



ICON College of Technology and Management

**Course Handbook
HND in Computing (RQF)**



Faculty of IT & Engineering

Semester structure of Pearson BTEC Level 5 Higher National Diploma in Computing at ICON College of Technology and Management (RQF)

Semester One	Semester Two
Unit 1* Programming (L4)	Unit 5* Security (L4)
Unit 2* Networking (L4)	Unit 6* Planning a Computing Project (Pearson-set) (L4)
Unit 3* Professional Practice (L4)	Unit 7* Software Development Lifecycles (L4)
Unit 4* Database Design & Development (L4)	Unit 13 Website Design & Development (L4)
Semester Three	Semester Four
Unit 16* Computing Research Project (Pearson-set) (L5)	Unit 16* Computing Research Project (Pearson-set) (L5)
Unit 17* Business Process Support (L5)	Unit 22 Application Development (L5)
Unit 19 Data Structures & Algorithms (L5)	Unit 27 Transport Network Design (L5)
Unit 20 Applied Programming and Design Principle (L5) or	Unit 45 Internet of Things (L5)
Unit 24 Advance Programming for data Analysis(L5)	

Total credits: 240

* Mandatory Core units

Important Note

The College reserves the right to amend the above table as and when required without prior notice.



ICON College of Technology and Management

Pearson BTEC Level 5 Higher National Diploma in Computing (RQF) Course Code: **HCCV4**

Unit Details

Units		Unit Credit	Level
Level 4 units: 120 credits			
1 Programming	Core Unit Mandatory	15	4
2 Networking	Core Unit Mandatory	15	4
3 Professional Practice	Core Unit Mandatory	15	4
4 Database Design & Development	Core Unit Mandatory	15	4
5 Security	Core Unit Mandatory	15	4
6: Planning a Computing Project (Pearson-set)	Core Unit Mandatory	15	4
7: Software Development Lifecycles	Core Unit Mandatory	15	4
13: Website Design & Development	From Optional Units	15	4

Level 5 units: 120 credits			
16 Computing Research Project (Pearson-set)	Core Unit Mandatory	30	5
17: Business Process Support	Core Unit Mandatory	15	5
19: Data Structures & Algorithms	From Optional Units	15	5
20: Applied Programming and Design Principle, or 24 Advance Programming for data Analysis	From Optional Units	15	5
22 Application Development	From Optional Units	15	5
27 Transport Network Design	From Optional Units	15	5
45 Internet of Things	From Optional Units	15	5

Total: 240 Credits

Course specifications Computing (RQF)

Course title

BTEC Higher National Diploma (HND) in Computing (RQF)

Awarding body

Pearson Education Ltd

Teaching Institution

ICON College of Technology and Management

Accreditation

Pearson BTEC Level 5 Higher National Diploma in Computing: 603/7596/6

Approval date: 01 September 2022

Expiry date: 31 August 2027

Final award

Pearson BTEC Level 5 HND in Computing

Progression

A progression path for Pearson BTEC HNC and HND learners is to the second or third year of a degree or honours degree Course, depending on the match of the Pearson BTEC Higher National units to the degree Course in question.

Details of entry requirements for BTEC Higher National graduates into degree Courses at institutions in the UK and internationally can be found on the Degree Course Finder website (<http://degrecoursefinder.pearson.com/>).

The skills offered as part of the Pearson BTEC Higher National Diploma can provide graduates with the opportunity to work in many different areas of the Computing sector. Below are some examples of job roles each qualification could lead to:

- ❖ Systems Analyst
- ❖ Data Designer
- ❖ Systems Tester
- ❖ Database Administrator
- ❖ IT Project Manager
- ❖ IT Support Technician
- ❖ Web Designer

Admission requirements

Applicants will normally need to have at least one of the following:

- a level 3 qualification
 - a level 2 qualifications and relevant work experience
 - or substantial work experience related to the field of proposed study
- and,
- Demonstrate capability in English equivalent to CEFR level B2 e.g. IELTS 5.5 (including 5.5 for reading and writing), PTE 51 or equivalent.
- and,
- Demonstrate a Commitment to Study and a reasonable expectation of success on the Course

International qualifications at the appropriate level and equivalent to the above will also be accepted.

Where applicants do not have a formal qualification to demonstrate capability in English, they will be required to undertake the Colleges written English Language test before an offer of a place on a Course is made. Judgement of their capability in spoken English will be assessed by the HoD at the interview. Suitable alternative arrangements to written tests will be made where a student declares a disability, specific learning difficulty or long-term health condition on their application form, e.g. oral questioning, amanuensis etc.

Aims of programme

- to equip students with computing skills, knowledge and understanding in order to achieve high performance in the global computing environment
- to provide education and training for a range of careers in computing, including network engineering, software engineering, data analytics, security, intelligent systems, applications development and testing
- to provide insight and understanding of international computing operations and the opportunities and challenges presented by a globalised market place
- to give students knowledge and understanding of culturally diverse organisations, cross-cultural issues, diversity and values
- to give students opportunities students to enter or progress in employment in computing, or to progress to higher education qualifications such as an honours degree in computing or a related area
- to provide opportunities for those students with a global outlook to aspire to international career pathways by achieving an internationally recognised professional qualification
- to provide opportunities for students to achieve vendor accredited certifications
- to allow flexibility of study and to meet local or specialist needs
- to offer a balance of employability skills and the knowledge that is essential for students with entrepreneurial, employment or academic aspirations.

Relevant external reference points

QAA benchmark standards for Computing undergraduate degree Course
Pearson Higher National in Computing Specification – RQF level 5
Institution of Engineering and Technology (IET)
British Computer Society (BCS)
The Skills Framework for the Information Age (SFIA)

Credit value

240 credits (see Course structure)

Course learning outcomes

1. Knowledge and Understanding

Learners will be expected to gain the following knowledge during the programme of study:

- developing the knowledge, understanding and skills of learners in the field of computing
- equipping learners with knowledge, understanding and skills for success in employment in the computing industry
- providing opportunities for specialist study relevant to individual vocations and contexts
- developing the learner's ability in the computing industry through effective use and combination of the knowledge and skills gained in different parts of the Course
- developing a range of skills and techniques, personal qualities and attributes essential for successful performance in working life and thereby enabling earners to make an immediate contribution to employment

2. Skills

Learners will be expected to develop the following skills during the programme of study:

- the ability to read and use appropriate literature with a full and critical understanding
- the ability to think independently and solve problems
- the ability to take responsibility for their own learning and recognise their own learning style
- obtaining and integrating several lines of subject-specific evidence to formulate and test propositions
- the ability to understand the need for ethical standards and professional codes of conduct when designing, planning, conducting and reporting an investigations
- the ability to undertake investigations of computer systems in a responsible, safe and ethical manner

Teaching, Learning and assessment strategies

The aims of the Teaching, Learning and Assessment Strategy is to achieve the following:

- To educate students who are motivated and self-directed critical thinkers, capable of independent enquiry
- To provide students with both sound academic knowledge and vocational expertise
- To foster independent and collaborative learning among students and to encourage lifelong learning leading to enhancing their career potentials

- To develop and implement approaches to feedback and assessment that maximise learning and student outcomes.
- To widen participation from students who are mature, from Black and Minority Ethnic Communities, and come from lower socio-economic backgrounds

The generic components of teaching and learning strategy normally involve a variety of approaches and include delivering many of the following:

- Regular use of formal lecture sessions in all units.
- Regular assignment workshops and seminars in all units.
- Regular use of individual and/or team-based projects in all units.
- Regular use of self-directed and directed reading in all units.
- Regular use of library resources in all units.
- Regular use of tutor-and student-led discussion groups via e-learning platform; ICON VLE in all units.

The assessment is criterion-referenced and learners' are assessed against published learning outcomes and assessment criteria. All units are individually graded as 'Pass', 'Merit' or 'Distinction'. To achieve a pass grade for the unit learners must meet the assessment criteria set out in the specifications.

Course structure

All students take a total of 15 units over 2 years to gain an HND in Computing. Units are at level 4 (8 units) and level 5 (7 units, which one unit is 30 credits).

Pearson BTEC Level 5 Higher National Diploma in Computing		Unit credit	Level
Core units:			
Level 4 units:			
Core Unit Mandatory	1 Programming	15	4
Core Unit Mandatory	2 Networking	15	4
Core Unit Mandatory	3 Professional Practice	15	4
Core Unit Mandatory	4 Database Design & Development	15	4
Core Unit Mandatory	5 Security	15	4

Core Unit Mandatory	6: Planning a Computing Project (Pearson-set)	15	4
Core Unit Mandatory	7: Software Development Lifecycles	15	4
Optional Unit	13: Website Design & Development	15	4
Level 5 Units: * Please note that centres can choose any of the 5 optional units from the units listed in the optional unit bank. The units have been grouped according to sector specialism for ease of recognition. It is strongly advised to choose one unit from each optional group to deliver a comprehensive general computing qualification.			
Core Unit Mandatory	16 Computing Research Project (Pearson-set)	30	5
Core Unit Mandatory	17: Business Process Support	15	5
Optional Unit	19: Data Structures & Algorithms	15	5
Optional Unit	20: Applied Programming and Design Principle, or 24: Advance Programming for data Analysis	15	5
Optional Unit	22 Application Development	15	5
Optional Unit	27: Transport Network Design	15	5
Optional Unit	45: Internet of Things	15	5

Total credits: 240

Please see appendices for Semester structure and module syllabus.

Mode of Study

Full-time and Part-time.

Four semester taught full-time for all students, with four units per semester.

Assessment Regulations

Computing units will be assessed using a variety of assessment methods, including case studies, assignments and work-based assignments, together with projects, performance observation, PowerPoint (or similar) presentations and time constrained assessment (written tests). All the assessment material should be valid, reliable and fit for purpose.

An assignment provides the final assessment for the relevant Learning Outcomes and is normally a final assessment decision. A student who, for the first assessment opportunity, has failed to achieve a Pass for that unit specification shall be expected to undertake reassessment.

- Only one opportunity for reassessment of the unit will be permitted.
- Reassessment for course work, project- or portfolio-based assessments shall normally involve the reworking of the original task.
- For examinations, reassessment shall involve completion of a new task.
- A student who undertakes a reassessment will have their grade capped at a Pass for that unit.
- A student will not be entitled to be reassessed in any component of assessment for which a Pass grade or higher has already been awarded.

Repeat units

A student who, for the first assessment opportunity and resubmission opportunity, still failed to achieve a Pass for that unit specification:

- At Centre discretion and Assessment Board, decisions can be made to permit a repeat of a unit
- The student must study the unit again with full attendance and payment of the unit fee
- The overall unit grade for a successfully completed repeat unit is capped at a Pass for that unit
- Units can only be repeated once.

Evaluation and revision

The Assessment Boards (AsBs) evaluates the external examiner's reports every year and makes sure the action plans produced from their reports are well managed and the progress is reported to Academic Board. The College also conducts a feedback on assignments to students by a progress monitoring sheet (control sheet) which has been commended by standard verifiers of Pearson as supportive and effective.

Internal verification ensures that before any assignment brief is released to students, clear assessment criteria, and correct administrative information on assignment are included. Internal verifier teams identify what changes if any in the assignment brief are required and what corrective action should be taken by assessor and should ensure that it is fit for purpose. Internal verifiers check a range of assessment decisions for all assessors and units by sampling some of the assignments. In case of unexpected assessment decisions, (e.g. everybody achieving Distinction in the assignment), additional sampling will be conducted on individual units/assessors and reported to Assessment Boards for decision.

Student Support

The teaching philosophy at Icon requires students to be exposed to a range of learning methods and materials.

All tutors now support their classes by the use of "ICON VLE", a suite of electronic web-based materials that permits students to use the ICON intranet to access materials such as syllabi, Course plan, reading lists, reading assignments, and PowerPoint presentations for each of their Courses.

Student Survey is the primary method of obtaining and gauging student feedback at Icon. The evaluation forms are comprised of both qualitative and quantitative elements. Also Student and Staff Liaison Panel meetings, held each semester, to discuss Course issues and concerns is another way to support the student.

