.

Subramanian, M. (2000) *Network Management: Principles and Practice*. Harlow: Addison-Wesley.

Tanenbaum, A. and Wetherall, D. (2013) *Computer Networks*. 5th Ed. Pearson.

Websites

www.dmtf.org	Distributed Management Task Force (General reference)
www.ietf.org	Internet Engineering Task Force (General reference)
www.iso.org	International Organization for Standardization (General reference)
www.itu.int	International Telecommunication Union (General reference)

www.tmforum.org	TM Forum (General reference)

Links

This unit links to the following related units:

Unit 9: Networking.

Unit 32: Digital Technologies as a Catalyst for Change

Unit code	**T/618/5662**
Unit level	**5**
Credit value	**15**

Introduction

Digital technology has transformed how people communicate, learn, and work. This sector is one of the most valuable and fastest growing economic areas in most of the world. Although the first electronic digital computer was created in the 1930s, the digital revolution began between the late 1950s and 1970s, when key developments of technologies from mechanical and analogue to digital took place. It was during this time that the use of digital computers and digital record keeping became the norm. The industry has grown rapidly in recent decades and digital technologies are now a part of our daily lives. The digital technologies we are familiar with today are the electronic tools, systems, devices and resources that generate, store or process data. Most popular examples include mobile phones, social media, online games, virtual reality and multimedia. Spanning cultural, creative, educational and many other industries, digital technologies are a vibrant sector with growth that has surpassed the rest of the economy. Digital technology has completely modified the way we live today and in years to come this will be even more incredible.

In this unit, students will explore the impact of both the current and emerging digital technologies across different industries and investigate how organisations and businesses use digital technologies to meet their needs. They will also look at how an organisations strategy and leadership decision making is impacted by digital technology implementation. They will plan a solution for a specific organisation to use a new or emerging technology.

This unit can be delivered alongside the Emerging Technologies unit where they must implement a planned solution, thus allowing students an opportunity to demonstrate putting their digital technology implementation plan into action.

On successful completion of the unit, students will have explored industry sectors that use digital technologies, the history of the industry, current and emerging digital technologies, and how organisations are adapting and solving problems using digital technologies and planning for the future.

Learning Outcomes

By the end of this unit a student will be able to:

LO1 Explore how digital technologies impacts organisational change

LO2 Evaluate how the use of digital technology impacts on an organisation's strategy and operations to meet its needs

LO3 Investigate how digital technologies influence leadership decision making in relation to a specific industry

LO4 Present a new or emerging digital technology solution to manage a change initiative within a specific organisation.

Essential Content

LO1 Explore how digital technologies impact organisational change

Evolution of current digital systems and technologies:

Development of the digital technologies sector and the impact on organisational change, e.g. evolution of digital technologies, computers, laptops, smartphones, tablets/touchscreen devices, SMART products and experiences, digital manufacturing, Cloud technologies, virtual reality experiences.

Industries using digital technologies:

The impact of digital transformation in different industries, e.g. automotive and manufacturing, banking and financial services, government/public sector, healthcare, marketing, retail and consumer packaged goods, sport, agriculture, telecom and media/entertainment, travel/transportation.

Emerging digital technologies:

Impact of emerging digital technologies on organisational change, e.g. robotics, Artificial Intelligence (AI) (including Machine Learning), cybersecurity, Internet of Things (IoT), Blockchain, Bitcoin, Virtual Reality and Augmented Reality, Edge Computing.

Purposes:

Purpose of digital technologies on organisational change, e.g. social connectivity, global communication/communication speed, wider consumer reach, support remote working, e.g. local, national, and international, versatile working, e.g. flexible working practices, increased connectivity options, information storage, reduce costs, improving productivity, increasing promotion and sales, meeting business goals, improving efficiency, recruitment, education, increase business support, enhance customer experience/providing instant customer service, technical support, news and updates, GPS and mapping.

Rationale for change management:

Digital transformation and the disruptive effects of emerging technologies on organisational change.

The value of digital transformation to improve organisational performance, seize new opportunities, address key issues, optimise the customer experience.

Types of organisational change:

Change in a business context, including large scale, e.g. radical, discontinuous, revolutionary and small scale, e.g. incremental, evolutionary.

Different types of change that include planned or emergent, initiated or imposed.

Types of internal organisational change: structural, strategic, people and process change.

Individual, group and organisational levels of change.

Change management models:

Different approaches to managing change within organisations, e.g. Kotter's 8 Step model, McKinsey 7-S, ADKAR (Awareness, Desire, Knowledge, Ability and Reinforcement), Kubler-Ross Change Curve, Lewin's change management model.

The benefits and drawbacks of the key change models.

LO2 **Evaluate how the use of digital technology impacts on an organisation's strategy and operations to meet its needs**

Responding to drivers of change:

Using systems theory and continuous improvement models to predict and proactively plan for change.

Burke-Litwen mode to make the change process efficient and effective.

Change impact assessment:

Organisational strategy, e.g. business plans, annual forecasts, aims and objectives, short/long-term goals, financial accounts (including profit and loss), financial projections.

Operational aspects, e.g. organisational structure, human resources, physical resources, working hours, staffing (internal and external), sales, advertising, marketing.

Business needs, business type e.g. large corporate, SME, freelance, self-employed.

Types of technology that organisations use to provide a product/service, needs and/or benefits of the customers/clients, hardware/software/network requirements, security requirements.

Methods to identify needs e.g. gap analysis process, feasibility study (based on organisation's needs, market research), digital strategy/digital policies of business plan, feedback from stakeholders, customers, employees.

Assessing if technology meets an organisation's needs:

Benefits realisation, e.g. improved efficiency, increased profit, increased productivity, reduction in wasted time, reduction in cost.

Risks and issues, e.g. customer feedback, complaints, loss of sales, profit loss.

Change management, e.g. training, transition from existing to new technology, risk of loss of service/data.

Ethical considerations, e.g. consultation with stakeholders, data ownership, impact on employees.

Data management and access, e.g. privacy, security of data.

Legal considerations of digital transformation use of data, technology and software as a means of generating meaningful business insight and conduct operations more efficiently. Legislation includes, e.g. Intellectual Property (IP), copyright, trademarks, trade secrets, compliance, e.g. data protection and security, data mining and control, use of data for advertising, Computer Misuse Act 1990.

Change management processes:

Sequence of steps or activities that move change from inception to delivery, e.g. identify need for change, impact analysis, approve/deny, implement, review/report.

LO3 **Investigate how digital technologies influence leadership decision making in relation to a specific industry**

Driving factors of change:

The external and internal drivers that are driving change.

The implications of current factors for future development of digital technologies and decision making, e.g. distributed ledger technology (DLT), and the impact for e-commerce, transformational impact of 5G networks on IT systems for faster and efficient decision making.

Barriers to change:

How barriers to change influence leadership decision making initiated or imposed change, e.g. deciding to be pre-emptive and proactive or responsive and reactive will be based on the situation and the nature/scope of the change.

Adaptive and constructive change.

The impact that the scope of the change may have on decision making.

Responding to barriers and resistance to change.

Barriers and resistance to change, e.g. force field analysis to understand likely opposition and support for change in a contemporary context.

Schein's organisational culture model, self-efficacy perceptions and situational resistance when determining barriers.

Leadership ethics for effective decision making e.g. respecting and valuing diversity, values and ethical beliefs.

Speed of change, e.g. pre-emptive and proactive or responsive and reactive.

Resource implications of digital development, e.g. financial, physical, human – requisite skills and experience.

Change factors:

Positive factors, e.g. increased skillsets, training opportunities, improve people's quality of life, wage increases, increased employment, enhanced career prospects.

Negative factors, e.g. loss of employment, reduced career progression opportunity, necessity to retrain in an alternative sector, impact of local community and wider economy.

Evolution of digital technologies and change management:

Current examples of digital technologies driving change.

Sustainability and the need for enhanced/refined digital technologies.

Agility and leadership in response to change.

Change at a time of crisis and long-term benefits, e.g. COVID 19 and rapid development of technology to provide lifesaving support, post-World War II enhanced vehicle manufacture, climate change.

Leadership skills and techniques to support change, e.g. focused, inspirational, flexible, ability to learn from mistakes, defined vision and outcome, clear communication, empowering, address unsatisfied employee issues, encourage team collaboration, challenge.

LO4 **Present a new or emerging digital technology solution to manage a change initiative within a specific organisation**

Initiating a change:

Influence of position and perception influence a view of change as negative or positive.

Types of organisational change as a result of digital technologies, e.g. structural and strategic, people and processes.

The impacts of change initiated by leaders, e.g. increased control, time and increased opportunity to select the best approach to apply.

The impacts of change that is imposed, e.g. opportunities are reduced or even negated.

The stages of the change lifecycle.

Managing change:

Different perspectives to dealing with change, e.g. individual, open system.

Change impact analysis, e.g. Bohner and Arnold, and impact analysis techniques.

The importance of stakeholder analysis and communication in change.

Application of the Burke-Litwin model to make the change process efficient and effective.

Planned and emergent change.

Strategies for managing different types of change, e.g. planning, communication, setting out a roadmap.

Developing solutions:

Project and time management plans.

The elements and principles of using digital technology hardware and software.

Equipment, techniques, and processes.

Suitability of selected equipment, techniques, and processes.

Health, safety, safe working practices.

Project reports and project evaluations.

Purpose and value of quality assurance techniques.

Present a resolved solution:

Different types of presentation formats, e.g. industry-standard presentation software.

Hierarchy of text-based and visual information.