The Personal Tutorial System is an essential part of the College's Teaching, Learning and Assessment Strategy. It is also aimed at contributing to enhancement of the teaching and learning experience of the students. The College assigns every student a designated Personal Tutor who is available by appointment throughout the academic year. The relationship between the student and the personal tutor is built on trust and confidentiality. Whether the problem is related to a financial hardship, accommodation matters, or learning disabilities and academic difficulties, the Personal Tutor is the first contact point at the College

Appendices

Semester structure and unit syllabus

Appendix A

Semester Structure;

Semester One	Semester Two
Unit 1* Programming (L4) Unit 2* Networking (L4) Unit 3* Professional Practice (L4) Unit 4* Database Design & Development (L4)	Unit 5* Security (L4) Unit 6* Planning a Computing Project (Pearson-set) (L4) Unit 7* Software Development Lifecycles (L4) Unit 13 Website Design & Development (L4)
Semester Three	Semester Four
Unit 16* Computing Research Project (Pearson-set) (L5) Unit 17* Business Process Support (L5) Unit 19 Data Structures & Algorithms (L5) Unit 20 Applied Programming and Design Principle (L5) or Unit 24 Advance Programming for data Analysis (L5)	Unit 16* Computing Research Project (Pearson-set) (L5) Unit 22 Application Development (L5) Unit 27 Transport Network Design (L5) Unit 45 Internet of Things (L5)

* Mandatory Core units

1 Programme purpose and objectives

1.1 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.

1.2 Objectives of the Pearson BTEC Higher Nationals

The aims of the Pearson BTEC Higher Nationals in Computing are:

- to equip students with computing skills, knowledge and understanding in order to achieve high performance in the global computing environment
- to provide education and training for a range of careers in computing, including network engineering, software engineering, data analytics, security, intelligent systems, applications development and testing
- to provide insight and understanding of international computing operations and the opportunities and challenges presented by a globalised market place
- to give students knowledge and understanding of culturally diverse organisations, cross-cultural issues, diversity and values
- to give students opportunities students to enter or progress in employment in computing, or to progress to higher education qualifications such as an honours degree in computing or a related area
- to provide opportunities for those students with a global outlook to aspire to international career pathways by achieving an internationally recognised professional qualification
- to provide opportunities for students to achieve vendor accredited certifications
- to allow flexibility of study and to meet local or specialist needs
- to offer a balance of employability skills and the knowledge that is essential for students with entrepreneurial, employment or academic aspirations.

1.3 Aims of the Pearson BTEC Level 4 Higher National Certificate in Computing

The Pearson BTEC Level 4 Higher National Certificate in Computing offers students a broad introduction to the subject area via a mandatory core of learning, a unit specialism which is pathway dependent and an optional unit of study; allowing for the acquisition of skills and experience across a range of occupational sectors at Level 4. The Level 4 pathway includes a general pathway and the following specialist pathways:

- Data Analytics
- Network Engineering
- Cyber Security.

The BTEC Level 4 Higher National Certificate in Computing builds underpinning core skills effectively, preparing students for further subject specialisation at Level 5. They will gain a wide range of sector knowledge that is tied to practical skills gained in research, self-study, directed study and workplace scenarios.

1.4 Aims of the Pearson BTEC Level 5 Higher National Diploma in Computing

The Pearson BTEC Level 5 Higher National Diploma in Computing offers students one general pathway and five specialist pathways, designed to support progression to relevant occupational areas or degree-level study.

The Pearson BTEC Higher National Diploma in Computing offers the following specialist pathways for students who wish to concentrate on a particular aspect of computing:

- Software Engineering
- Applications Development and Testing
- Data Analytics
- Network Engineering
- Cyber Security.

The non-specialist 'General' pathway allows students to complete a Pearson BTEC Higher National Diploma without committing to a particular professional specialism. This offers additional flexibility to providers and students.

Holders of the Pearson BTEC Higher National Diploma will have developed a sound understanding of the principles in their field of study and will have learned to apply those principles more widely. They will have learned to evaluate the appropriateness of different approaches to solving problems. They will be able to perform effectively in their chosen field and will have the qualities necessary for employment in situations that require the exercise of personal responsibility and decision making.

The pathways at both Level 4 and Level 5 are mapped to the Institute for Apprenticeships and Technical Education's Occupational Standards, professional body standards and vendor-accredited certification (where appropriate) and can provide professional status and progression to direct employment.

1.5 Developing students' employability skills and academic study skills

Employability skills (sometimes referred to as transferable skills) are vital in increasing students' career prospects and they contribute to their personal development. Our BTEC Higher Nationals in Computing 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 computing and business sector
- IT and systems integration across the business environment
- project management
- programming
- application and systems development.

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

The 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: Transferable skills mapping 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/>.

1.5.1 Use of Maths and English within the curriculum

Those working in the computing sector cannot just rely on their technical skills, they must ensure that **all** their skills are relevant so as to increase their employment opportunities. They will be required to communicate appropriately with stakeholders throughout their career and the ability to use maths and English in a professional context is an essential employability skill that must be developed at all levels of study.

Development of essential maths and English skills are embedded in these qualifications in accordance with industry requirements, examples of how these skills are developed in the BTEC Higher Nationals Curriculum are:

- written reports
- formal presentations
- informal conversations
- use of professional, sector-specific language
- using binary data
- understanding algorithms
- calculating costs.

Some aspects of computing require higher-level maths skills than others, but throughout students' studies they will be using some level of maths in the curriculum. It is vital that students taking a BTEC Higher National in Computing are aware that these skills will be required throughout their studies and that they are part of the learning activities and assessments to ensure that their skills are in line with current industry standards.

Some units in the qualification, such as Maths for Computing, Discrete Maths and Applied Analytical Models, also require maths skills. We strongly recommend that all students, as well as having a grade A* to C or 9 to 4 in GCSE Maths, complete maths diagnostic assessments before beginning a Higher National course. (See *Entry requirements* in section 5.2).

1.6 What could these qualifications lead to?

The Level 4 Higher National Certificate provides a solid foundation in computing, 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 5 Higher National Diploma, they can develop their career in the respective sector by:

- entering employment
- continuing existing employment
- linking with the appropriate professional body

- committing to continuing professional development, or
- studying at university.

1.6.1 Progression to university

The Level 5 Higher National Diploma is recognised by higher education providers as meeting admission requirements to many computing-related courses, for example:

- BSc (Hons) in Computing
- BSc Data Science
- BSc (Hons) in Information Technology
- BSc (Hons) Business Computer Systems
- BEng (Hons) Software Engineering
- BSc (Hons) Cyber Security and Forensic Computing.

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 their courses. 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>.

2 Preparing students for employment

2.1 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.

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.

2.1.1 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 an HNC or an HND qualification.

2.1.2 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 in the sector to perform a job successfully, as defined in current, advertised job vacancies.

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

2.1.3 Professional Body recognition and exemption

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

Types of professional body agreements for Higher Nationals in Computing

There are a variety of agreements that we can have in place with professional organisations, although note that not all of these will apply to all qualifications.

- Professional accreditation: where a specific study programme prepares students to register for a regulated professional qualification. In some cases, completing the Higher National Diploma may be enough for students to receive the professional qualification.
- Membership: where students are offered student membership whilst studying, or progression to membership on completion of their qualification.
- Recognition: where a professional organisation recognises the value of a Higher National qualification in preparing students for the industry.
- Exemption: professional organisations may also offer exemptions from units on some of their qualifications. This means that students completing these Higher National units will have covered the material required for those professional body units and can claim exemption when studying for the professional body qualification.

For the full accreditation and exemption details for this qualification, please refer to the Professional Recognition pages on HN Global:

<https://hnglobal.highernationals.com/progression-hub/memberships-certs>
or on the Industry Engagement page:

<https://qualifications.pearson.com/en/qualifications/btec-higher-nationals/computing-2022/industry-engagement.html>

We continuously work to update and add new agreements, therefore please refer to these online pages for the most up-to-date information

2.1.4 Alignment to Occupational Standards and Higher Apprenticeships

The BTEC Higher Nationals in Computing 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	General			Data Analytics	Network Engineer	Cyber Security
Level 5 Pathway	General	Software Engineering	Applications Development & Testing	Data Analytics	Network Engineering	Cyber Security
Occupational Standard	Business Analyst	Software Developer	Software Tester	Data Analytics	Network Engineer	Cyber Security Technologist

NOTE: The Level 4 General pathway feeds into three Level 5 pathways: General, Software Engineering and Applications Development and Testing, therefore the appropriate Level 5 pathway must be selected for alignment to a specific OS.

2.1.5 Vendor accreditation

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

<https://hnglobal.highernationals.com/delivery-materials/computing>.

In redeveloping the Pearson BTEC Higher National qualifications in Computing, we have worked closely with vendors to offer students the skills required to gain accredited certifications.

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 Computing:

Cisco is the largest networking company in the world, it sponsors IT professional certifications for Cisco products. Cisco Certifications and specialist qualifications are an IT industry standard used to validate knowledge of Cisco products and technologies. Getting certified brings measurable rewards and opens up further professional opportunities.

The Cisco Certified Network Associate (CCNA) certification has been designed to prepare students for today's associate-level job roles in IT technologies. The CCNA curriculum is one training programme and one exam, which leads to certification but that is presented in three courses that cover a broad range of fundamentals and provide integrated and comprehensive coverage of networking topics. The three CCNA courses are covered as follows:

- Introduction to Networks (ITN) covered in full
- Switching, Routing and Wireless Essentials (SRWE) covered in full
- Enterprise Networking, Security and Automation (ENSA) covered partially.

The essential principles and skills for these courses are covered through studying the relevant units. See HN Global for full mapping.

For students to be in a position to achieve Cisco accredited certification, the relevant units must be delivered using Cisco technologies.

Students who study these units with non-Cisco technologies will achieve a BTEC Higher National Diploma but will not have the skills necessary to take Cisco Certification assessments.

Details of how to take Cisco Certification exams can be found on the Pearson Vue website: <http://www.pearsonvue.com/cisco/>.

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.

A few standalone units have been aligned to Microsoft certifications. These are 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 certifications aligned are:

- Microsoft Certified: Azure Fundamentals
- 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 Computing 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/>.

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 the certification exam can be found on the Pearson Vue website: <https://home.pearsonvue.com/Clients/Huawei.aspx>.

Oracle is a leading database software company and has developed technologies into the entire technology stack. The Oracle Certification Program certifies students on skills and knowledge related to Oracle products and technologies.

- Java SE 8 Fundamentals: validates skills in object-oriented programming using the Java language.
- Oracle Database Introduction to SQL: validates skills in the SQL programming language.
- Oracle Database 12c Administration: validates understanding of the Oracle Database architecture.

For students to be in a position to achieve Oracle-accredited certification the relevant units must be delivered using Java and/or SQL. Students who study these units with non-Oracle technologies will achieve a BTEC Higher National Diploma but will not have the skills necessary to take Oracle's certification assessments.

Details of how to take Oracle Certification exams are available on the Pearson Vue website: <http://www.pearsonvue.com/oracle/>.

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.

- CompTIA A+: validates understanding of the most common hardware and software technologies and certifies the skills necessary to support complex IT infrastructures.
- Network+: validates the essential knowledge and skills needed to confidently design, configure, manage and troubleshoot any wired and wireless networks.
- CompTIA Security+: validates foundational, vendor-neutral IT security knowledge and skills. Covers the essential principles for Network Security and risk management.
- CompTIA Cloud+: validates the skills and expertise of IT practitioners in implementing and maintaining cloud technologies.
- CompTIA Server+: validates planning, securing and maintaining a variety of server equipment.
- CompTIA Linux+: certifies foundational skills and knowledge of Linux.

Details of how to take CompTIA Certification exams can be found on the Pearson Vue website: <http://www.pearsonvue.com/comptia/>.

AXELOS is a joint venture set up by the government of the UK and Capita, to develop, manage and operate qualifications in best practice methodologies.

- Prince 2 Foundation Qualification: confirms sufficient knowledge and understanding of the PRINCE2 method to be able to work effectively with, or as a member of, a project management team.
- RESILIA Foundation Qualification: verifies understanding of how decisions impact good/bad cyber resilience.

Details of how to take the various exams are available in the links below:

- Prince 2 Foundation (<http://www.axelos.com/certifications/>)
- RESILIA Foundation (<https://www.axelos.com/certifications/>).

3 Calculating the final qualification grade

3.1.1 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.

3.1.2 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.

3.1.3 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 +

3.1.4 Modelled student outcomes

Pearson BTEC Level 4 Higher National Certificate

	Credits	Level	Grade point	Student 1		Student 2		Student 3		Student 4		Student 5	
				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 general examples of using unit grades to calculate qualification grades. They do 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 general examples of using unit grades to calculate qualification grades. They do not reflect the specifics of this qualification.

Units

Unit 1: Programming

Unit code H/618/7388

Unit type Core

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 and 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, 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		D1 Evaluate the implementation of an algorithm in a suitable language and the relationship between the written algorithm and the code variant.
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.	
LO2 Explain the characteristics of procedural, object-orientated and event-driven programming		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.
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.	
LO3 Implement basic algorithms in code using an IDE		D3 Evaluate the use of an IDE for development of applications contrasted with not 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.	
LO4 Determine the debugging process and explain the importance of a coding standard		D4 Evaluate the role and purpose of a coding standard and why it is necessary in a team as well as for the individual.
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.	

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 19: Data Structures & Algorithms

Unit 20: Applied Programming and Design Principles

Unit 54: Prototyping.

Unit 2: Networking

Unit code M/618/7393

Unit type Core

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.

Learning Outcomes and Assessment Criteria

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

Recommended Resources

Textbooks

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

Donahue, G. A. (2011) *Network Warrior* 2nd Ed. O'Reilly Media.

Goransson, P. Black, C. et al (2016) *Software Defined Networks: A Comprehensive Approach* 2nd Ed. Morgan Kaufmann.

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).

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

Links

This unit links to the following related units:

Unit 9: Computer Systems Architecture

Unit 27: Transport Network Design

Unit 29: Network Security

Unit 39: Network Management

Unit 40: Client/Server Computing Systems.

Unit 3: Professional Practice

Unit code	L/618/7398
Unit type	Core
Unit level	4
Credit value	15

Introduction

In the workplace, it is essential to be effective as a communicator, critical thinker, analyser, team worker and team leader. These skills are needed on a daily basis in order to carry out designated tasks as part of a job role. The development of academic competence and the continuation of lifelong learning and continuing professional development (CPD) are required to ensure that individuals have a valued set of interpersonal skills that can be applied to any situation or environment.

This unit provides a foundation for good practice in a variety of contexts. The ability to communicate effectively using different tools and mediums will ensure that practical, research, design, reporting and presentation tasks are undertaken professionally and in accordance with various communication conventions. In everyday life, the ability to apply critical reasoning and solve problems are skills that enable tasks to be completed successfully and facilitate effective decision making. Working with others in a group environment such as an academic setting or in the workplace is an integral part of everyday life. Therefore, understanding the dynamics of teams in terms of culture, roles and responsibilities will ensure that there is a better understanding and awareness of the importance and value of teamwork. Continuing professional development, self-improvement, reflective practice and working towards various goals are encouraged in the workplace through an appraisal framework. Professional development includes at higher levels of learning and the ability to demonstrate effective research skills and academic reporting skills.

This unit covers the development of communication skills and communication literacy and the use of qualitative and quantitative data to demonstrate analysis, reasoning and critical thinking. Students will carry out tasks that require working with others in a team-based scenario and planning and problem solving.

On successful completion of the unit, students will be able to demonstrate leadership skills through the dynamics of team working. Through reflective practice, they will be able to evaluate the contributions they make as an individual and those of others.

Learning Outcomes

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

- LO1 Demonstrate a range of interpersonal and transferable communication skills to a target audience.
- LO2 Apply critical reasoning and thinking to a range of problem-solving scenarios.
- LO3 Discuss the importance and dynamics of working within a team and the impact of team working in different environments.
- LO4 Examine the need for continuing professional development (CPD) and its role within the workplace and for higher-level learning.

Essential Content

LO1 **Demonstrate a range of interpersonal and transferable communication skills to a target audience**

Effective communication:

Verbal and non-verbal, e.g. awareness and use of body language, openness and responsiveness, formal and informal dialogue and feedback to a range of different stakeholders, academic report writing, use of IT to enhance communication, use of source information to undertake research.

Understanding of the reasons for communicating with internal and external stakeholders, e.g. responding to queries, technical support, providing instructions, raising awareness of issues.

Considerations when communicating with internal and external stakeholders, e.g. maintaining privacy and security, tone of voice, use of technical vocabulary or jargon, company image.

Consideration of issues relating to inclusion and diversity when communicating and interacting with others.

Interpersonal skills:

Soft skills, e.g. personal effectiveness, working with others, use of initiative, negotiating skills, assertiveness skills and social skills.

Time-management skills:

Prioritising workloads, setting objectives, using time effectively, making and keeping appointments, planning and scheduling tasks and activities.

LO2 **Apply critical reasoning and thinking to a range of problem-solving scenarios**

Specification of the problem:

Definition of the problem; analysis and clarification.

Identification of possible outcomes:

Identification and assessment of various alternative outcomes.

Tools and methods:

Use of problem-solving methods and tools.

Demonstrate resourcefulness and creativity when solving problems.

Plan and implement:

Sources of information, solution methodologies, selection and implementation of the best corrective action, e.g. timescale, stages, resources, critical path analysis.

Evaluation:

Evaluation of problem solving, measurement of solution against specification and desired outcomes, sustainability.

LO3 Discuss the importance and dynamics of working within a team and the impact of team working in different environments

Working with others:

Nature and dynamics of team and group work, informal and formal settings.

Purpose of teams and groups, e.g. long-term corporate objectives and strategy, problem-solving and short-term development projects, flexibility and adaptability, team player.

Individual responsibility when working as part of a team.

Working effectively on individual and collaborative tasks regardless of levels of supervision.

Allocation and management of tasks between members of the team, identifying team members' strengths, communicating requirements and expectations effectively.

Teams and team building:

Selecting team members e.g. specialist roles, skill and style/approach mixes.

Identification of team and work group roles.

Stages in team development, including team building, identity, loyalty, commitment to shared beliefs, professionalism.

Team health evaluation, including promoting and maintaining a safe and secure working environment, action planning, monitoring and feedback, coaching skills, ethics.

Effective leadership skills, e.g. setting direction, setting standards, motivating, innovative, responsive, effective communicator, reliability, consistency.

LO4 Examine the need for continuing professional development (CPD) and its role within the workplace and for higher-level learning

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.

Other responsibilities, including employment legislation, ethics, employment rights and responsibilities.

Maintaining a productive, professional and secure working environment.

Performance objectives:

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

CPD, including lifelong learning, training and development, personal development, professional development.

Evidence criteria:

Production data, personnel data, judgemental data.

Rating methods, e.g. ranking, paired comparison, checklist, management by objectives.

Skills audit, including personal profile using appropriate self-assessment tools, evaluating self-management.

Personal and interpersonal skills.

Motivation and performance:

Application and appraisal of motivational theories and techniques, rewards and incentives; manager's role; self-motivational factors.

Development plan:

Plan to include current performance, future needs, opportunities and threats to career progression, aims and objectives, achievement dates, review dates, learning programme or activities, action plans, personal development plans, ongoing commitment to CPD.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Demonstrate a range of interpersonal and transferable communication skills to a target audience		D1 Evaluate the effectiveness and application of interpersonal skills used in the design and delivery of a training event.
<p>P1 Demonstrate effective design and delivery of a training event for a given target audience, using different communication styles and formats</p> <p>P2 Demonstrate effective time-management skills in planning an event.</p>	<p>M1 Design a professional schedule to support the planning of an event, to include contingencies and justifications of time allocated.</p>	
LO2 Apply critical reasoning and thinking to a range of problem-solving scenarios		D2 Evaluate the overall success of the event delivered, in terms of how well critical reasoning and thinking were applied to achieve the end goal.
<p>P3 Demonstrate the use of different problem-solving techniques in the design and delivery of an event.</p> <p>P4 Demonstrate that critical reasoning has been applied to the design and delivery of the event.</p>	<p>M2 Research the use of different problem-solving techniques used in the design and delivery of an event.</p> <p>M3 Justify the use and application of a range of methodologies in the design and delivery of an event.</p>	

Pass	Merit	Distinction
<p>L03 Discuss the importance and dynamics of working within a team and the impact of team working in different environments</p>		<p>D3 Critically evaluate your own role and contribution to a group scenario.</p>
<p>P5 Discuss the importance of team dynamics in the success and/or failure of group work.</p> <p>P6 Work in a team to achieve a defined goal.</p>	<p>M4 Analyse team dynamics, in terms of the roles that group members play in a team and the effectiveness in terms of achieving shared goals.</p>	
<p>L04 Examine the need for Continuing Professional Development (CPD) and its role within the workplace and for higher-level learning</p>		<p>D4 Evaluate a range of evidence criteria that is used as a measure for effective CPD.</p>
<p>P7 Discuss the importance of CPD and its contribution to own learning and motivation.</p> <p>P8 Review different motivational theories and the impact they can have on performance in the workplace.</p> <p>P9 Produce a development plan that outlines responsibilities, performance objectives and required skills for future goals.</p>	<p>M5 Justify the role of CPD and development planning in building motivation.</p>	

Recommended Resources

Textbooks

Cottrell, S. (2001) *Critical Thinking Skills: Developing Effective Analysis and Argument*. 2nd Ed. Palgrave Macmillan.

Forde, C. et al (2006) *Professional Development, Reflection and Enquiry*. Sage Publications.

Meggison, D. and Whitaker, V. (2007) *Continuing Professional Development*. 2nd Ed. Chartered Institute of Personnel and Development.

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

Journals

Journal of Group Dynamics - Japan Institute for Group Dynamics

Professional Development in Education - Taylor and Francis Online

Web

ipda.org.uk International Professional Development Association
(General reference)

www.thinkwatson.com Critical Thinking Resources
Critical Thinking Correlation Studies (Research)

Links

This unit links to the following related units:

Unit 6: Planning a Computing Project

Unit 16: Computing Research Project.

Unit 4: Database Design & Development

Unit code	A/618/7400
Unit type	Core
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

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

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

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. white box, black box; 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

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

Pass	Merit	Distinction
LO1 Use an appropriate design tool to design a relational database system for a substantial problem		D1 Evaluate the effectiveness of the design in relation to user and system requirements.
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.	M1 Produce a comprehensive design for a fully-functional system, which includes interface and output designs, data validations and data normalisation.	
LO2 Develop a fully-functional relational database system, based on an existing system design		D2 Evaluate the effectiveness of the database solution in relation to user and system requirements and suggest improvements.
P2 Develop the database system with evidence of user interface, output and data validations, and querying across multiple tables.	M2 Implement a fully-functional database system, which includes system security and database maintenance.	
P3 Implement a query language into the relational database system.	M3 Assess whether meaningful data has been extracted through the use of query tools to produce appropriate management information.	
LO3 Test the system against user and system requirements		
P4 Test the system against user and system requirements.	M4 Assess the effectiveness of the testing, including an explanation of the choice of test data used.	

Pass	Merit	Distinction
LO4 Produce technical and user documentation		
P5 Produce technical and user documentation.	M5 Produce technical and user documentation for a fully-functional system, including data flow diagrams and flowcharts, describing how the system works.	

Recommended Resources

Textbooks

- Churcher, C. (2012) *Beginning 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*

Web

- | | |
|--|---|
| mva.microsoft.com | Microsoft Virtual Academy Database Development (Training) |
| mva.microsoft.com/ebooks | Microsoft Virtual Academy
Microsoft Press (E-books) |
| www.lynda.com | Database Training (Tutorials) |

Links

This unit links to the following related units:

Unit 11: Strategic Information Systems

Unit 41: Database Management Systems.

Unit 5: Security

Unit code D/618/7406

Unit type Core

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		D1 Evaluate a range of physical and virtual security measures that can be employed to ensure the integrity of organisational 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.	
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		D2 Recommend how IT security can be aligned with an organisational policy, detailing the security impact of any misalignment.
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.	

Pass	Merit	Distinction
LO4 Manage organisational security		
<p>P7 Design a suitable security policy for an organisation, including the main components of an organisational disaster recovery plan.</p> <p>P8 Discuss the roles of stakeholders in the organisation in implementing security audits.</p>	<p>M5 Justify the security plan developed giving reasons for the elements selected.</p>	

Recommended Resources

Textbooks

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.