The key considerations for delivering a presentation, e.g. timing, structure, pace.

Selection and editing of content presentation skills.

Audience:

The importance of understanding audiences and stakeholder requirements and the implications this has on presentation style etc.

Techniques for generating and collating audience feedback.

Justifications:

Supporting and justifying the choice of solutions using creative, cultural, social, political, economic trends and contexts.

Industry-specific terminology.

How to engage, interact and respond to audience feedback.

Reflective practice.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Explore how digital technologies impact organisational change</td><td rowspan="5">LO1 and LO2

D1 Make evidence-based recommendations on the use of emerging digital technologies for an organisation's strategy and operations to meet its needs, in a specific industry context.</td></tr>
<tr><td>P1 Investigate how digital technologies drive organisational change.

P2 Examine the impact of digital technologies, in the context of different industries.</td><td>M1 Analyse the relationship between current and emerging technologies, their purposes and how these are being used in a specific industry context.</td></tr>
<tr><td colspan="2">LO2 Evaluate how the use of digital technology impacts on an organisation's strategy and operations to meet its needs</td></tr>
<tr><td>P3 Assess how the use of digital technology impacts on an organisation's strategy and operations to meet business needs.

P4 Evaluate the methods used by an organisation to identify digital technology requirements.</td><td>M2 Critically evaluate the methods used by an organisation to identify need and support the implementation of digital technology to meet its strategic goals.</td></tr>
<tr><td colspan="2">LO3 Investigate how digital technologies influence leadership decision making in relation to a specific industry</td></tr>
<tr><td>P5 Examine barriers to change and determine how they influence leadership decision making in relation to digital technology implementation in a given industry context.

P6 Discuss the positive and negative factors that may arise as a result of a new digital technology implementation in relation to a given industry context.</td><td>M3 Critically analyse the connection between positive and negative factors of digital technology development and its influence on the leadership decision making process.</td><td>D2 Make valid conclusions based on critical analysis of factors of digital technology development, and their influence upon leadership decision making.</td></tr>
</table>

Pass	Merit	Distinction
LO4 Present a new or emerging digital technology solution to manage a change initiative within a specific organisation		
P7 Develop a plan to implement a digital technology solution for a specific organisational need. **P8** Conduct a change impact analysis to minimise the potential impact on the organisation of the digital technology solution.	**M4** Develop a strategic plan to implement a digital technology solution which minimises the impact of change.	**D3** Justify the digital technology solution developed, and its potential for successful implementation, and minimal organisational impact.

Recommended Resources

Textbooks

LEWIS, L. K. (2011) *Organizational Change: Creating Change Through Strategic Communication.* Chichester: Wiley-Blackwell.

SCHAEFFER, E. (2019) *Reinventing the Product: How to Transform your Business and Create Value in the Digital Age.* London: Kogan Page.

STANFORD, N. (2013) *Organization Design: Engaging with Change*. 2nd edn. London: Routledge.

VENKATRAMAN, V. (2017) *The Digital Matrix: New Rules for Business Transformation Through Technology.* Canada: Life Tree Media.

Journals

International Journal of Digital Enterprise Technology

Journal of Change Management

Journal of Organisational Change Management Leadership

International Journal of Digital Technology & Economy

Links

This unit links to the following related units:

Unit 17: Management in the Digital Economy

Unit 19: Business Intelligence.

Unit 36: Application Development

Unit code	**Y/618/7436**
Unit level	**5**
Credit value	**15**

Introduction

Application development is a process of planning, creating, testing, and deploying an information system. Often applications are developed to automate a process, build a product to address business need or to get ahead of the competition by being innovative. Professionalism and critical thinking supported by an ability to work independently and as part of a team are core skills for a developer.

This unit introduces students to application development. It is designed to simulate the roles and responsibilities of a commercial developer working in a suitable business environment, with access to a small team of colleagues. Initially, students are introduced to a business-related problem and will need to adopt and use appropriate methods and practices to analyse, break down and discuss the issues – then decide, design, create and test a possible solution. Students should be free to debate, evaluate and select different design and development methodologies, depending on their own judgement and consideration.

Among the topics included in this unit are design and developer documentation; problem analysis; research, system and user requirements; design methodologies and principles; security considerations; development methodologies; software development lifecycles; teamwork, peer reviews, development tools and techniques; integrated development environments; debugging, testing, software versions and quality assurance.

On successful completion of this unit, students will be able to produce a software design document by analysing a business-related problem and deduce an appropriate solution, including a set of initial requirements. They will be able to select and use design and development methodologies, with tools and techniques associated with the creation of a business application. They will also be able to work individually and as part of a team to plan, prepare and produce a functional business application with support documentation, and assess and plan improvements to a business application by evaluating its performance against its software design document and initial requirements. As a result, students will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

By the end of this unit students will be able to:

LO1 Produce a software design document for a business-related problem based on requirements

LO2 Research design and development tools and methodologies for the creation of a business application

LO3 Plan and produce a functional business application with support documentation

LO4 Evaluate the performance of a business application against its software design document and initial requirements.

Essential Content

LO1 Produce a software design document for a business-related problem based on requirements

Business-related problem and solutions:

Problem definition statement, including highlighting and describing the issues that need to be addressed

Consider possible business application solutions that address problem

Predict the overall success of the application.

Produce a software design document:

Proposed solution, including relevant details on requirements, system analysis, system design, coding, user interface, testing and implementation

The value of software design documents with regard to application development

Consider software design approaches and patterns, which offer reusable solutions for commonly occurring problems

Research and use information relating to software testing to create a suitable Test Plan for a business application.

LO2 Research design and development tools and methodologies for the creation of a business application

Discuss different design and development methodologies:

Consider current design and development methodologies, e.g. Agile, DevOps, Rapid Application Development (RAD), Waterfall

Strengths and weaknesses commonly associated with each methodology

Security implications of design and development methodologies

Selection of a design and development methodology for use with the creation of a proposed application development.

Use appropriate tools and techniques:

Different tools and techniques available to create a business application

Advantages and disadvantages of your preferred or selected tools and techniques.

LO3 **Plan and produce a functional business application with support documentation**

Preparing a business application:

Peer review a development plan

Interpret and implement a given design while remaining compliant with security and maintainability requirements

Communicate and defend effectively the ideas in a software design document

Discuss differences with regard to the possible strengths and weakness of each software design document

Modify software design document to reflect any new insights or considerations.

Prepare and produce a functional business application:

Use a software design document with a preferred design and development methodology, and selected tools and techniques

Functional business application, with an effective user interface and data set for testing

Apply appropriate algorithms, logic and data structures as required in the development of an application

Build, manage and deploy code for the business application into a relevant environment and link code to data sets

Create and quality check appropriate support documents for an application.

LO4 **Evaluate the performance of a business application against its software design document and initial requirements.**

Assess the performance of a business application:

Factors that influence the performance of a business application with regard to its system requirements

Review of the performance and development of a developed application against all identified factors and any adopted design and development methodologies

Measure the overall success of the application against original prediction and identify any new areas of personal insight.

Plan improvements to a business application:

Strengths and weaknesses of a business application against its software design document and initial requirements

Detailed planning of possible revisions (including implementation) in terms of improving application's performance.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Produce a software design document for a business-related problem based on requirements</td><td rowspan="5">LO1 and LO2
D1 Evaluate the solution to a business-related problem and the preferred software development methodology by comparing the various software development tools and techniques researched.</td></tr>
<tr><td>P1 Produce a well-defined problem definition statement, supported by a set of user and system requirements for a business problem.
P2 Review areas of risk related to the successful development of a proposed application.</td><td>M1 Analyse a business-related problem using appropriate methods to produce a well-structured software design document.</td></tr>
<tr><td colspan="2">LO2 Research design and development tools and methodologies for the creation of a business application</td></tr>
<tr><td>P3 Research the use of software development tools and techniques for the development of a proposed application.</td><td>M2 Justify the software development tools and development methodology selected.</td></tr>
</table>

Pass	Merit	Distinction
LO3 Plan and produce a functional business application with support documentation		
P4 Conduct a peer review of the problem definition statement, proposed solution and development strategy, documenting any feedback given. **P5** Develop a functional business application, with support documentation based on a specified business problem.	**M3** Interpret peer-review feedback and identify opportunities not previously considered. **M4** Develop a functional business application based on a specific software design document, with supportive evidence of using the preferred tools, techniques and methodologies.	**LO3 and LO4** **D2** Justify improvements to the business application system made because of feedback and also feedback which was not acted on, including opportunities for improvement and further development.
LO4 Evaluate the performance of a business application against its software design document and initial requirements.		
P6 Review the performance of the business application against the problem definition statement and initial requirements.	**M5** Critically review the design, development and testing stages of the application development process, including risks.	

Recommended Resources

Textbooks

Cormen, T. et al. (2009) *Introduction to Algorithms*. USA: MIT Press.

Martin, R. C. (2011) *The Clean Coder: A Code of Conduct for Professional Programmers*. USA: Prentice Hall.

McConnell, S. (2004) *Code Complete: A Practical Handbook of Software Construction*. USA: Microsoft Press.

Links

This unit links to the following related units:

Unit 4: Programming

Unit 15: Fundamentals of Artificial Intelligent (AI) and Intelligent Systems

Unit 37: Application Program Interfaces.

Unit 37: Application Program Interfaces

Unit code	**L/618/7434**
Unit level	**5**
Credit value	**15**

Introduction

Many applications in use today are a composite of other software. This is true of an application, be it web based, mobile or on a desktop where the functionality of one is taken and used to build on. Think of an application that locates nearby restaurants – this may utilise an already existing map service as its basis. Or a game application that enables players to invite other players to chat and post high scores to social media, all within the game environment. How an application interacts with another is through an Application Program Interface (API).