Web

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 29: Network Security

Unit 30: Applied Cryptography in the Cloud

Unit 31: Forensics

Unit 32: Information Security Management.

Unit 6: Planning a Computing Project (Pearson Set)

Unit code H/618/7407

Unit type Core

Unit level 4

Credit value 15

Introduction

This unit is assessed through a Pearson-set assignment. The project brief will be set by the centre, based on a theme provided by Pearson (this will change annually). The theme and chosen project within the theme will enable students to explore and examine a relevant and current topical aspect of computing in the context of a business environment.

As computing systems and technologies continually develop so do the ways in which businesses utilise technologies to support their operations and remain competitive. As a computing professional it is important to understand the ways in which technology evolves and how it can be utilised in different sectors.

The aim of this unit is to give students an opportunity to demonstrate the research skills required for developing a deeper understanding of a subject and the ability to use evidence to inform decisions. Students will undertake independent research, and investigation of a theme set by Pearson. Students will also investigate and research an industry sector as outlined in the centre-set project brief. Students will use the outcomes of their research to help them plan a computer-based project and to support recommendations for how the identified business could utilise the tools and technologies identified as part of their research.

On successful completion of this unit, students will have the confidence to engage in decision making, problem solving, research activities and project planning tasks. They will have the fundamental knowledge and skills that will enable them to investigate and examine relevant computing concepts in a work-related context, determine appropriate outcomes, decisions or solutions and present evidence to various stakeholders in an acceptable and understandable format.

Learning Outcomes

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

- LO1 Conduct small-scale research, information gathering and data collection to generate knowledge on an identified subject
- LO2 Explore the features and business requirements of organisations in an identified sector.
- LO3 Produce project plans based on research of the chosen theme for an identified organisation
- LO4 Present your project recommendations and justifications of decisions made, based on research of the identified theme and sector.

Essential Content

LO1 **Conduct small-scale research, information gathering and data collection to generate knowledge on an identified subject**

Project execution phase:

Selecting appropriate methods of information gathering, data collection and material resourcing.

The distinct phases that support a coherent and logical argument. Use of secondary research to inform a primary empirical study.

Qualitative and quantitative research methods.

Field work:

Selecting a sample of the consumer market, businesses or individuals (those who meet certain characteristics relevant to the research theme) used to gather data (qualitative or quantitative).

Sampling approaches and techniques, including probability and non-probability sampling.

Analysing information and data:

Using data collection tools, such as interviews and questionnaires, and their advantages and disadvantages.

Using analytical techniques such as trend analysis, coding and typologies.

Sources of, and access to, data, including open and public data, administrative and sensitive data, research data.

The principles of data to govern data, including data has value, data should be reusable, data is managed according to its value, data should be fit for purpose.

Ethics, reliability and validity:

Ensure that all research is conducted, data stored, processed and used in an ethical way.

Research should also be reliable (similar results achieved from a similar sample) and valid (the research should measure what it aimed to measure).

Ensure validity and reliability of secondary data and information used, including consideration of who wrote or collected the information or data, age of data collected, original purpose of the data collection, potential errors or variability in the data, potential bias, e.g. sample size, sample participants, questions used, interpretation of results.

LO2 Explore the features and business requirements of organisations in an identified sector

Features of businesses:

Types of business, their ownership and liability.

Private, e.g. sole trader, private limited company, public limited company.

Public, e.g. government department, not-for-profit, e.g. charity, voluntary.

Industry sectors, including primary, secondary, tertiary, quaternary.

How an organisation may provide a specific product(s) or service within a sector.

How some organisations provide both products and services.

The concept of diversification to aid business success.

Operational areas of businesses:

The operational areas of a business ('business functions') and how they support the organisation's purpose, e.g. human resources, research and development, sales, marketing, purchasing, production and quality, finance, customer service, IT, administration.

Stakeholders:

Internal stakeholders, e.g. management, employees, shareholders.

External stakeholders, e.g. suppliers, customers, government agencies, communities.

How stakeholders influence business processes and decisions.

The impact of stakeholders on an organisation's success.

Challenges to the success of a business:

Legislation and industry standards relevant to the organisation and sector.

Change management, including planned change, e.g. expansion, diversification, changes in legislation, system upgrades.

Unplanned change, e.g. response to a security breach, disaster response and recovery.

Communication of need for change to stakeholders.

Management of stakeholders before during and after change, e.g. training, target setting, support

Method of implementation of change, e.g. parallel running, direct change over, phased changeover.

Documenting the change process, testing changes to the system and business.

Security and privacy concerns relevant to the organisation and sector.

LO3 Produce project plans based on research of the chosen theme for an identified organisation

Project planning and initiation:

The role of a business or systems analyst and the activities they undertake as part of initiation of a project.

Analysing the features and requirements of an identified organisation to establish their requirements.

Recommend potential solutions to identified business needs, including carrying out a cost/benefit analysis, defining business objectives, scope and purpose of the project.

Comprehensive project plans, including defining functional and non-functional requirements of the system, stakeholder requirements and expectations, carrying out impact analysis, prioritising requirements, describing the deliverables to be produced, timescales and time management, costs, change management planning, risk and challenges analysis.

Success criteria to be used, e.g. Key Performance Indicators (KPIs), performance metrics, quality metrics, and business targets.

Use of an identified project management methodology, e.g. Waterfall, Agile, Rapid Application Development (RAD).

Consider approaches to continuous integration, version and source control.

Tools:

Tools for effective project planning, resource planning and allocation, and work breakdown structure, including Project Initiation Documents (PID), bar and Gantt charts, Critical Path Analysis (CPA), risk matrix.

LO4 Present your project recommendations and justifications of decisions made based on research of the identified theme and sector

Presenting and communicating project recommendations:

Presenting to different technical and non-technical stakeholders, e.g. emphasis on operational or strategic information, technical terminology used, levels of detail given and simplifying concepts.

Consider the methods and mediums to be used, including written or verbal, report, online or presentation.

Understand how project research and intended audience will influence on method and medium.

Justification of decisions made:

Justification of recommendations, including use of key points from cost/benefit analysis, deliverables, success criteria, impact analysis.

Justifications of planning, including chosen development methodology, work and resource allocation, key deadlines and timescales.

Rationale for decisions made in the recommended solution and project plan, including use of research and data for the identified technology and business sector, analysis of evidence and business requirements, contextual factors specific to the identified organisation.

Reflection on the quality of research:

Quality of secondary and primary data used to inform planning and make decisions.

Awareness that some studies may result in generalised findings and how this can impact on the quality of decisions and the accuracy of conclusions made.

Evaluate the quality of the data and information used to inform project initiation plans, e.g. sample size, sample characteristics, user experience during collection, domain context.

Reach conclusions as to the likely accuracy and reliability of assertions made.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Conduct small-scale research, information gathering and data collection to generate knowledge on an identified subject		D1 Interpret findings to generate knowledge on how the research theme supports business requirements in the identified sector.
P1 Demonstrate qualitative and quantitative research methods to generate relevant primary data for an identified theme. P2 Examine secondary sources to collect relevant secondary data and information for an identified theme.	M1 Analyse data and information from primary and secondary sources to generate knowledge on an identified theme.	
LO2 Explore the features and business requirements of organisations in an identified sector		
P3 Discuss the features and operational areas of a businesses in an identified sector. P4 Discuss the role of stakeholders and their impact on the success of a business.	M2 Analyse the challenges to the success of a business in an identified sector.	

Pass	Merit	Distinction
<p>L03 Produce project plans based on research of the chosen theme for an identified organisation</p>		<p>D2 Evaluate the project planning recommendations made in relation to the needs of the identified organisation and the accuracy and reliability of the research carried out.</p>
<p>P5 Devise comprehensive project plans for a chosen scenario, including a work and resource allocation breakdown using appropriate tools.</p>	<p>M3 Produce comprehensive project plans that effectively consider aims, objectives and risks/benefits for an identified organization.</p>	
<p>L04 Present your project recommendations and justifications of decisions made, based on research of the identified theme and sector</p>		
<p>P6 Communicate appropriate project recommendations for technical and non-technical audiences.</p> <p>P7 Present arguments for the planning decisions made when developing the project plans.</p> <p>P8 Discuss accuracy and reliability of the different research methods applied.</p>	<p>M4 Assess the extent to which the project recommendations meet the needs of the identified organisation, including fully-supported rationales for planning decisions made.</p>	

Recommended Resources

Textbooks

Costley, C., Elliot, G. and Gibbs, P. (2010) *Doing Work Based Research: Approaches to Enquiry for Insider-researchers*. London: SAGE.

Dawson, C. (2016) *Projects in Computing and Information Systems: A Student's Guide*. UK: Pearson Education.

Flick, U. (2011) *Introducing Research Methodology: A Beginner's Guide to Doing a Research Project*. London: SAGE.

Gray, D. (2009) *Doing Research in the Real World*. 2nd Ed. London: SAGE.

Guay, M., Schreiber, D. and Briones, S. (2016) *The Ultimate Guide to Project Management: Learn everything you need to successfully manage projects and get them done*. Free Kindle Edition. US: Zapier Inc.

Lock, D. (2013) *Project Management 8th Edition*. UK: Routledge.

Pinto, J. K. (2015) *Project Management: Achieving Competitive Advantage* 4th Ed. Pearson.

Journals

International Journal of Quantitative and Qualitative Research (IJQQR) – EA Journals

Qualitative Research Journal (QRJ) – Sage Journals

Web

www.apm.org.uk

Association for Project Management

www.gov.uk/government/publications

Department of Business Innovations and Skills, *Guidelines for managing projects – How to organise, plan and control projects*. (Report)

www.hesa.ac.uk

Higher Education Statistics Agency (HESA) – data collection and analysis for higher education

www.ons.gov.uk

Office for National Statistics(ONS)

www.pmi.org.uk

Project Management Institute UK

Links

This unit links to the following related units:

Unit 3: Professional Practice

Unit 16: Computing Research Project

Unit 17: Business Process Support

Unit 35: Systems Analysis & Design.

Unit 7: 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, black box and white box 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		D1 Assess the merits of applying the Waterfall lifecycle model to a large software development project.
<p>P1 Describe two iterative and two sequential software lifecycle models.</p> <p>P2 Explain how risk is managed in software lifecycle models.</p>	<p>M1 Discuss using an example, why a particular lifecycle model is selected for a development environment.</p>	
LO2 Explain the importance of a feasibility study		D2 Assess the impact of different feasibility criteria on a software investigation.
<p>P3 Explain the purpose of a feasibility report.</p> <p>P4 Describe how technical solutions can be compared.</p>	<p>M2 Discuss the components of a feasibility report.</p>	
LO3 Undertake a software development lifecycle		D3 Evaluate the process of undertaking a systems investigation with regard to its effectiveness in improving a software quality.
<p>P5 Undertake a software investigation to meet a business need.</p> <p>P6 Use appropriate software analysis tools/techniques to carry out a software investigation and create supporting documentation.</p>	<p>M3 Analyse how software requirements can be traced throughout the software lifecycle.</p> <p>M4 Discuss two approaches to improving software quality.</p>	
LO4 Discuss the suitability of software behavioural design techniques		D4 Present justifications of how data-driven software can improve the reliability and effectiveness of software.
<p>P7 Discuss, using examples, the suitability of software behavioural design techniques.</p>	<p>M5 Analyse a range of software behavioural tools and techniques.</p> <p>M6 Differentiate between a finite state machine (FSM) and an extended FSM, providing an application of use for both.</p>	

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.

Web

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 6: Planning a Computing Project

Unit 16: Computing Research Project

Unit 22: Application Development

Unit 35: Systems Analysis & Design

Unit 42: Game Design Theory

Unit 43: Games Development

Unit 54: Prototyping.