Typically, APIs consist of methods and tools that are developed by the software author and which can provide services and functionality to other application developers without having to 'reinvent the wheel'. Existing APIs provide a huge range of functionality that can be integrated into an application by following the rules of the relevant API. One of the benefits in using APIs is access to existing and proven services that can help speed up development and help standardisation.

The aim of this unit is to introduce students to the nature of APIs by developing a proof-of-concept application that utilises existing APIs for common tasks, such as communication, displaying interactive visuals, audio playback and handling a range of user inputs. Among the topics included in this unit are identifying what an API is and the need for APIs; types of APIs; application design and development utilising relevant APIs in a suitable development environment; testing of the application; and a critical review of the APIs used.

On successful completion of this unit, students will be able to identify and select relevant APIs to use in an application from a given scenario. They will also be able to test and document the results against the initial design requirement. As a result, students will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

By the end of this unit students will be able to:

LO1 Examine the role of an API and its suitability for a given scenario

LO2 Design a solution that extends an existing application using relevant APIs for a given scenario

LO3 Implement an application in a suitable development environment based on a designed solution

LO4 Test an API developed for a given scenario to determine security vulnerabilities.

Essential Content

LO1 **Examine the role of an API and its suitability for a given scenario**

Research existing APIs, their role and the need for an API

Identify types of API uses, e.g. visual, social media, device manipulation

Evaluate suitable APIs for use in an application (web/mobile/desktop) for a given scenario

Examine security issues of APIs, e.g. inefficient coding, inadequate authentication and authorisation.

LO2 **Design a solution that extends an existing application using relevant APIs for a given scenario**

Investigate an existing application and identify ways that it could be extended, e.g. adding social media integration, linking to a webstore/payment handling; integrating stock control/stock levels with webstore, reactive layouts for different platforms

Develop relevant wireframes diagrams, concept the design of the application. Consider the application design/its purpose

Consider the target platform (web/mobile/desktop). Identify the scope of the application

Justify the selection/relevancy/purpose of the chosen APIs for the application. Take the security of APIs into consideration.

LO3 **Implement an application in a suitable development environment based on a designed solution**

Select suitable implementation processes to understanding the stages involved in development of APIs

Consider the use of a suitable development environment

Utilise tools and features available in a range of development environments for developing code and integrating APIs

Utilise best practices for implementing the API.

LO4 **Test an API developed for a given scenario to determine security vulnerabilities.**

Document the testing procedure carried out to satisfy the design requirements/purpose of application

Apply structural testing techniques

Apply common functional testing techniques to derive test conditions and test cases, e.g. Equivalence Partitioning, Boundary Value Analysis, Decision Table Testing and State Transition Testing

Reflect on the application development process, including identifying the chosen API's strengths, weaknesses, security concerns, ease of use and access to features within it.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Examine the role of an API and its suitability for a given scenario</td><td rowspan="3"></td></tr>
<tr><td>P1 Examine the relationship between an API and a software development kit (SDK).

P2 Review a range of APIs for different platforms.</td><td>M1 Assess a range of APIs that covers a variety of uses, suitable for a given scenario.</td></tr>
<tr><td>D1 Evaluate a selected API for a given scenario, including potential security issues.</td></tr>
<tr><td colspan="2">LO2 Design a solution that extends an existing application using relevant APIs for a given scenario</td><td rowspan="3"></td></tr>
<tr><td>P3 Investigate an existing application that could be extended with a suitable API.</td><td>M2 Design a solution that extends the existing application using an API for a given purpose.</td></tr>
<tr><td>D2 Critically review the designed solution to inform improvements, including utilising a range of APIs.</td></tr>
<tr><td colspan="2">LO3 Implement an application in a suitable development environment based on a designed solution</td><td rowspan="5">LO3 and LO4

D3 Evaluate the APIs used in the application developed, based on the test results, including a data security report of the application.</td></tr>
<tr><td>P4 Build on an existing application framework to implement an API.</td><td>M3 Refine an application framework, utilising multiple APIs based on a designed solution.</td></tr>
<tr><td colspan="2">LO4 Test an API developed for a given scenario to determine security vulnerabilities.</td></tr>
<tr><td>P5 Conduct structural and functional testing of the application, recording the results.</td><td>M4 Refine the application based on the results of testing.</td></tr>
</table>

Recommended Resources

Textbooks

Guinard, D. D. Trifa, V. M. (2016) *Building the Web of Things*. Manning Publications.

Pandian, P. (2018) *Building Node.js REST API with TDD Approach*. Independently published.

Spencer, T. et al. (2015) *Securing the API Stronghold: The Ultimate Guide to API Security.* 1st Ed. Kindle. Amazon.

Websites

www.developers.google.com	Google Developers (Development tool)
www.khronos.org	The Khronos Group Inc. Vulkan API (Development tool)
www.outsystems.com	OutSystems – developer community, tools and knowledge bases (Development tool)

Links

This unit links to the following related units:

Unit 15: Fundamentals of AI & Intelligent Systems

Unit 36: Application Development.

Unit 38: Planning Social Media Campaigns

Unit code	**H/618/5138**
Unit level	**5**
Credit value	**15**

Introduction

Facebook, Twitter, LinkedIn, blogs on countless themes, the ability to leave comments about news, online stores, file-sharing platforms and wikis have become essential elements of daily life. They are also valuable tools in the way that businesses communicate with their existing and potential audiences. Social media has transformed the way that people and businesses communicate, by allowing engagement across multiple channels with greater personalisation and targeted dissemination.

While we are experiencing a time of transformation that generates interesting opportunities, we are also faced with new challenges for organisations and individuals. The rapid growth in social media raises questions about authorship, authenticity and privacy, to name but a few.

In this unit, students will explore this new cultural ecosystem, where we use new practices of communication and social interaction through social media.

On successful completion of this unit, students will be able to analyse a market to plan and develop strategic communication campaigns through social media.

Learning Outcomes

By the end of this unit students will be able to:

LO1 Examine the key concepts and features of social media for different business activities

LO2 Discuss the uses of social media and their impact on market and audience

LO3 Plan a social media campaign for an organisation, based on client need, market and user research

LO4 Implement a social media campaign plan for an organisation to meet business objectives.

Essential content

LO1 Examine the key concepts and features of social media for business activities

Social media concepts and features:

Defining social media and different types of social media platforms

The use of social media as interactive platforms and primary uses of social media platforms

Corporate use of social media to influence and project brand, culture and values, e.g. brand building, culture of the company, positioning in social networks

Consumer engagement, e.g. customer service support

Communication and advertising, e.g. internal communication, external communication, contents, platforms.

The social media environment:

Emerging technologies and their impact on the social media environment, e.g. Artificial Intelligence (AI), the transformational impact of 5G networks, new access to virtual space and technologies

Globalisation and increased connectivity worldwide, leading to social media activism

Proactive and reactive social media responses in 'real time' to current news and events

The influences of culture and society on social media adoption and usage.

Business activities:

The benefits to business, e.g. driving sales through advertising and promotion, providing insight into consumer trends, strengthening customer relationships

How social media facilitates communications with customers both B2C and B2B, e.g. expands market reach, provides marketing insights and research, enables targeted promotion of product and services

Social media for building brand and creating positive brand association

The use of social media for increasing web traffic and building and increasing conversion rates

Risks to business activities, e.g. no tangible return, wasted time and investment, negative impact of incorrect messaging.

Social media roles and business activities:

The roles and responsibilities of a social media manager, community manager, social media content creator, social media marketing manager

Specific competences and skills sets, including managing different social media channels, facilitating social media communities, forming relationships with key influencers, creating engaging written, graphic brand messaging and monitoring competitor activities.

LO2 **Discuss the uses of social media platforms and their influence on market and audience**

Social media platforms:

Social media platforms and their customer profiles, understanding that each platform caters for a different demographic of customer and that modifying communication to suit each platform can maximise impact of message

Different social media channels and their benefits and limitations e.g. Facebook, LinkedIn, Snapchat, Twitter, Instagram

Techniques for building, managing and sustaining a loyal community on social media platforms.

Influencing market and audience:

Influencer marketing to grow social media presence

User motivations and purpose of using different social media platforms, e.g. for social networking, entertainment, social interaction

Using social media for consumer-to-consumer recommendations and sharing of opinions

Community and interest-driven platforms that provide the opportunity to share user profiles and create online networks

The use of blogs, podcasts and videos to influence, share and interact with consumers.

LO3 **Plan a social media campaign for an organisation, based on client need, market and user research**

Planning a social media campaign:

Methods of conducting market research of target audience and competitor analysis to define social media marketing aims and objectives

Identifying types of strategies for optimising social media accounts, creating and curating engaging content, managing the community and social listening

Applying metrics, e.g. number of clicks, hashtag performance, tracking reach

Differentiation between vanity metrics vs key metrics

Different approaches for gathering and evaluating feedback in real time to adapt and optimise.

Content strategies and management:

Creating different types of visual creation content using consistent themes and colours, e.g. use of Instagram, Pinterest

Techniques used for user-generated content and postings for interaction, e.g. hashtags, posting photos

Developing stories, competitions and time-sensitive content to share, e.g. using Instagram and Facebook

Factors to consider in planning a social media campaign including use of custom and internal forum software and Content Management System to manage and schedule posts and content delivery .e.g. timing of posts and visibility of content on social media channels

Building in and maintaining the audience through active influencers including analysing, interpreting and evaluating the information and ideas that are raised by the online community

Professional social media management including moderating users who violate the forum or company policy, intervening to change behaviour or issuing warnings, suspensions and bans as appropriate and manage conflict positively

Using social media analytics and dashboards to track usage and engagement.