Unit 13: 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 the 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:

Investigate 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 regards 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. 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

Pass	Merit	Distinction
LO1 Explain server technologies and management services associated with hosting and managing websites		D1 Justify the technologies, management services, tools and software chosen to realise a custom-built website.
<p>P1 Identify the purpose and types of DNS, including explanations on how domain names are organised and managed.</p> <p>P2 Explain the purpose and relationships between communication protocols, server hardware, operating systems and web server software with regard to designing, publishing and accessing a website.</p>	<p>M1 Analyse the impact of common web development technologies and frameworks with regard to website design, functionality and management.</p> <p>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.</p>	
LO2 Categorise website technologies, tools and software used to develop websites		
<p>P3 Discuss the capabilities and relationships between front-end and back-end website technologies and explain how they relate to presentation and application layers.</p> <p>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).</p>	M3 Analyse a range of tools and techniques available to design and develop a custom-built website.	

Pass	Merit	Distinction
<p>LO3 Utilise website technologies, tools and techniques with good design principles to create a multipage website</p>		<p>D2 Evaluate the design and development process of the multipage website against the design document including any technical challenges faced.</p>
<p>P5 Create a design document for a branded, multipage website, supported with medium fidelity wireframes and a full set of client and user requirements.</p> <p>P6 Use the design document with appropriate principles, standards and guidelines to produce a branded, multipage website supported with realistic content.</p>	<p>M4 Justify the multipage website implementation decisions against the design document.</p>	
<p>LO4 Create and use a Test Plan to review the performance and design of a multipage website</p>		<p>D3 Evaluate the results of the Test Plan and the overall success of the multipage website with recommendations for improvement.</p>
<p>P7 Create a suitable test plan, identifying key performance areas to review the functionality and performance of the multipage website developed</p>	<p>M5 Analyse the Quality Assurance (QA) process and review how it was implemented during the multipage website design and development stages.</p>	

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.

Web Links

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 36: User Experience and Interface Design.

Unit 16: Computing Research Project (Pearson Set)

Unit code	K/618/7425
Unit type	Core
Unit level	5
Credit value	30

Introduction

This unit is assessed through a Pearson-set assignment. Students will choose their own project based on a theme provided by Pearson (this will change annually). The project must be related to their specialist pathway of study (unless the student is studying the general computing pathway). This will enable students to explore and examine a relevant and current topical aspect of computing in the context of a business environment and their chosen specialist pathway.

The aim of this unit is to give students the opportunity to engage in sustained research in a specific field of study. Students will be able to demonstrate the capacity and ability to identify a research theme, to develop research aims, objectives and outcomes, and to present the outcomes of such research in both written and verbal formats. Students are encouraged to reflect on their engagement in the research process, during which recommendations for personal development are key learning points.

On successful completion of this unit, students will have the confidence to engage in problem-solving and research activities. Students will have fundamental knowledge and skills that will enable them to investigate workplace issues and problems, determine appropriate solutions and present evidence to various stakeholders in an acceptable and understandable format.

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 this unit students will be able to:

- LO1 Examine appropriate research methodologies and approaches as part of the research process
- LO2 Conduct and analyse research relevant to a computing research project
- LO3 Communicate the outcomes of a research project to identified stakeholders
- LO4 Reflect on the application of research methodologies and concepts.

Essential Content

LO1 **Examine appropriate research methodologies and approaches as part of the research process**

Developing a research proposition:

The importance of developing methodical and valid propositions as the foundation for a research project.

Rationale: the purpose and significance for research question or hypothesis.

The value of the philosophical position of the researcher and the chosen methods.

Use of Saunders' Research Onion as a guide to establishing a methodological approach.

Literature review:

Conceptualisation of the research problem or hypothesis.

The importance of positioning a research project in context of existing knowledge.

Significance and means of providing benchmarks by which data can be judged.

Qualitative, quantitative, and mixed method research methodologies:

Key theoretical frameworks for research.

Advantages and limitations of qualitative and quantitative research approaches and methods.

LO2 **Conduct and analyse research relevant to a computing research project**

Research as a process:

Follow distinct phases of research to support a coherent and logical argument including using secondary research to inform a primary, empirical study.

Identify the reason and goal of the business research project, e.g. solving identified problems, business expansion, improve competitiveness, response to developments in technology, changes in the industry.

Elicite information from stakeholders.

Application of key skills and behaviours to guide the research project and ensure success, e.g. critical thinking, analysis and reasoning, dealing with difficult situations, misunderstanding or mistakes.

Selecting a sample:

The importance of gathering primary and secondary data and information (qualitative or quantitative) to support research analysis.

Selecting sample types and sizes that are relevant to the research.

Considering sampling approaches and techniques, including probability and non-probability (random) sampling.

Ethics, reliability and validity:

Conduct research ethically including reporting of findings.

Consider how to ensure reliable and valid research.

Analysing data:

Using data collection tools such as interviews and questionnaires.

Using analytical techniques such as trend analysis, coding and typologies.

LO3 Communicate the outcomes of a research project to identified stakeholders

Stakeholders:

Techniques to support the identification and analysis of internal and external stakeholders.

Stakeholder analysis to determine approaches to communications, including who the stakeholders are, high and low priority status, type of communication, frequency of communication, level to which the project outcomes are conveyed.

Communicating research outcomes:

Consideration of different methods of communicating outcomes, e.g. written word, spoken word, and the medium, e.g. report, online, presentation. The method and medium will be influenced by the research and its intended audience.

Considerations when communicating with stakeholders, e.g. maintaining privacy and security, tone of voice, use of technical vocabulary or jargon, maintaining or promoting company image.

Convincing arguments:

No matter what the method/medium, all research should be convincing and presented logically where the assumption is that the audience has little or no knowledge of the research process.

The importance of developing evaluative conclusions.

LO4 **Reflect on the application of research methodologies and concepts**

Reflection for learning and practice:

Difference between reflecting on performance and evaluating a research project. The former considers the research process; the latter considers the quality of the research argument and use of evidence.

Reflection on the merits, limitations and potential pitfalls of the chosen methods.

The cycle of reflection:

To include reflection in action and reflection on action.

Considering how to use reflection to inform future behaviour and future considerations.

Reflective writing:

Avoiding generalisation and focusing on personal development and the research journey in a critical and objective way.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Examine appropriate research methodologies and approaches as part of the research process		D1 Critically evaluate research methodologies and processes in application to a computing research project to justify chosen research methods and analysis.
P1 Produce a research proposal that clearly defines a research question or hypothesis, supported by a literature review.	M1 Analyse different research approaches and methodology and make justifications for the choice of methods selected based on philosophical/theoretical frameworks.	
P2 Examine appropriate research methods and approaches to primary and secondary research.		
LO2 Conduct and analyse research relevant to a computing research project		
P3 Conduct primary and secondary research using appropriate methods for a computing research project that consider costs, access and ethical issues.	M2 Discuss merits, limitations and pitfalls of approaches to data collection and analysis.	
P4 Apply appropriate analytical tools, analyse research findings and data.		

Pass	Merit	Distinction
LO3 Communicate the outcomes of a research project to identified stakeholders		D2 Evaluate outcomes and make valid, justified recommendations.
P5 Communicate research outcomes in an appropriate manner for the intended audience.	M3 Analyse the extent to which outcomes meet set research objectives and communicate judgements effectively for the intended audience	
LO4 Reflect on the application of research methodologies and concepts		D3 Demonstrate reflection and engagement in the resource process, leading to recommended actions for future improvement.
P6 Discuss the effectiveness of research methods applied, for meeting objectives of the computing research project. P7 Discuss alternative research methodologies and lessons learnt in view of the outcomes.	M4 Analyse results in recommended actions for improvements and future research considerations.	

Recommended Resources

Textbooks

Cornford, T., Smithson S. (2005) *Project Research in Information Systems: A Student's Guide*. Paperback. Palgrave Macmillan.

Costley, C., Elliott, G. and Gibbs, P. (2010) *Doing Work Based Research: Approaches to Enquiry for Insider-researchers*. London: SAGE.

Fink, A. (2020) *Conducting Research Literature Reviews: From the Internet to Paper*. 5th Ed. Sage Publications Inc.

Flick, U. (2020) *Introducing Research Methodology: A Beginner's Guide to Doing a Research Project*. London: Sage Publications Ltd.

Gray, D.E. (2009) *Doing Research in the Real World*. 2nd Ed. London: SAGE.

Saunders, M., Lewis, P. and Thornhill, A. (2012) *Research Methods for Business Students*. 6th Ed. Harlow: Pearson.

Wellington, J. (2000) *Educational Research: Contemporary Issues and Practical Approaches*. Continuum International Publishing Group Ltd.

Journals

International Journal of Quantitative and Qualitative Research

Qualitative Research

Links

This unit links to the following related units:

Unit 3: Professional Practice

Unit 6: Planning a Computing Project

Unit 7: Software Development Lifecycles.

Unit 17: Business Process Support

Unit code A/618/7428

Unit type Core

Unit level 5

Credit value 15

Introduction

Data and information are core to any organisation and business process. Accurate data and meaningful information are of high value to an organisation and are key drivers for effective decision making and problem solving. Business intelligence relies on the use of data science, which makes use of a range of tools and methods, including 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 used for acquiring data and processing it into meaningful information that can be used to support business functions and processes.

Students will examine how data and information support business processes, the mechanisms to source and utilise data and turn it in to usable, and valuable, information output. Students will explore real-world business problems, the emergence of data science and how the application of data science can be used to support business processes. Finally, students will demonstrate practical application of data science techniques to support real-world business problems.

On successful completion of this unit, students will appreciate the importance and value of data and information in terms of optimising decision making and performance. By exploring the tools, techniques and systems that support business processes, students will be aware of the role and contribution of these technologies and methodologies, 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 the use of data and information to support business processes and the value they have for an identified organisation
- LO2 Discuss the implications of the use of data and information to support business processes in a real-world scenario
- LO3 Explore the tools and technologies associated with data science and how it supports business processes
- LO4 Demonstrate the use of data science techniques to make recommendations to support real-world business problems.

Essential Content

LO1 Discuss the use of data and information to support business processes and the value they have for an identified organisation

Data and information in organisations:

Value of data and information for an organisation, including decision making (strategic, tactical and operational), deliver and improve services, optimise workflow and efficiency, increase profit margins, diversification, reduce overheads.

Types of data used by organisations, including structured and unstructured data.

Impact on business processes in terms of elicitation and storage.

The importance of reliable data and impact on businesses.

Use of data and information to support business processes:

Analysing market trends to identify patterns.

Factors impacting fluctuations in supply and demand, and prices of goods.

Monitoring system performance metrics.

Monitoring and controlling the quality of a product or service.

Analysing levels of user or customer interaction and engagement.

Analysing trends in browsing and purchasing for targeted marketing purposes.

Mechanisms:

Data generation, including human generated, e.g. social media posts, documents and files, email and text messages, website content.

Machine generated data, e.g. sensor readings, log files, system performance metrics, transactional data.

Tools to collect, store, manage, analyse and display data and information, including application software, content management systems, social media platform analytics tools, databases, scripting languages.

LO2 Discuss the implications of the use of data and information to support business processes in a real-world scenario

Social, legal and ethical implications:

Recognise the social, ethical and professional issues related to the use of data and information to support business processes, e.g. how data and information is collected and used, use of cookies and other transactional data, sharing of data, e.g. between departments, services and organisations.

Legal and regulatory issues related to the use of data and information to support business processes in reference to current legislation and principles of good practice, as recommended by computing professional bodies.

Cybersecurity management:

Common threats to data and information, e.g. internal and external threats.

Impact of human behaviour on cyber security, e.g. how motive and opportunity combine to become a threat.

Concept of 'secure by design' when developing and using systems to handle data and information.

Ways to mitigate common threats to data and information at personal and organisational level.

Organisational implications of failing to adequately protect data and information, e.g. legal actions, financial impact, disruption of operations and reduction in productivity, damage to public image.

LO3 Explore the tools and technologies associated with data science and how it supports business processes

Data science overview:

Explore how the exponential growth of the amount of data generated impacts on the way data is collected and used.

The core aims of data science, including making data useful and retrievable, extracting actionable intelligence to improve business performance, automating extraction and implementation.

Key job roles, including data engineer and data scientist, and how they work with other members of a team, e.g. senior managers, business and data analysts, software engineers in change and development lifecycles.

Data-science-related skills, including mathematics and statistics, programming and scripting skills, investigation and integration of data, core business knowledge.

Sub-disciplines in the data science field, including data engineering, machine learning and artificial intelligence.

Using data:

Core data handling techniques and concepts, including input and capture, data processing and conversion, information output and security considerations.