LO4 **Implement a social media campaign for an organisation to meet business objectives.**

The stages of a social media campaign plan:

The purpose of a social media campaign

Devising different social media campaign goals and promotion on different social media channels

Techniques for promoting one message and uniqueness of brand, e.g. livestreaming, hashtags

Creating a content calendar

The factors to be considered for content creation, e.g. content type and format, balancing promotional and non-promotional content, meeting ethical and sustainable requirements

Follow-up promotion techniques.

Market testing:

Purpose of market testing

Different models for pilot testing, e.g. focus groups, questionnaire/survey interviews.

Social media analytics:

Use of analytical tools, e.g. Facebook Insight, Google Analytics, Twitter Analytics

Data searching

Data modelling

Metrics and techniques for measuring engagement, e.g. 'Followers'

'Likes', click-thru rate

Customer attitudes/behaviours.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Examine the key concepts and features of social media in different business practices</td><td rowspan="4">LO1 and LO2
D1 Critically analyse how social media is used by organisations to develop and promote business aims.</td></tr>
<tr><td>P1 Explore the key concepts of social media and the social media environment.
P2 Discuss the business activities that can be influenced by social media.</td><td>M1 Analyse the use of social media in the relationship between businesses and consumers.</td></tr>
<tr><td colspan="2">LO2 Discuss the uses of social media and their impact on market and audience</td></tr>
<tr><td>P3 Explore the use of social media platforms for different communication objectives.
P4 Debate the impact of different social media platforms on brand awareness and consumer engagement.</td><td>M2 Compare different social media platforms to identify their areas of greatest influence.</td></tr>
<tr><td colspan="2">LO3 Plan a social media campaign for an organisation, based on client need, market and user research</td><td rowspan="2">D2 Create a dynamic and unique social media campaign that influences users, is strategically focused and which has measurable outcomes.</td></tr>
<tr><td>P5 Conduct market and user research to consider different social media options in response to a given brief.
P6 Plan content and a content calendar for a social media campaign to address client needs and meet customer expectations.</td><td>M3 Justify design choices and the selection of technology platforms and tools for use in a social media campaign.</td></tr>
</table>

Pass	Merit	Distinction
LO4 Implement a social media campaign for an organisation to meet business objectives.		
P7 Implement a social media campaign, including content creation, and monitoring of audience engagement. **P8** Deliver a social media campaign that captures audience engagement through in-built analytics, across a range of social media platforms.	**M4** Implement a social media campaign designed to trigger strong audience emotions and add value to users. **M5** Compare audience engagement across a range of social media platforms, using in-built analytics to analyse the success of a campaign.	**D3** Evaluate performance and success of a social media campaign in meeting business objectives to make justified improvements.

Recommended Resources

Textbooks

ATHERTON, J. (2019) *Social Media Strategy: A Practical Guide to Social Media Marketing and Customer Engagement*. London: Kogan Page.

BARTNIK, M. (2019) T*he 8 Pillars of Social Media Marketing: Learn How to Transform Your Online Marketing Strategy For Maximum Growth with Minimum Investment.* Independently published.

McGRUER, D. (2019) *Dynamic Digital Marketing: Master the world of online and social media marketing to grow your business*. John Wiley and Sons.

WRIGHT, C. (2020) *Social Media Marketing 2020: How to Crush it with Instagram Marketing – Proven Strategies to Build Your Brand, Reach Millions of Customers, and Grow Your Business Without Wasting Time and Money.* Independently published.

Websites

i-socialmarketing.org	International Social Marketing Association Professional association (General reference)
socialmediaassoc.com	Social Media Association Professional association (General reference)
socialmediaclub.org	Social Media Club Professional association (General reference)
womma.org	WOMMA – Word of Mouth and Social Media Marketing Professional association (General reference)

Links

This unit links to the following related units:

Unit 16: Website Design & Development

Unit 39: Digital Marketing

Unit 40: Customer Value Management.

Unit 39: Digital Marketing

Unit code	**R/618/5121**
Unit level	**5**
Credit value	**15**

Introduction

To support digital transformation and growth, business organisations are becoming more digital savvy and are developing digital marketing plans. The role of digital marketing is to help organisations gain new traffic, leads and sales for their business by expanding reach to consumers looking for products and services.

The aim of this unit is to introduce students to digital marketing and its importance in the successful marketing of organisations. The unit will enable students to develop an understanding of how organisations use various digital tools and techniques to engage their customers and maintain a competitive advantage.

Digital marketing is a major component of the successful marketing of organisations. The digital landscape is continually evolving, it is important for marketers to stay ahead of their competitors and deliver cutting-edge digital marketing approaches and strategies.

This unit is designed to give students the knowledge and tools to work as part of a digital marketing team or to go on to further study in this specific area.

Learning Outcomes

By the end of this unit a student will be able to:

LO1 Investigate the influence of the digital environment for effective marketing of business organisations

LO2 Apply digital tools and techniques for an integrated marketing approach within a given business organisation

LO3 Design a digital marketing campaign using multimedia to optimise content that targets key audiences

LO4 Evaluate methods of monitoring and measuring a digital marketing campaign in line with marketing objectives to increase engagement and conversions.

Essential Content

LO1 Investigate the influence of the digital environment for effective marketing of business organisations

The digital environment:

Definitions of digital marketing

Digital marketing career opportunities and roles, e.g. digital marketing executive

Search Engine Optimisation (SEO) specialist, content strategist

Key knowledge and skills that includes digital integration, product management, customer experience, branding, monitoring and evaluating effectiveness and risk management

Key behaviours, e.g. influencing, collaboration, creativity, commercial awareness, entrepreneurial, innovative and inspiring, and being financially literate

Overview of the digital landscape and online consumer power

Key benefits of digital marketing as a business tool including the ability to deliver the organisations message and goals to the community in a manner appropriate to the community and forum

The role of digital marketing in relation to the 7Ps

Stages of the digital marketing lifecycle

Organisation challenges of digital marketing: legislation, technological resources and availability of skills.

Digital marketing opportunities:

Role of digital marketing strategy including proactively stimulate and drive customer interaction with brand

Digital marketing for business establishment and growth

Use of Artificial Intelligence (AI) in marketing and how it impacts digital campaigns, e.g. personalisation

Importance of customer insight and understanding in developing digital marketing campaigns

The growth of 'micro-moments' and their impact on business

Consumer lifecycle stages of digital adoption.

LO2 **Apply digital tools and techniques for an integrated marketing approach within a given business organisation**

Digital tools, platforms and channels:

Advantages and disadvantages of digital tools, platforms, channels

Selecting appropriate digital tools, platforms and channels for organisation context, e.g. website, social media, apps

Digital marketing techniques to encourage customer acquisition, conversion and retention, e.g. SEO, display and video advertising, email marketing, pay-per-click advertising

Reach, impact and cost effectiveness of digital marketing tools and techniques.

Content marketing:

Advantages and disadvantages of different content formats

Content marketing process, including research best practice to develop content topics based on target personas, developing a content calendar to plan and structure content creation and promotion, aligning content to achieving business goals

Creating, curating and appraising content, including aligning content to different stages of the buyer journey, identifying the key components in a company's brand personality, recognising the benefits of content personalisation, tools to create and curate different types of content

Format and restrictions on content.

Integration of digital with other marketing channels:

Frameworks and models of integration

Multi-channel marketing vs Omni channel marketing

Benefits of integrated data and analysis

Integration and resource planning.

LO3 **Design a digital marketing campaign using multimedia to optimise content that targets key audiences**

Digital marketing campaign planning:

A digital campaign vs regular communications plan

Different audience research methods and social listening techniques

Awareness of specific cultural factors that influence research

Establishing campaign goals and messaging proposition

Alignment with wider organisation marketing objectives

Integrating elements of the marketing mix

Auditing existing digital channels and assets

Setting objectives, selecting digital tools, platforms and channels, e.g. Snapchat, Instagram, Facebook to meet social media objectives

Resource and implementation planning.

Digital marketing campaign design:

Campaign theme and the creative concept

Structuring the digital marketing campaign to maximise reach, e.g. timescales, frequency

Craft the tone of communications to appeal to the different audiences on different digital platforms, in keeping with company brand and message including unwelcome information about a product in a positive manner, protecting brand reputation

Deliver effective written communication when messaging the online community via forums and online media channels

Factors to determine offer and desired audience 'call to action'

Creating buyer personas and value proposition

Design factors to provide a seamless customer experience, e.g. mapping customer journey, consistent brand identity and messaging

Platform holder policies and best practice guidelines.

LO4 **Evaluate methods of monitoring and measuring a digital marketing campaign in line with marketing objectives to increase engagement and conversions.**

Monitoring and measuring techniques:

Measures of digital campaigns using KPIs, measurable metrics and use of analytics platforms

Procedures used for measuring digital campaigns

Performance measures using online metrics

Populations measures.