Forms of data, including unstructured and semi-structured data, and implications on use and analysis.

Data types, e.g. date, integer, real, character, string, Boolean.

Format of source and target data files, e.g. JSON, fixed-width text file, CSV, ASCII, XML.

The use of coding and scripting languages to automate data science processes, e.g. Python, R.

Turning data into usable information, including data mining techniques to find anomalies, cluster patterns and relationships between data sets, web scraping, descriptive and predictive analysis, converting data into visual information, e.g. charts, graphs, histograms, other visual mediums.

Predictive modelling, e.g. forecasting, use of statistical models to predict and identify trends.

Communicating information effectively to a range of stakeholders.

LO4 Demonstrate the use of data science techniques to make recommendations to support real-world business problems

Solutions:

Supporting a business process, including techniques to elicit end user requirements, systems requirements, application to automate procedures, including when it is most appropriate to use each one.

Designing a tool, program or package that can perform a specific task to support problem solving or decision making, e.g. e-commerce function for a website to support purchase analysis, a user dashboard to investigate specific market trends, optimising delivery routes for a logistics company.

Analysing and modelling business processes using relevant techniques, standards, notation and software tools.

Design considerations:

Addressing user and system requirements, e.g. user-friendly and functional interface, considering user engagement and interaction, quality risks inherent in data, mitigate or resolve risks, meaningful data output, customisation to satisfy the user and system requirements, phases of testing of business system changes.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
L01 Discuss the use of data and information to support business processes and the value they have for an identified organisation		D1 Evaluate the wider implications of using data and information to support business processes in an identified organisation.
P1 Discuss how data and information support business processes and the value they have for organisations. P2 Discuss how data is generated and the tools used to manipulate it to form meaningful data to support business operations.	M1 Assess the value of data and information to individuals and organisations in relation to real-world business processes.	
L02 Discuss the implications of the use of data and information to support business processes in a real-world scenario		
P3 Discuss the social legal and ethical implications of using data and information to support business processes. P4 Describe common threats to data and how they can be mitigated at on a personal and organisational level.	M2 Analyse the impact of using data and information to support business real-world business processes.	

Pass	Merit	Distinction
LO3 Explore the tools and technologies associated with data science and how it supports business processes		
P5 Discuss how tools and technologies associated with data science are used to support business processes and inform decisions.	M3 Assess the benefits of using data science to solve problems in real-world scenarios.	D2 Evaluate the use of data science techniques against user and business requirements of an identified organisation.
LO4 Demonstrate the use of data science techniques to make recommendations to support real-world business problems		
P6 Design a data science solution to support decision making related to a real-world problem. P7 Implement a data science solution to support decision making related to a real-world problem.	M4 Make justified recommendations that support decision making related to a real-world problem.	

Recommended Resources

Textbooks

Boyer, J. (2010) *Business Intelligence Strategy*. MC Press (US).

Jeston, J. and Nelis, J. (2018) *Business Process Management*. 4th 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.

VanderPlas, J. (2016) *Python Data Science Handbook: Tools and Techniques for Developers: Essential Tools for Working with Data*. O'Reilly.

Journals

International Journal of Business Intelligence and Data Mining

International Journal of Business Intelligence Research (IJBIR)

Web

gartner.com/en

Research and Advisory
(General reference)

datascience.codata.org

Data science
(Online data science journal)

Links

This unit links to the following related units:

Unit 6: Planning a Computing Project

Unit 8: Data Analytics

Unit 33: Applied Analytical Models

Unit 34: Analytical Methods.

Unit 19: 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		D1 Analyse the operation, using illustrations, of two network shortest path algorithms, providing an example of each.
<p>P1 Create a design specification for data structures, explaining the valid operations that can be carried out on the structures.</p> <p>P2 Determine the operations of a memory stack and how it is used to implement function calls in a computer.</p>	<p>M1 Illustrate, with an example, a concrete data structure for a First in First out (FIFO) queue.</p> <p>M2 Compare the performance of two sorting algorithms.</p>	
LO2 Specify abstract data types and algorithms in a formal notation		D2 Discuss the view that imperative ADTs are a basis for object orientation offering a justification for the view.
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.	

Pass	Merit	Distinction
LO3 Implement complex data structures and algorithms		D3 Critically evaluate the complexity of an implemented ADT/algorithm.
<p>P4 Implement a complex ADT and algorithm in an executable programming language to solve a well-defined problem.</p> <p>P5 Implement error handling and report test results.</p>	<p>M4 Demonstrate how the implementation of an ADT/algorithm solves a well-defined problem.</p>	
LO4 Assess the effectiveness of data structures and algorithms		D4 Evaluate three benefits of using implementation independent data structures.
<p>P6 Discuss how asymptotic analysis can be used to assess the effectiveness of an algorithm.</p> <p>P7 Determine two ways in which the efficiency of an algorithm can be measured, illustrating your answer with an example.</p>	<p>M5 Interpret what a trade-off is when specifying an ADT, using an example to support your answer.</p>	

Recommended Resources

Textbooks

Cormen, T. et al (1990) *Introduction to Algorithms*. MIT Press.

Cormen, T. et al (2002) *Instructor's Manual: Introduction to Algorithms*. MIT Press.

Heineman, G. et al (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 1: Programming

Unit 20: Applied Programming and Design Principles

Unit 30: Applied Cryptography in the Cloud.

Unit 20: Applied Programming and Design Principles

Unit code T/618/4902

Unit level 5

Credit value 15

Introduction

The advanced features of programming languages are used to develop software that is efficient, robust and can be mathematically proven to work. Well-designed code can positively impact the performance of an application as well as the readability and extensibility of the code, thereby improving productivity and reducing cost.

Effective object orientated programming (OOP) should have low coupling, high cohesion and strong encapsulation, which is something that the SOLID principles help to obtain. The idea is that by applying those principles together, it makes it easier to write better quality code with greater diversity and robustness. The system created becomes easy to maintain, to reuse and to extend over time. SOLID principles help software developers to achieve scalability and avoid creating code that breaks every time it needs a change. Clean coding maintains the readability of the programs produced by encouraging descriptive naming of objects and keeping to a single purpose model for each entity. Programming patterns work to ensure that designs produced are language independent, encapsulate ideas and are reusable in multiple circumstances.

The development of an application to process a large data set is a practical example of how to solve a problem that can be used in many different situations, can help deepen the understanding of OOP and help improve software design and reusability.

The aim of this unit is to familiarise students with these concepts 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, introduction to design patterns and SOLID, including its version of five principles of object-oriented programming and automated software testing.

The unit is especially useful for those intending to move into computer science, software development, programming, systems analysis and software testing

Learning Outcomes

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

- LO1 Investigate the impact of SOLID development principles on the OOP paradigm
- LO2 Design a large dataset processing application using SOLID principles and clean coding techniques
- LO3 Build a data processing application based on a developed design
- LO4 Perform automatic testing on a data processing application.

Essential Content

LO1 Investigate the impact of SOLID development principles on the OOP paradigm

Object-orientated programming (OOP) paradigm characteristics:

Understand the OO characteristics and their application in developing code, including encapsulation, polymorphism, constructors and destructors, sub-objects, abstraction, interface, method overriding and redefinition, templates and containers.

Object-orientated class relationships:

Understand the elements of the OO relationships, including generalisation and inheritance, realisation, dependency, aggregation and composition.

Design patterns:

Aims and benefits of reusable design patterns, e.g. general reusable solution, represent an idea and language independent.

Grouping of design patterns into creational, structural and behavioural groups.

Clean coding techniques:

Simple design, e.g. keeping configurable data at high levels, polymorphism, consistency in methods, meaningful variable and constant names and encapsulate boundary conditions.

Creating small functions by including single action, minimal parameters, descriptive names, comments to explain code and warn of consequences.

Structure source code to separate concepts vertically, declare variables close to usage and keep lines short.

Develop objects and data structures for one action so that they are small.

Understand why non-static methods are preferable to static methods.

Design tests to ensure they are readable, fast and independent.

Understand bad test design, e.g. rigid, fragile, immobile, complex, repetitive.

SOLID design principles:

Understand and apply the component parts of SOLID design principles to make software understandable, flexible and maintainable, including Single-responsibility principle, Open-closed principle, Liskov substitution principle, Interface segregation principle and Dependency inversion principle.

LO2 **Design a large dataset processing application using SOLID principles and clean coding techniques**

Large datasets (public domain):

Design of application that can accommodate pre-existing large (500+) datasets, e.g. list of members of parliament, register of members' interests (Commons and Lords), list of public domain films (e.g. in the USA), list of public domain books, list of public domain music.

Data structures:

Use of data structures in application development, e.g. stack, array, multi-dimensional array, set, queue, list and linked list.

Apply tree types, including active, passive and recursive.

Operations:

Use of operations in application development, e.g. hash functions and pointers.

Utilise sorts, e.g. insertion, quick, merge and heap.

Utilise searches, e.g. linear, binary tree and recursive.

LO3 **Build a data processing application based on a developed design**

Implementation:

Utilise an appropriate language and development tools, incorporate security and maintainability expectations.

Produce program code that implements a design based on SOLID principles, clean coding techniques and programming patterns.

Understand and interpret design features, meet requirements, input, output, processing security, portability and maintainability.

LO4 **Perform automatic testing on a data processing application**

Types of automatic testing:

Understand the uses of automation in setting up regression tests, data set up generation, product installation, GUI interaction, defect logging, unit testing and integration testing of main application.

Tool automation parameters:

Understand the meaning of data driven capabilities, debugging and logging capabilities, platform independence, extensibility and customisability, email notifications, version control friendly.

How automated testing features support unattended test runs.

Understanding of testing logic and updates code to make testing easier through the use of stubbing/patching

Follow common testing frameworks and methodologies:

Understand the circumstances where different frameworks perform best, Data Driven Automation Framework, Keyword Driven Automation Framework, Modular Automation Framework and Hybrid Automation Framework.

Tools:

Investigate a range of tools that are commercially available.

Functional, e.g. QuickTest Professional (HP), Coded UI (Microsoft), Selenium, Open IT (open source).

Non-functional, e.g. LoadRunner (HP), JMeter (Apache), Burp Suite (PortSwigger).

Self-built testing tools:

Investigate the value of developer-designed and built tools to test features and functions of a specific application.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Investigate the impact of SOLID development principles on the OOP paradigm		D1 Evaluate the impact of SOLID development principles on object-orientated application development.
P1 Investigate the characteristics of the object-orientated paradigm, including class relationships and SOLID principles. P2 Explain how clean coding techniques can impact on the use of data structures and operations when writing algorithms.	M1 Analyse, with examples, each of the creational, structural and behavioural design pattern types.	
LO2 Design a large dataset processing application using SOLID principles and clean coding techniques		
P3 Design a large data set processing application, utilising SOLID principles, clean coding techniques and a design pattern. P4 Design a suitable testing regime for the application, including provision for automated testing.	M2 Refine the design to include multiple design patterns.	

Pass	Merit	Distinction
LO3 Build a data processing application based on a developed design		D2 Analyse the benefits and drawbacks of different forms of automatic testing of applications and software systems, with examples from the developed application.
P5 Build a large dataset processing application based on the design produced.	M3 Assess the effectiveness of using SOLID principles, clean coding techniques and programming patterns on the application developed.	
LO4 Perform automatic testing on a data processing application		
P6 Examine the different methods of implementing automatic testing as designed in the test plan. P7 Implement automatic testing of the developed application.	M4 Discuss the differences between developer-produced and vendor-provided automatic testing tools for applications and software systems.	

Recommended Resources

Textbooks

CLARKE JILL, (2020) *Software Developer*, London: BCS

FISHPOOL B & FISHPOOL M, (2020) *Software Development in Practice*, BCS

FREEMAN E., FREEMAN E., SIERRA K., BATES B. (2004) *Head First Design Patterns*, London: O'Reilly

GAMMA E, HELM R, JOHNSON R, VLISSIDES J, (1994) *Design Patterns: elements of reusable object-oriented software*, Addison Wesley

MARTIN, RC, (2017) *Clean Architecture: A Craftsman's Guide to Software Structure and Design*. London Pearson, Addison Wesley

Journal

academic.oup.com

Oxford Academic

ITNow: British Computer Society

(general reference)

Web

baeldung.com

Baeldung

A Solid Guide to SOLID Principles

(general reference)

tutorialspoint.com

Software Testing Dictionary

(general reference)

Links

This unit links to the following related units:

Unit 1: Programming

Unit 7: Software Development Lifecycles

Unit 19: Data Structures and Algorithms

Unit 22: Application Development

Unit 24: Advanced Programming for Data Analysis

Unit 22: 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 which 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, testing and implementation.