Monitoring changes in the technological environment:

Tools and techniques for monitoring and reporting digital changes

Environmental scanning

Capturing and reporting on changes in the technological environment.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Investigate the influence of the digital environment for effective marketing of business organisations</td><td rowspan="5">LO1 and LO2
D1 Critically analyse digital marketing to draw valid conclusions for effective marketing of business organisations.</td></tr>
<tr><td>P1 Examine the opportunities and challenges digital marketing presents for effective marketing of business organisations.</td><td>M1 Analyse the opportunities and challenges for business organisations in the digital marketing landscape.</td></tr>
<tr><td colspan="2">LO2 Apply digital tools and techniques for an integrated marketing approach within a given business organisation</td></tr>
<tr><td>P2 Apply key digital tools and techniques that are available to marketers for an integrated marketing approach.
P3 Discuss their effectiveness in terms of reach, impact and cost.</td><td>M2 Analyse the effectiveness of applying an integrated marketing approach and the benefits this has for an organisation.</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td colspan="2">LO3 Design a digital marketing campaign using multi-media to optimise content that targets key audiences</td><td rowspan="5">LO3 and LO4
D2 Create a multimedia digital marketing campaign that provides a seamless customer experience and applies appropriate measures and performance metrics aligned to digital marketing objectives.</td></tr>
<tr><td>P4 Design a digital marketing campaign that integrates and optimises multi-digital channels to reach target key audiences.</td><td>M3 Design a digital marketing campaign that applies a creative concept to capture audience interest and inspire ‘call to action’.</td></tr>
<tr><td colspan="2">LO4 Evaluate methods of monitoring and measuring a digital marketing campaign in line with marketing objectives to increase engagement and conversions.</td></tr>
<tr><td>P5 Evaluate the measurement techniques and performance metrics in digital marketing.
P6 Present a set of actions to improve performance in digital marketing.</td><td>M4 Critically evaluate the application of key digital measurement techniques and performance metrics used in digital marketing.</td></tr>
<tr><td colspan="2"></td></tr>
</table>

Recommended Resources

Textbooks

CHAFFEY, D. and ELLIS-CHADWICK, F. (2019) *Digital Marketing: Strategy, Implementation and Practice.* 7th Ed. Harlow: Pearson.

HEMANN, C. and BURBARY, K. (2018) *Digital Marketing Analytics: Making Sense of Consumer Data in a Digital World*. 2nd Ed. Que Publishing.

KINGSNORTH, S. (2019) *Digital Marketing Strategy: An Integrated Approach to Online Marketing*. 2nd Ed. Kogan Page.

Websites

digitalmarketer.com	DigitalMarketer Resources (General reference)
digitalmarketinginstitute.com	Digital Marketing Institute Membership (General reference)
hubspot.com	Hubspot Resources (Templates)
marketingdonut.co.uk	Marketingdonut Online Marketing (General reference)
smartinsights.com	Smart Insights Resources (Toolkits and templates)

Links

This unit links to the following related units:

Unit 16: Website Design & Development

Unit 38: Planning Social Media Campaigns

Unit 40: Customer Value Management.

Unit 40: Customer Value Management

Unit code	**F/618/5129**
Unit level	**5**
Credit value	**15**

Introduction

This unit is designed to enhance students' knowledge and understanding of why it is important for marketers to enhance and manage the value of customer interactions. Students will learn underpinning theories and frameworks, and will be expected to relate them to real-world examples, including their own experiences.

Organisations ideally seek a mutually beneficial relationship between themselves and their customers. This is particularly important when considering the costs associated with acquiring a new customer. It has been suggested that it can cost five times as much to gain a new customer as it is to retain an existing one. Moreover, there is no guarantee that a new customer will be as loyal as a current one. Any organisation, whether for profit, NGO or a charity, seeks ways of retaining customers through enhanced customer experiences.

To retain loyal (and profitable) customers, organisations seek to understand them better. By understanding customers through the capture of relevant data, organisations can enhance a customer's lifetime value. They then aim to build a relationship with the customer where they remain loyal and continue to purchase a range of products and services.

The knowledge, understanding and skill sets that students will gain on successfully completing this unit will enhance their career opportunities, whether they are setting up in business independently or if they are employed by an organisation.

Learning Outcomes

By the end of this unit a student will be able to:

LO1 Examine the concept of customer lifetime value, how to calculate it and the different factors that influence it

LO2 Evaluate the different segments in a customer base and the appropriate opportunities for customer value creation

LO3 Apply appropriate techniques and methods in order to increase customer lifetime value.

Essential Content

LO1 **Examine the concept of customer lifetime value, how to calculate it and the different factors that influence it**

Traditional concepts of marketing compared with those of value and retention:

The benefits of managing customer value, satisfaction and retention

Customer lifetime values (CLVs)

Merits of CLVs

Value of customer data

Measurement and analysis of CLVs

The key factors that drive CLV, e.g. transaction value, number of repeat sales, customer retention.

How to calculate and increase your CLV:

Determining your customer acquisition costs, repeat transactions and customer retention rate

Calculations applied to calculate CLV

Creating balance in the business model.

Factors influencing CLVs:

CLVs in both a B2C and B2B context

Customer experience and how it can affect CLVs.

LO2 **Evaluate the different segments in a customer base and the appropriate opportunities for customer value creation**

Marketing segmentation:

The role of segmentation, targeting and positioning (STP) to identify lifetime value opportunities.

Identification and diagnosis of value creation opportunities:

Customer perceptions, e.g. section, nature of stimulus, expectations, motives and selective perception

Consumer imagery, including product and service positioning, price, quality relationships and company's image

How consumers store, retain and retrieve information

Involvement theory and consumer relevance

Measures of consumer learning, including recognition and recall, responses to media, brand loyalty

Perceived risk and methods for handling risk

Acquisition costs in relation to CLVs

Basic B2C and B2B decision-making models.

LO3 **Apply appropriate techniques and methods in order to increase customer lifetime value.**

Strategies for enhancing customer lifetimes values in both a B2C and B2B context:

Strategies for building long-term customer relationships and making CLV a strategic priority

Digital strategies, including increased connectivity with customers through mobile device, apps, social media and online chat and forums

Use of advanced technology such as the 'Internet of Things' and cognitive systems to gather real-time data and predict and forecast market trends

Creating brand loyalty.

Techniques and methods:

Different types of communication to build brand loyalty and advocacy

Personalisation of content and leveraging dynamic content on website, app, social media to target specific personal preferences

Rewarding loyalty by creating exclusive offers and choosing the right rewards and incentives

Value-driven cross-selling and upselling

Developing multiple points and channels of contact.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Examine the concept of customer lifetime value, how to calculate it and the different factors that influence it</td><td rowspan="9">LO1, LO2 and LO3
D1 Provide evidence of critical evaluation and synthesis of the key concepts of customer lifetime value management in an organisational context.</td></tr>
<tr><td>P1 Discuss the various components that enable an organisation to determine and calculate a customer's lifetime value.
P2 Explore the factors that influence the customer lifetime value.</td><td>M1 Analyse the concept of customer lifetime value and the use of collating customer data in either a B2C or B2B context.</td></tr>
<tr><td colspan="2">LO2 Evaluate the different segments in a customer base and the appropriate opportunities for customer value creation</td></tr>
<tr><td>P3 Determine the types of market segmentation strategies that can be applied to a customer base.
P4 Evaluate B2C and B2B decision-making models and demonstrate how opportunities for customer value creation can be applied.</td><td>M2 Critically evaluate various segmentation models in a B2C or B2B context to generate key insights and marketing intelligence for customer value creation.</td></tr>
<tr><td colspan="2">LO3 Apply appropriate techniques and methods in order to increase customer lifetime value.</td></tr>
<tr><td>P5 Apply different techniques and methods to increase customer relationships and customer loyalty in a given organisation.</td><td>M3 Apply appropriate techniques and methods at different stages of the consumer decision-making process and CLV.</td></tr>
</table>

Recommended Resources

Textbooks

BUTTLE, F. and MAKLAN, S. (2019) *Customer Relationships Management: Concepts and Technologies.* 4th Ed. Oxford: Routledge.

GOODMAN, J. (2019) *Strategic Customer Service: Managing the Customer Experience to Increase Positive Word of Mouth, Build Loyalty, and Maximize Profits.* 2nd Ed. Maidenhead: Amacom.

KUMAR, V. and REINARTZ, W. (2018) *Customer Lifetime Value: Concept, Strategy and Tools.* 3rd Ed. Springer.

Websites

acca-global.com	Customer Care Association Global Research and publications (General reference)
mckinsey.com	McKinsey & Company The expanding role of design in creating an end-to-end customer experience (Article)
mindtools.com	Mind Tools Customer Experience Mapping (General reference)

Links

This unit links to the following related units:

Unit 17: Management in the Digital Economy

Unit 38; Planning Social Media Campaigns

Unit 39: Digital Marketing.

Unit 41: Digital Sustainability

Unit code	**A/618/5694**
Unit level	**5**
Credit value	**15**

Introduction

Living and working in the 21st century in the digital technologies sector presents a range of unforeseen sustainability challenges. These challenges are based on, among other potential issues, mineral resource, ethical working and employment practices, economic impact, supply chain and climate impact.

The Brundtland Commission of the United Nations in March 1987 defined sustainability as: 'sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs'. Digital technologies is a sector in the frontline of the battle to overcome the challenges of creating a sustainable economy, but no single discipline has the capability to tackle the problems. Sustainability is a multidisciplinary challenge and technologists of the future will have to work collaboratively with a whole range of other stakeholders, such as engineers, scientists, governmental bodies and financiers, in order to find, within an urgent timescale, the practical and technological solutions needed.

On successful completion of this unit, students will have gained a wide range of knowledge and understanding of the issues and topics associated with sustainability and low impact digital technology solutions. They will have explored the interdisciplinary context of sustainability and how the development of a low carbon economy is essential in the digital technology sector. Students will also have explored a current digital technology solution and evaluated its impact and potential sustainability, evaluating a range of solutions and data sources.

Learning Outcomes

By the end of this unit, students will be able to:

LO1 Determine the nature and scope of the technical challenges, ensuring sustainability, within the digital technologies sector

LO2 Explore the importance of collaborating with other disciplines in developing digital technical solutions to sustainability problems

LO3 Evaluate the use of sustainable techniques in relation to their contribution to a low carbon economy

LO4 Calculate the carbon footprint of a digital technologies' solution.

Essential Content

LO1 Determine the nature and scope of the technical challenges, ensuring sustainability, in the digital technologies sector

The scope and social context of sustainability:

Current sustainable development and digital technology challenges

Moore's Law and the Brundtland definition of sustainability in a digital technologies context

Impact of global demographics, trends and predictions, population growth and how it affects demand, economics, employment ethics and resource availability.

Environmental issues:

Climate change, planetary energy balance, carbon cycle science, carbon footprint of digital technologies, including power consumption, mineral and material use, shipping, heat/energy output, packaging, recycling and safe disposal, potential pollution issues, contaminants in older equipment, low carbon power sources, corporate social responsibility and sustainable use of technologies – extending lifetime utilisation.

LO2 Explore the importance of collaborating with other disciplines in developing digital technical solutions to sustainability problems

Systems thinking and socio-technical systems:

The politics and economics of sustainability, following the principles of the Kyoto Protocol, UN Climate Change Conference (COP) and European Union Emissions Trading System (EU ETS).

Maintaining sustainable infrastructures:

Low-carbon transport systems, engaging with sustainable cities and societies, using green building and built infrastructure principles, ensuring the use of low- impact power generation, power storage and power distribution. Assuring low- impact, sustainable logistics and maintaining a low-waste-based system.

Ethical standards:

Ensuring that 3rd party supplier, manufacturer and supply chain contractors all conform to current ethical sustainable and fair employment standards, along with associated legislation, e.g. ethical sourcing and disposal of end-of-life electrical equipment – Waste Electrical and Electronic Equipment (WEEE) Regulations (2013). Use of environmentally neutral, beneficial 3rd party cloud solutions, reviewing ecological credentials of cloud provisioning organisation.

LO3 **Evaluate the use of sustainable techniques in relation to their contribution to a low carbon economy**

Sustainable techniques:

Evaluating how digital technologies can be maintained via nuclear, solar, wind, tidal and wave, geothermal, biomass and bioenergy. Ensuring whole life cycle costing and using the precautionary principle

Exploring the cost, power consumption and impact of digital technologies in a sustainability context, e.g. data centres, robotics in engineering, digital manufacturing, automated transport, telecommunications, health technologies, agri-tech

Evaluating the KWH (kilowatt hour) power consumption of cloud solutions, data transmission and device use (routers, switches, servers, desktop systems, mobile computing, smart devices, wireless, wired etc.). Powering down devices when unused, reducing standby time, power consumption on 'spin up' to full utilisation.

LO4 **Calculate the carbon footprint of a digital technologies' solution.**

Impact of digital technologies on climate:

Direct carbon emissions associated with digital technology manufacture, use and disposal. Case studies, e.g. Google Carbon Offset Data Centers, Microsoft and Ørsted offshore wind power, HP ink cartridge recycling program, NHS Electronic Prescription Service (EPS), Coca Cola manufacturing and warehouse automated robots

Indirect positive emission effects from using digital technologies, e.g. travel substitution and transportation optimisation

Impact that digital technologies have on behaviours and references, e.g. reshaping how we lead our lives.

Carbon footprint:

Evaluating the digital technology carbon footprint perspective, including organisational, value and supply chain, product-based challenges, current carbon footprint science, calculation of footprint based on system boundaries (limits of sphere of influence and control), geographical location, e.g. Global Carbon Project (GCP) map

Calculation of carbon footprint, e.g. ISO 14067:2018 – Greenhouse gases – Carbon footprint of products – Requirements and guidelines for quantification.

Decarbonisation of digital technologies:

Significance of digital technology electricity consumption. Use of renewable energy, e.g. solar and wind power, to lower carbon emissions

Impact of new and evolving digital technologies, e.g. artificial intelligence (AI).

Digital technologies as a driver of greater sustainability

Approaches to reducing digital technologies carbon footprint, e.g. maintaining digital devices to prolong life, using digital devices for longer before upgrading, recycling/reusing equipment, consuming digital services on smaller devices, charging batteries with electricity from renewable sources, purchasing digital devices and services from companies that have science-based targets (SBTs), using digital technology to help to reduce carbon emissions.

Data sources:

Evaluating power consumption, manufacturers' ecological/green rating of device(s), data sheets, regional waste-management metrics, energy efficiency ratings.

Long-term sustainability:

Projecting long-term sustainability of selected digital technologies to include sustainability plan and practices, e.g. zero-carbon, carbon neutral, net-positive approach, green IT; voluntary sustainability report, stakeholder engagement.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Determine the nature and scope of the technical challenges, ensuring sustainability, in the digital technologies sector		
P1 Investigate the nature and scope of the technical challenges of ensuring sustainability for the digital technologies sector.	**M1** Analyse the impact of sustainability on the deployment of digital technologies.	**D1** Critically analyse the interrelationship between sustainability, digital technology demand and resource availability.
LO2 Explore the importance of collaborating with other disciplines in developing digital technical solutions to sustainability problems		
P2 Explain the interdisciplinary issues associated with the construction of sustainable infrastructures, with attention to the competing pressures within these infrastructures.	**M2** Analyse how political, economic and ethical standards can impact digital technical solutions.	**D2** Critically analyse how a systemic approach can be used to support interdisciplinary collaboration in developing sustainable digital technologies.
LO3 Evaluate the use of sustainable techniques in relation to their contribution to a low carbon economy		
P3 Discuss the sustainable techniques that need to be considered when selecting alternative low-carbon energy sources.	**M3** Analyse the challenges present, when selecting low-carbon sustainable techniques for a digital technology solution.	**D3** Critically analyse how current digital technology solutions could be improved via the application of low-carbon sustainable techniques.
LO4 Calculate the carbon footprint of a digital technologies' solution.		
P4 Calculate the carbon footprint of a digital technologies' solution.	**M4** Analyse the use of renewable energy to lower carbon emissions to support a digital technologies' solution.	**D4** Critically review the overall carbon footprint impact and long-term sustainability of an existing digital technologies solution.

Recommended Resources

Textbooks

Berners-Lee, M. (2019) *There Is No Planet B: A Handbook for the Make or Break Years.* Cambridge University Press.

Berners-Lee, M. (2010) *How Bad Are Bananas?* Profile Books.

Boyle, G. (2012) *Energy Systems and Sustainability: Power for a Sustainable Future.* Oxford University Press.

Fenner, A. and Ainger, C. (2013) *Sustainable Infrastructures: Principles into Practice*. ICE Publishing.

Hazas, M. and Nathan, L. (2017) *Digital Technology and Sustainability: Engaging the Paradox*. Routledge.

Helm, D. (2015) *The Carbon Crunch: Why we are Getting Climate Change Wrong and How to Fix It*. Yale University Press.

Hone, D. (2014) *Putting The Genie Back: 2°C Will Be Harder Than We Think*. Whitefox Publishing.

Websites

bsigroup.com	Product Carbon Footprinting for Beginners – guidance for smaller businesses on tackling the carbon foot printing challenge (General reference)
carbontrust.com	Carbon Trust Carbon foot printing (General reference)
fern.org	FERN Trading Carbon How it Works and Why it is Controversial (E-book)
gov.uk	UK Government Technology Waste Disposal Regulations waste electrical and electronic-equipment (WEEE) (General reference)
populationinstitute.org	Population Institute Demographic Vulnerability report (Report)

Links

This unit links to the following related unit:

Unit 21: Emerging Technologies.

Unit 42: Pitching and Negotiating Skills

Unit code	**K/618/5125**
Unit level	**5**
Credit value	**15**

Introduction

This unit gives students a comprehensive overview of the essential pitching and negotiation skills required to win new contracts on agreeable terms. Good pitching skills for a new product or service will generate sales and networking opportunities, while negotiating with different people and in different business transactions will secure more favourable deals. These transferable skills can be applied in various contexts to add value to a business.

These skills are essential for the managing and running of a small business or for being part of a dynamic and innovative workforce. Individuals and groups working in key sales, tendering and contracting roles benefit from developing their skills further to increase and maintain a competitive edge within its markets.

This unit aims to give students a knowledge base and tools that will help them to develop these skills. Topic areas that they will investigate include analysing context prior to negotiation, information management prior to and during negotiation, the process of developing and presenting a case and being able to assess the successes of a new pitch.

Learning Outcomes

By the end of this unit a student will be able to:

LO1 Evaluate the context of a negotiation and identify the key considerations to prepare for a negotiation

LO2 Manage information and documentation relevant to tenders and contracts

LO3 Develop a pitch to achieve a sustainable competitive edge

LO4 Assess the outcome of a pitch and negotiation.

Essential Content

LO1 Evaluate the context of a negotiation and identify the key considerations to prepare for a negotiation

Context for negotiating:

The rationale for negotiation and the importance of negotiating skills in the workplace

Generating new business and winning new deals

Key negotiation tactics and strategies for group and individual negotiations

Preparing to negotiate and the Request For Proposal (RFP) process

Ethical behaviours in negotiation versus unethical

Closing a deal e.g. creating and finalising a contract

The value of understanding the context and behavioural factors that influence individuals in a negotiation, including cultural awareness and differences in international business negotiations

The value of forming and building long term negotiation relationships

Collapse and recovery when negotiating.