The value of software design documents with regard to application development.

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

Work as a small team to plan and prepare a business application:

Peer review a development plan.

Interpret and implement a given design whilst remaining compliant with security and maintainability requirements.

Communicate and defend effectively the ideas in a software design document.

Discuss differences with regards 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 including 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

Pass	Merit	Distinction
LO1 Produce a software design document for a business-related problem based on requirements		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.
P1 Produce a well-defined problem definition statement, supported by a set of user and system requirements for a business problem.	M1 Analyse a business-related problem using appropriate methods to produce a well-structured software design document.	
P2 Review areas of risk related to the successful development of a proposed application.		
LO2 Research design and development tools and methodologies for the creation of a business application		
P3 Research the use of software development tools and techniques for the development of a proposed application.	M2 Justify the software development tools and development methodology selected.	

Pass	Merit	Distinction
LO3 Plan and produce a functional business application with support documentation		
<p>P4 Conduct a peer review of the problem definition statement, proposed solution and development strategy, documenting any feedback given.</p> <p>P5 Develop a functional business application with support documentation based on a specified business problem.</p>	<p>M3 Interpret peer-review feedback and identify opportunities not previously considered.</p> <p>M4 Develop a functional business application based on a specific software design document, with supportive evidence of using the preferred tools, techniques and methodologies.</p>	
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 6: Planning a Computing Project

Unit 7: Software Development Lifecycles.

Unit 24: Advanced Programming for Data Analysis

Unit code H/618/5723

Unit level 5

Credit value 15

Introduction

The world of programming and software engineering is vast and includes many occupational pathways to pursue. Most areas of modern computing involve some form of data analysis. These range from enhanced reality development through to robotic control and communication systems, to medical imaging machines. All of these require significant management of data but the area with the most common requirements is in data analysis and manipulation for business intelligence. An analyst's role is becoming increasingly complex. Experienced analysts use modelling and predictive analytics techniques to generate useful insights and actions, which they present to interested parties and decision makers in an appropriate, clearly understood way.

This unit is designed to develop the skills required to become a skilled data analyst. It includes investigation of a range of different programming languages, aimed at both data analytics and general use, good development guidelines and the design, development and testing of a sizeable tool to analyse and utilise a large data set.

These skills are especially relevant to today's data analyst, data scientist, social researcher, market researcher and others who utilise large data sets in their work.

Learning Outcomes

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

- LO1 Explore the tools a programmer can use to manipulate large data sets for data analysis
- LO2 Design a software tool to analyse a large data set for a given scenario
- LO3 Develop a software tool to analyse a large data set for a given scenario
- LO4 Test a software tool used to analyse a large data set for quality of information produced.

Essential Content

LO1 Explore the tools a programmer can use to manipulate large data sets for data analysis

Data analysis languages:

Explore data analysis languages, e.g. R, SAS, SQL, Julia, Matlab.

General programming languages:

Explore general programming languages: C++, C, C#, Java, F#, Visual Basic, Python.

Identify interaction methods, R.Net, linking at runtime, direct manipulation of objects.

Proposal:

What dataset will be used, the language to be used, what outcomes are to be achieved and the method of interrogating and analysing the dataset.

Good coding techniques:

Simple design, e.g. keeping configurable data at high levels, consistency in methods, meaningful variable and constant name

Create small functions and procedures by including single action, minimal parameters, descriptive names, comments to explain code functions and variables clearly.

Structure source code logically, declare local variables close to usage and keep lines short. Keep global variables together with comments on function and where used.

Develop objects and data structures for one action so that they are small.

Design tests to ensure they are readable, effective and test boundary conditions too.

Understand bad test design, e.g. over complex, repetitive, miss conditions.

Large datasets:

Investigate the availability of large public domain and other datasets suitable for use with your software tool, data.NASA.gov, data.gov.uk, etc.

LO2 **Design a software tool to analyse a large data set for a given scenario**

Software design:

Design to include details of acquisition, cleaning and analysis of digital data.

Dataset operations:

Use of operations in application development, e.g. hash functions and pointers, sorts, e.g. insertion, quick, merge and heap, searches, e.g. linear, binary tree and recursive. acquisition, cleaning and analysis of digital data.

Data analysis methods:

Apply an appropriate range of data analysis methods.

Qualitative methods, e.g. content analysis

Quantitative analysis methods e.g. standard deviation, frequency, range and average and hypothesis testing and descriptive analysis.

Specific descriptive analysis techniques e.g. regression analysis, factor analysis, dispersion analysis, discriminant analysis and time series analysis.

LO3 **Develop a software tool to analyse a large data set for a given scenario**

Implementation:

Utilise an appropriate language and development tools.

Produce good quality program code that implements a design for a data analysis software tool.

LO4 **Test a software tool used to analyse a large data set for quality of information produced**

Types of testing:

Understand the uses of unit testing and integration testing of main application.

Understand the meaning of data driven capabilities, debugging and logging capabilities, platform independence, extensibility and customisability, email notifications, version control friendly.

Assessing effectiveness of the data analysis:

Evaluate how effective the data analysis tool is, e.g. level of detail, accuracy, validity, execution and clarity of outcomes.

Present results:

Methods, summary, e.g. charts, histogram, frequency polygon, imaginative use of diagrams, narrative, interpretation, tables, interpretation.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Explore the tools a programmer can use to manipulate large data sets for data analysis		D1 Analyse the ways code written in different programming languages can be linked and called at run time to extend functionality of computationally intensive tasks and manipulate data analysis objects directly.
P1 Investigate the functions of a data analysis language. P2 Prepare a proposal for analysing a large dataset, including the method of analysis and the outcomes to be achieved.	M1 Examine the ways that general programming languages can interact with a data analysis language.	
LO2 Design a software tool to analyse a large data set for a given scenario		
P3 Design a software tool to carry out a specific analysis on a chosen large dataset. P4 Create a detailed test plan for a software tool, identifying expected outcomes of the analysis.	M2 Apply program code from both a general programming language and a data analysis-based language in designing the software tool.	
LO3 Develop a software tool to analyse a large data set for a given scenario		D2 Analyse the output of the data analysis process with focus on the quality of information produced from the dataset and identify possible improvements.
P5 Build a software tool for analysing a large dataset according to a developed design.	M3 Modify the program to include code from both a general programming language and a data analysis-based language in building the software tool.	
LO4 Test a software tool used to analyse a large data set for quality of information produced		
P6 Implement a detailed test plan on a data analysis software tool. P7 Present the results of the analysis on the chosen data set.	M4 Review the outcomes, utilising the software tool and the results of testing.	

Recommended resources

Textbooks

Clarke, J. (2020) *Software Developer*, BCS.

Fishpool, B. & Fishpool, M. (2020) *Software Development in Practice*, BCS.

Martin, R. C. (2017) *Clean Architecture: A Craftsman's Guide to Software Structure and Design*. London Pearson, Addison-Wesley.

Journal

academic.oup.com *Oxford Academic*
ITNOW: British Computer Society
(General reference)

Web

data.nasa.gov NASA public domain datasets
(General reference)

github.com/niderhoff/nlp-
datasets Alphabetical list of free/public datasets

smartdatacollective.com Big data sources – public domain datasets
(General reference)

tutorialspoint.com Software Testing Dictionary
(General reference)

Links

This unit links to the following related units:

Unit 1: Programming

Unit 8: Data Analytics

Unit 20: Applied Programming and Design Principles

Unit 22: Application Development

Unit 26: Big Data Analytics and Visualisation.

Unit 27: Transport Network Design

Unit code K/618/7439

Unit level 5

Credit value 15

Introduction

The exponential growth of the World Wide Web has put unprecedented demand on private and public networking infrastructures. The traffic generated by private and commercial networks has become dominated by Voice over Internet Protocol (VoIP) and video on demand. These developments require existing infrastructures to be adapted, that the design of new networks mitigates best-effort delivery issues, avoiding low bandwidths and high latency problems, and that they are based on traffic priority. For enterprise networks and internet infrastructures to meet expected demand, their design will have to take into consideration principles such as availability, scalability, resiliency, reliability and quality of service (QoS). As a result, network engineers designing and supporting enterprise or Internet Service Provider (ISP) networks will need the knowledge and skills to support diverse business needs, such as converged network traffics, centralised control and mission-critical applications.

This unit introduces students to enterprise network design principles, design models, scalable networks and their effectiveness in supporting business requirements. After evaluating the features of scalable networks, such as availability, reliability and hierarchy, students will apply network design principles to the design and implementation of redundant networks to provide Layer 2 and Layer 3 redundant solutions. Students are expected to evaluate Wide Area Network (WAN) technologies and make choices based on specific enterprise requirements. They will implement a range of WAN connections and protocols, such as Point-to-Point (PPP), Frame Relay and Virtual Private Network (VPN) with Internet Protocol Security (IPSec), using network simulators or network lab equipment. They will also solve network-related issues using network monitoring and troubleshooting methods and techniques.

Among the topics included in this unit are: network design principles, network design modules, features of enterprise IT networks, such as scalability, reliability, availability and hierarchy, Local Area Network (LAN) redundancy and related issues, spanning tree protocols, router redundancy protocols, link aggregation, in-band and out-of-band network device management, features and characteristics of WAN networks, WAN technologies and protocols, such as PPP, Frame Relay and VPN with IPSec, network monitoring tools, network security, network documentation, network troubleshooting methods and LAN and WAN connectivity issues.

On successful completion of this unit, students will be able to evaluate LAN design principles and their application in the network design process, implement a network using LAN design principles based on a predefined set of requirements, produce an appropriate WAN solution to a set of organisational requirements and solve a range of network-related problems using appropriate troubleshooting techniques and methods. 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 Explore LAN design principles and their application in the network design process
- LO2 Implement a network using LAN design principles based on a predefined set of requirements
- LO3 Produce an appropriate WAN solution to a set of organisational requirements
- LO4 Solve a range of network-related problems using appropriate troubleshooting techniques and methods.

Essential Content

LO1 Explore LAN design principles and their application in the network design process

Discuss and evaluate LAN design principles based on business needs:

Analysing diverse business needs: support critical applications, support converged network traffic, centralised administrative control.

Network features: bandwidth, delay, load.

Evaluate LAN design models:

Review of OSI and TCP/IP models, three-layer design model, enterprise architecture design model, features of scalable networks (redundancy, hierarchy, scalability, availability, reliability and small failure domains).

Explore the characteristics and functions of routing protocols, e.g. OSPF (open shortest path first), RIPng (Routing Information Protocol next generation).

Analyse LAN redundancy:

Issues related to redundancy, Spanning Tree Concepts, Spanning Tree Protocols.

Solving bandwidth and load related issues:

Examine link aggregation concepts and operations, configure link aggregation using EtherChannel technology.

Evaluate the need for redundancy at router level:

Default gateway-related issues, router redundancy protocols.

LO2 Implement a network using LAN design principles based on a predefined set of requirements

Application of LAN design principles in network design and configuration:

Selecting network devices to implement a LAN design: use of modularity, stackability, port density, subnets, static and dynamic routes, switch forwarding, multi-layer switching and router requirements in the selection process.

Configuring LAN devices:

Comparison of out-of-band and in-band management, evaluate user interfaces, examine operating system management and licencing issues, basic device configuration.

Describe the concepts related to VLAN.

Implementing Layer 2 LAN redundancy:

Configuration of different Spanning Tree Protocols (STP and Rapid STP).

Implementing Layer 3 LAN redundancy for IPv4:

Configuring First Hop Redundancy Protocols (Hot Standby Routing Protocol, Virtual Router Redundancy Protocol and Gateway Load Balancing Protocol).

Implementing Layer 3 LAN redundancy for IPv6:

Configuring the 'new generation' of redundancy routing protocols, e.g. OSPFv3 (open shortest path first V3), RIPng (RIP New Generation), stateless address auto-configuration.