LO2 Manage information and documentation relevant to tenders and contracts

Context for tendering:

Key sources of information required during a negotiation, contextual information, client data, new solution information and contingencies

The key elements of an RFP document

The contractual process for both personal and classified information

The key elements of master agreements and statements of work

Contract law and compliance of processes, bribery and corruption, conflict of interest

Amending contracts and breaches of terms and conditions

Defining procurement and the different types of procurement processes

Online bidding and tendering.

LO3 **Develop a pitch to achieve a sustainable competitive edge**

Developing a competitive strategy for pitching:

The benefits of having a sustainable competitive advantage

The types of sustainable competitive advantage e.g. cost, value focus

The structure of pitching with emphasis on the value of brand loyalty, innovation and networking and partnerships, fit-for-purpose steps and stages to consider

Building the bridge of trust during a pitch and the importance of providing realistic solutions to problems, opportunity focus and partnership approaches

Importance of relationship building during negotiation

Methods for managing a negotiation team versus individual

Determining key outcomes and the pursuit of value

Dealing with rejection and asking for referrals

Tactics for avoiding misunderstanding

Summarising and follow-up.

Stages of negotiation process:

Preparation and planning

Discussion and defining ground rules

Clarification of goals

Negotiate and bargain towards a Win-Win outcome

Agreement

Implementation of a course of action.

Pitching and presentation skills:

Audience awareness, research and sensitivity

Competitor research

Business and product narratives

Structure and time

Verbal and non-verbal communication to meet audience requirements

Communicating and persuading internal and external stakeholders

Strong negotiation and sales skills, e.g. persuasion, strategising, compromising and co-operating

Presentation, behaviour and conduct of presenter, e.g. attire, attitude, professional conduct, suitability for audience, preparation and organisation.

LO4 **Assess the outcome of a pitch and negotiation.**

Outcomes of a pitch and negotiation:

Determining key outcomes and tangible success indicators for negotiation

Contingency planning for dealing with rejection

Contractual implementation and fulfilling obligations, on-going monitoring/review of contracts

Managing relationships and generating incremental revenue

Terminating contracts

Record keeping and analysis for future tender development.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Evaluate the context of a negotiation and identify the key considerations to prepare for a negotiation		
P1 Determine what is a negotiation, why it occurs and who the key stakeholders are during a negotiation process. **P2** Evaluate the key steps and considerations required for negotiating and generating deals.	**M1** Present a concise rationale for the negotiation process, including detailed steps that organisations go through during a negotiation process.	**D1** Critically evaluate the steps of the negotiation process and present valid solutions for dealing with issues that can arise.
LO2 Manage information and documentation relevant to tenders and contracts		
P3 Examine the RFP process and the relevant types of information and documentation required. **P4** Discuss the contractual process and how relevant documentation is managed and monitored.	**M2** Evaluate the RFP process in an organisational context, outlining the key documentation and information required, and consequences of breaching the terms of an agreement.	**D2** Critically evaluate the competitive tendering and contract process and make recommendations for completing a successful tender with minimal risk.
LO3 Develop a pitch to achieve a sustainable competitive edge		
P5 Deliver an appropriate pitch, applying key principles that achieve a sustainable competitive advantage.	**M3** Present a structured pitch that focuses on sustainable competitive advantage and maximises the opportunities for success.	**D3** Pitch a dynamic and creative strategy that is both concise and persuasive, to achieve a sustainable competitive advantage.
LO4 Assess the outcome of a pitch and negotiation.		
P6 Assess the potential outcomes of a pitch, using specific success indicators. **P7** Determine how organisations fulfil their obligation from a pitch, identifying potential issues that can occur.	**M4** Critically evaluate the pitch and post-pitch outcomes to determine potential issues and risk management.	**D4** Recommend ways in which an organisation can fulfil their post-pitch obligations, highlighting any potential issues.

Recommended Resources

Textbooks

CASTLE, T. (2018) *The Art of Negotiation: How to get what you want, every time.* I_AM Self Publishing.

COUGHTER, P. (2016) *The art of the pitch: Persuasion and Presenting Skills that win Business.* New York: Palgrave Macmillan.

CREMADES, A. (2016) *The Art of Startup Fundraising: Pitching Investors, Negotiating the Deal, and Everything Else Entrepreneurs Need to Know.* London: Wiley and Sons.

VOSS, C. and RAZ, T. (2017). *Never Split the Difference: Negotiating As If Your Life Depended On It.* 1st Ed. Random House Business.

Websites

gov.uk	UK Government Tendering for public service contracts (General reference)
hbr.org	Harvard Business School How to pitch a brilliant idea (Article)
mindtools.com	Mind Tools Essential Negotiation Skills (General reference)
skillsyouneed.com	Skills You Need What is Negotiation (General reference)

Links

This unit links to the following related units:

Unit 1: Professional Practice in the Digital Economy.

11 Appendices

Appendix 1: Mapping of HND in Digital Technologies for England against FHEQ Level 5

Key	
KU	Knowledge and Understanding
CS	Cognitive Skills
AS	Applied Skills
TS	Transferable Skills

The qualification will be awarded to students who have demonstrated:

FHEQ Level 5 descriptor		Digital Technologies for England HND programme outcome
Knowledge and critical understanding of the well-established principles of their area(s) of study, and of the way in which those principles have developed.	KU1	Knowledge and understanding of the fundamental principles and practices of the contemporary global digital technologies environment, responding to and shaping the dynamic and changing nature of digital technologies.
	KU2	Knowledge and understanding of interrelationships and integration between areas of business within organisations and across the digital technologies environment.
	KU3	Knowledge and understanding of the rapidly-changing external digital technologies environment and its impact on local, national and global levels of strategy, behaviour, management and sustainability.
	KU4	Understanding and insight into different businesses; their diverse nature, purposes, cultures, structures and operations, and their influence on the external environment.
	KU5	Knowledge and understanding of digital business and technology reshaping traditional revenue streams and business models, disruptive innovation and driving the need for digital strategic priorities in a changing environment.
	KU6	A critical understanding of the cultural, ethical, legal, professional and operational frameworks within which businesses operate.

FHEQ Level 5 descriptor		Digital Technologies for England HND programme outcome
	KU7	A critical understanding of processes, procedures and practices for effective management of products, services and people, including corporate social responsibility and sustainable management.
	KU8	A critical understanding of the evolving concepts, theories and models in the study of digital technologies across a range of practical and hypothetical business scenarios.
Ability to apply underlying concepts and principles outside the context in which they were first studied, including, where appropriate, the application of those principles in an employment context.	CS1	Apply knowledge and understanding of essential concepts, principles and models in the contemporary global digital technologies environment, to provide solutions supported by evidence-based decision making.
	AS1	The ability to develop appropriate policies and strategies in a changing environment, to meet stakeholder expectations and maximise achievement of strategic objectives.
	AS2	Apply innovative digital technology ideas to develop, create and communicate new products or services that respond to the changing nature of digital technologies and deliver successful outcomes.
	AS3	Integrate theory and practice through the investigation and examination of digital technology practices in the workplace and the wider business environment.
	AS4	Develop successful outcomes for clients/businesses using appropriate digital technology practices, business data and information to make justified recommendations.
	CS2	Develop different strategies and methods to show how resources (human, financial and information) are integrated and effectively managed to successfully meet digital technology objectives.

FHEQ Level 5 descriptor		Digital Technologies for England HND programme outcome
Knowledge of the main methods of enquiry in the subject(s) relevant to the named award, and ability to evaluate critically the appropriateness of different approaches to solving problems in the field of study.	CS3	Critically evaluate current digital technology processes and practices, and their application in providing customer satisfaction and building customer loyalty.
	CS4	Ability to evaluate a broad range of digital technology tools/techniques and financial reporting for planning, control and problem solving.
	KU9	Knowledge and understanding of how the key aspects of leadership and performance management influence the development of people and businesses.
	CS5	Critique a range of digital technology systems and operations, and their application to maximise and successfully meet strategic objectives.
	KU10	An understanding of the appropriate techniques and methodologies used to resolve real-life problems in the workplace.
	TS1	Develop appropriate research skills and skills of critical enquiry to enable the evaluation of different approaches to problem solving in a specific digital technologies context.
An understanding of the limits of their knowledge, and how this influences analysis and interpretations based on that knowledge.	TS2	Self-reflection, including self-awareness; the ability to become an effective self-student and appreciate the value of the self-reflection process.

Typically, holders of the qualification will be able to:

FHEQ Level 5 descriptor		Digital Technologies for England HND programme outcomes
Use a range of established techniques to initiate and undertake critical analysis of information, and to propose solutions to problems arising from that analysis.	TS3	Competently use digital literacy to access a broad range of research sources, data and information.
	CS6	Interpret, analyse and evaluate a range of data, sources and information to inform evidence-based decision making.
	CS7	Synthesise knowledge and critically evaluate strategies and plans to understand the relationship between theory and real-world digital technology scenarios.
Effectively communicate information, arguments and analysis in a variety of forms to specialist and non-specialist audiences, and deploy key techniques of the discipline effectively.	TS4	Communicate confidently and effectively, orally and in writing, both internally and externally with businesses and other stakeholders.
	TS5	Communicate ideas and arguments in an innovative manner, using a range of digital media.
	AS5	Locate, receive and respond to a variety of information sources (e.g. textual, numerical, graphical and computer based) in defined contexts.
	TS6	Demonstrate strong interpersonal skills, including effective listening and oral communication skills, as well as the associated ability to persuade, present, pitch and negotiate.
Undertake further training, develop existing skills and acquire new competences that will enable them to assume significant responsibility within organisations.	TS7	Identify personal and professional goals for continuing professional development in order to enhance competence to practice in a chosen digital technologies field.
	TS8	Develop specific competences and skills required in a specialist digital technologies sector through the completion of specialist pathways and progression routes.

Holders will also have:

FHEQ Level 5 descriptor		Digital Technologies for England HND programme outcomes
The qualities and transferable skills necessary for employment requiring the exercise of personal responsibility and decision making.	TS9	Develop a range of skills to ensure effective team working, independent initiatives, organisational competence and problem-solving strategies.
	TS10	Reflect adaptability and flexibility in approach to digital technologies; showing resilience under pressure and meeting challenging targets within given deadlines.
	TS11	Use quantitative skills to manipulate data, evaluate and verify existing theory.
	CS8	Evaluate the changing needs of the business environment and have confidence to self-evaluate and undertake additional continuing professional development as necessary.
	TS12	Emotional intelligence and sensitivity to diversity in relation to people and cultures.

Appendix 2: HNC/HND Digital Technologies for England Programme Outcomes for Students

	Knowledge and understanding										Cognitive skills								Applied skills					Transferable skills											
Unit	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	1	2	3	4	5	1	2	3	4	5	6	7	8	9	10	11	12
1	X	X	X	X	X	X				X	X				X	X					X		X	X		X	X					X	X		X
2	X	X		X		X	X			X	X	X	X			X	X		X	X	X	X	X			X	X				X		X		
3	X	X	X	X		X	X	X	X	X		X					X		X		X					X	X				X	X	X		X
4	X	X	X	X	X	X	X	X	X		X	X				X	X	X	X		X	X		X							X	X	X		X
5	X				X		X			X		X		X		X					X	X	X	X		X	X				X	X	X	X	
6				X		X		X		X						X	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X		X
7	X			X		X	X				X					X					X	X		X		X						X	X		
8	X				X	X	X			X	X		X			X				X	X	X	X			X	X	X			X		X		
9			X	X	X	X	X													X			X									X		X	
10	X				X	X	X			X	X	X		X		X						X	X	X		X	X				X	X	X		
11	X		X		X	X				X	X	X			X	X					X	X	X	X		X	X					X	X		
12						X					X	X							X		X	X					X	X	X		X		X		X
13	X	X	X	X		X	X		X							X	X		X		X	X				X	X	X			X		X		X
14	X	X		X	X	X				X	X	X	X		X	X	X		X	X	X	X	X			X	X	X	X				X		
15	X	X			X	X	X	X		X					X	X	X				X					X	X	X			X		X	X	
16	X	X			X		X			X	X	X	X		X				X	X		X	X			X	X	X	X	X		X	X	X	X
17				X		X	X									X		X					X		X		X		X	X			X		
18	X	X		X		X	X	X			X					X		X		X		X		X	X	X	X	X	X	X	X	X	X	X	X
19	X					X		X								X		X			X	X	X	X	X	X			X	X		X	X	X	

	Knowledge and understanding										Cognitive skills								Applied skills					Transferable skills											
Unit	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	1	2	3	4	5	1	2	3	4	5	6	7	8	9	10	11	12
20	X	X	X	X		X	X	X	X	X	X					X	X	X	X		X	X	X	X		X	X			X	X	X	X	X	
21	X	X		X		X	X			X	X	X		X	X	X	X		X		X	X	X	X		X	X				X	X	X	X	
22	X		X			X	X			X	X	X		X	X	X	X		X		X	X	X	X		X	X				X	X	X	X	
23	X		X			X				X	X	X		X	X	X				X	X	X	X	X		X	X				X	X	X	X	
24	X			X		X	X	X	X	X	X					X	X	X		X	X	X	X						X			X	X	X	X
25	X		X	X		X	X	X			X					X	X				X	X	X			X		X				X	X	X	X
26	X	X		X		X	X	X	X	X			X		X	X	X				X	X				X	X	X			X	X	X	X	X
27	X			X	X	X	X				X						X		X		X	X	X							X	X	X	X		X
28				X				X			X	X		X		X	X	X			X	X		X							X	X		X
29			X				X				X	X		X		X				X		X	X	X		X	X	X	X		X	X	X		X
30	X		X	X		X	X	X	X		X	X	X					X		X	X		X	X	X	X	X	X	X		X	X	X	X	X
31	X		X			X	X	X	X	X	X	X	X			X	X		X				X	X		X	X	X	X	X	X	X	X	X	X
32	X	X	X	X	X	X	X	X	X		X	X				X	X	X		X	X		X	X		X	X	X	X		X	X	X	X	X
33			X	X		X	X				X	X			X			X	X		X	X	X	X		X	X		X		X	X	X	X	X
34	X	X		X	X	X	X				X		X		X		X			X	X		X	X		X	X	X	X		X	X	X		X
35	X	X		X	X	X	X				X	X	X				X		X	X	X	X	X	X		X		X			X	X	X	X	X
36	X	X	X		X	X	X	X	X	X	X	X	X		X	X	X			X	X		X	X		X	X		X		X	X	X	X	
37			X			X	X			X	X							X			X	X	X	X	X		X				X	X	X	X	X
38						X	X			X		X				X			X			X	X	X		X	X				X	X	X	X	
39	X		X		X	X	X			X	X	X				X	X	X	X	X	X	X	X	X		X	X				X	X	X	X	X
40	X					X					X	X			X	X				X						X		X			X		X		
41					X	X						X				X				X		X	X	X							X		X	X	
42					X	X				X		X				X		X				X	X	X		X	X	X		X			X		

Appendix 3: Transferable skills mapping

Level 4 Higher National Certificate in Digital Technologies for England: mapping of transferable employability and academic study skills

Skill Set	Cognitive skills							Intra-personal skills				Interpersonal skills			
Unit	Problem Solving	Critical Thinking/ Analysis	Decision Making	Effective Communication	Digital Literacy	Numeracy	Creativity	Plan Prioritise	Self-management	Independent Learning	Self-reflection	Team work	Leadership	Cultural Awareness	Interpersonal Skills
1	X	X	X	X			X	X	X	X				X	
2	X	X	X	X	X			X	X	X					
3		X		X				X	X	X	X	X	X	X	X
4				X				X	X	X	X		X	X	X
5	X	X	X	X	X	X		X	X	X					
6		X		X	X		X	X	X	X	X	X			X
7	X		X	X				X	X	X					
8			X	X	X		X	X	X	X	X			X	
9		X		X	X		X	X	X	X		X			X
10	X	X	X	X		X		X	X	X					
11		X				X		X	X	X					
12	X	X	X	X				X	X	X			X	X	X

Skill Set	**Cognitive skills**							**Intra-personal skills**				**Interpersonal skills**			
Unit	Problem Solving	Critical Thinking/ Analysis	Decision Making	Effective Communication	Digital Literacy	Numeracy	Creativity	Plan Prioritise	Self-management	Independent Learning	Self-reflection	Team work	Leadership	Cultural Awareness	Interpersonal Skills
13			X					X	X	X	X	X	X	X	X
14		X	X	X	X			X	X	X					
15	X	X	X	X	X			X	X	X					
16	X		X	X	X		X	X	X	X					
17		X	X	X				X	X	X	X	X	X	X	X
18		X		X				X	X	X	X	X	X	X	X

Level 5 Higher National Diploma in Digital Technologies for England: mapping of transferable employability and academic study skills

Skill Set	Cognitive skills							Intra-personal skills				Interpersonal skills			
Unit	Problem Solving	Critical Thinking/ Analysis	Decision Making	Effective Communication	Digital Literacy	Numeracy	Creativity	Plan Prioritise	Self-management	Independent Learning	Self-reflection	Team work	Leadership	Cultural Awareness	Interpersonal Skills
19	X	X		X	X	X	X	X	X	X	X				
20		X	X	X				X	X	X	X	X	X	X	X
21	X		X	X	X	X		X	X	X					
22	X		X	X	X	X		X	X	X					
23	X		X	X	X	X		X	X	X					
24		X	X	X			X	X	X	X	X	X	X	X	X
25		X	X	X				X	X	X				X	X
26	X	X	X	X	X			X	X	X			X	X	
27				X			X	X	X	X	X			X	
28			X	X	X	X	X	X	X	X	X	X	X	X	X
29		X	X	X		X		X	X	X	X	X	X	X	X
30		X	X	X	X		X	X	X	X		X		X	X
31		X	X	X				X	X	X					
32	X	X	X	X				X	X	X					
33		X	X	X	X	X	X	X	X	X	X	X		X	X
34		X	X	X	X		X	X	X	X					
35	X	X	X	X	X	X	X	X	X	X	X				
36	X	X	X	X				X	X	X				X	X
37	X	X	X	X				X	X	X	X			X	X

Skill Set	Cognitive skills							Intra-personal skills				Interpersonal skills			
Unit	Problem Solving	Critical Thinking/ Analysis	Decision Making	Effective Communication	Digital Literacy	Numeracy	Creativity	Plan Prioritise	Self-management	Independent Learning	Self-reflection	Team work	Leadership	Cultural Awareness	Interpersonal Skills
38	X	X	X	X				X	X	X					
39	X	X	X	X				X	X	X					
40	X	X		X			X	X	X	X					
41	X			X	X	X		X	X	X					
42	X			X	X	X		X	X	X					

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