Configuring, managing and verifying interior routing protocols, e.g. OSPF, RIP.

LO3 Produce an appropriate WAN solution to a set of organisational requirements

WAN networks and protocols:

Analyse features and requirements of enterprise networks: analyse WAN enterprise architecture, uptime, bandwidth, ISPs, traffic flows, prioritisation, queuing algorithms, latency, QoS models, teleworking.

WAN technologies:

Examine WAN operations and services, analyse and compare private and public WAN technologies, select the appropriate WAN protocol and service for a specific network requirement.

Investigate the need for and methods of performing IOS upgrades to a router.

WAN serial connections:

Configuring point-to-point connections using Point-to-Point Protocol (PPP): explain point-to-point serial WAN serial communication, analyse and configure HDLC, analyse and configure PPP.

Configuring Frame Relay:

Analyse and compare Frame Relay and leased lines benefits and drawbacks, explain Frame Relay protocol Permanent Virtual Circuits (PVC), Link Management Interface (LMI) extensions, Data Link Connection Identifier (DLCI) mappings, configure static Frame Relay, implement advanced Frame Relay configurations.

VPN over a public infrastructure connection:

Explaining Virtual Private Network (VPN) features and benefits, compare VPN types, configure site-to-site secure tunnel connections, configure VPN with IP Security (IPSec) and compare IPSec and SSL VPNs (Secure Socket Layer).

LO4 Solve a range of network-related problems using appropriate troubleshooting techniques and methods

Network security considerations:

Network security issues, their impacts and solutions.

Network monitoring and troubleshooting methods:

Network monitoring tools including Syslog, Network Time Protocol (NTP), NetFlow and Simple Network Management Protocol (SNMP).

Network troubleshooting including establishing network baselines, optimising network performance troubleshooting methods with a systematic approach, e.g. root cause analysis, gathering information, questioning end users, preparing network documentation, comparing network troubleshooting tools.

Troubleshooting LAN and WAN connectivity issues:

Physical and Data Link layers networking issues and troubleshooting: examine cable faults, device failures, bottlenecks, congestions, attenuation, noise, power issues (redundant power supplies), encapsulation mismatches, STP related issues, etc.

Network layer issues and troubleshooting:

Evaluate divide and conquer method, importance of ipconfig, ping and traceroute commands, subnetting issues, troubleshooting routing protocols, PPP, Frame Relay and VPN configuration issues.

Transport and application layers networking issues and troubleshooting:

Examine the use of port numbers in Access Control Lists (ACL), denying and allowing errors, ACL misconfigurations, Network Address Translation (NAT), Domain Name System (DNS) and Dynamic Host Configuration Protocol (DHCP) related issues.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Explore LAN design principles and their application in the network design process		D1 Evaluate different implementations of link aggregation, using EtherChannel to solve bandwidth and load issues.
P1 Examine the network design models and features of scalable networks, based on a given set of business needs.	M1 Analyse the switch and router redundancy protocols and their effectiveness in supporting scalable networks.	
P2 Discuss LAN redundancy, bandwidth and load related issues and possible solutions, with reference to Layer 2 and Layer 3 of the OSI Model.		
LO2 Implement a network using LAN design principles based on a predefined set of requirements		
P3 Select LAN devices based on features and requirements and apply basic configuration commands for network connectivity.	M2 Analyse different switch redundancy protocols and their effectiveness in solving redundancy issues.	
P4 Implement a LAN design with Layer 2 and Layer 3 redundancy, using switch and router redundancy protocols.	M3 Analyse Layer 3 redundancy implementations for IPv4 and IPv6.	

Pass	Merit	Distinction
LO3 Produce an appropriate WAN solution to a set of organisational requirements		D2 Evaluate troubleshooting methods and their effectiveness in solving enterprise-wide networking issues.
<p>P5 Examine WAN technologies and select the appropriate one for a set of enterprise requirements.</p> <p>P6 Configure WAN protocols as part of an enterprise network solution.</p>	<p>M4 Analyse the benefits and drawbacks of private and public WAN technologies.</p> <p>M5 Analyse features and benefits of different VPN types based on organisational needs.</p>	
LO4 Solve a range of network-related problems using appropriate troubleshooting techniques and methods		
<p>P7 Deploy network monitoring tools and troubleshooting methods to establish network baselines and produce network documentation.</p> <p>P8 Troubleshoot LAN and WAN connectivity issues at different networking layers.</p>	<p>M6 Develop effective documentation of troubleshooting methods and steps based on a given scenario.</p>	

Recommended Resources

Textbooks

Meyers, M. (2015) *CompTIA Network+ Guide to Managing and Troubleshooting Networks, Fourth Edition*. London, UK: McGraw Hill Professional.

Subramanian, M. (2012) *Network Management: Principles and Practices*. USA: Prentice Hall.

Thomatis, M. (2015) *Network Design Cookbook: Architecting Cisco Networks*. USA: Lulu Press, Inc.

White, R. and Donohue, D. (2014) *The Art of Network Architecture: Business-Driven Design*. USA: Cisco Press.

Web

www.cisco.com Cisco International networking company
(General reference)

www.ncsc.gov.uk National Cyber Security Centre
(General reference)

www.sciencedirect.com ScienceDirect online science journal
Computer science section
(General reference)

Links

This unit links to the following related units:

Unit 2: Networking

Unit 9: Computer Systems Architecture Unit 29: Network Security

Unit 39: Network Management

Unit 40: Client/Server Computing Systems.

Unit 45: Internet of Things

Unit code	J/618/7481
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, social and economic benefit to people.

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; be able to 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 application

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, smart

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.

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:

Specific problem to solve using IoT.

Evaluate the benefits, features, advantages and disadvantages of IoT to solve a specific problem.

Review 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 addresses 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 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

Pass	Merit	Distinction
LO1 Analyse what aspects of IoT are necessary and appropriate when designing software applications		D1 Evaluate specific forms of IoT architecture and justify their use when designing software applications.
<p>P1 Explore various forms of IoT functionality.</p> <p>P2 Review standard architecture, frameworks, tools, hardware and APIs available for use in IoT development.</p>	<p>M1 Analyse the impact of common IoT architecture, frameworks, tools, hardware and APIs in the software development lifecycle.</p> <p>M2 Examine specific forms of IoT architecture, frameworks, tools, hardware and APIs for different problem-solving requirements.</p>	
LO2 Outline a plan for an appropriate IoT application, using common architecture, frameworks, tools, hardware and APIs		D2 Make multiple iterations of the IoT application and modify each iteration with enhancements gathered from user feedback and experimentation.
<p>P3 Investigate architecture, frameworks, tools, hardware and API techniques available to develop IoT applications.</p> <p>P4 Discuss a specific problem to solve using IoT.</p>	<p>M3 Plan the most appropriate IoT architecture, frameworks, tools, hardware and API techniques to include in an application to solve a problem.</p> <p>M4 Apply selected techniques to create an IoT application development plan.</p>	
LO3 Develop an IoT application using any combination of hardware, software, data, platforms and services		
<p>P5 Employ an appropriate set of tools to develop a plan into an IoT application.</p> <p>P6 Run end-user experiments and examine feedback.</p>	<p>M5 Reconcile end-user feedback and determine advantages and disadvantages of chosen IoT techniques.</p>	

Pass	Merit	Distinction
<p>LO4 Evaluate your IoT application and the problems it might encounter when integrating into the wider IoT ecosystem</p>		<p>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.</p>
<p>P7 Review the IoT application, detailing the problems it solves.</p> <p>P8 Investigate the potential problems the IoT application might encounter when integrating into the wider system.</p>	<p>M6 Compare the final application with the original plan.</p>	

Recommended Resources

Textbooks

Bahga, A. and Madiseti, 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 21: Application Program Interfaces

Unit 47: Emerging Technologies.

Appendix 1: Mapping of HND in Computing 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		Computing 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 computing environment.
	KU2	Understanding and insight into different organisations, their diverse nature, purposes, structures and operations and their influence upon the external environment.
	KU3	A critical understanding of the evolving concepts, theories and models within the study of computing across a range of practical and hypothetical scenarios.
	KU4	An ability to evaluate and analyse a range of concepts, theories and models to make appropriate decisions.
	KU5	An appreciation of the concepts and principles of CPD, staff development, leadership and reflective practice as methods and strategies for personal and people development.
	KU6	Knowledge and understanding of vital concepts, principles and theories relating to computing and computer applications, software development, networking and media systems.

FHEQ Level 5 descriptor		Computing HND Programme Outcome
	KU7	Critical understanding of how computer-based technologies interrelate and communicate with one another, support processes and lead to a computerised solution to a problem.
	KU8	Understanding of the application of appropriate mathematical techniques in the design and development of software and computer systems.
	KU9	Critical understanding of the use of industry-standard technical documentation and practices.
	KU10	Develop a range of multi-disciplined programming and coding skills.
	KU11	Deploy appropriate tools, theories, principles and methodologies to analyse, specify, construct, test and evaluate a computer-based system in an appropriate context.
	KU12	An ability to apply industry-standard methods in human-computer interaction to inform the development of usable interfaces.
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	AS1	Evidence the ability to show client relationship management and develop appropriate policies and strategies to meet stakeholder expectations.
	AS2	Apply innovative ideas to develop and create new systems or services that respond to the changing nature of organisations.
	AS3	Integrate theory and practice through the investigation and examination of practices in the workplace.
	AS4	Develop outcomes for clients using appropriate practices and data to make justified recommendations.

FHEQ Level 5 descriptor		Computing HND Programme Outcome
	AS5	Apply IT concepts and principles to critically evaluate and analyse complex practical problems and provide IT-based solutions.
	AS6	Apply appropriate computer- based technologies to analyse, develop and maintain reliable software.
	CS1	Deploy appropriate theory, practices and tools in order to analyse, specify, design and implement computing systems and software applications.
	CS2	Recognise and critically evaluate the professional, economic, social, environmental, moral and ethical issues that influence the sustainable exploitation of computer-based technologies.
	AS7	Employ a range of analytical techniques and design tools in the development of secure software.
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	Critique a range of systems and operations and their application to maximise and successfully meet strategic objectives.
	KU13	An understanding of the appropriate techniques and methodologies used to resolve real-life problems in the workplace.
	TS1	Develop a skill set to enable the evaluation of appropriate actions taken for solving problems in a specific organisational 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.
	TS3	Undertake independent learning to expand on own skills and delivered content.

Typically, holders of the qualification will be able to:

FHEQ Level 5 descriptor		Computing 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.	TS4	Competently use digital literacy to access a broad range of research sources, data and information.
	CS4	Interpret, analyse and evaluate a range of data, sources and information to inform evidence-based decision making.
	CS5	Synthesise knowledge and critically evaluate strategies and plans to understand the relationship between theory and real-world 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.	TS5	Communicate confidently and effectively, both orally and in writing, both internally and externally with organisations and other stakeholders.
	TS6	Communicate ideas and arguments in an innovative manner using a range of digital media.
	AS8	Locate, receive and respond to a variety of information sources (e.g. textual, numerical, graphical and computer-based) in defined contexts.
	TS7	Communicate effectively, verbally and in writing and articulate well-defined issues, for a variety of purposes, taking into account the audience viewpoint
	TS8	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	TS9	Identify personal and professional goals for continuing professional development in order to enhance competence to practise within a chosen computing field.
	TS10	Take advantage of available pathways for continuing professional development through higher education, Professional Body Qualifications and Vendor Accredited Certifications.

Holders will also have:

FHEQ Level 5 descriptor	Computing HND Programme Outcomes	
The qualities and transferable skills necessary for employment requiring the exercise of personal responsibility and decision-making.	TS11	Develop a range of skills to ensure effective team working, independent initiatives, organisational competence and problem-solving strategies.
	TS12	Show an ability to work as a member of a development team, recognising the different roles within a team and the different ways of organising teams
	TS13	Reflect adaptability and flexibility in approach to work; showing resilience under pressure and meeting challenging targets within given deadlines.
	TS14	Use quantitative skills to manipulate data, evaluate and verify existing theory.
	TS15	Show awareness of current developments within the computing industry and their impact on employability and CPD.
	TS16	Manage small to medium scale projects using appropriate planning and time management techniques.
	CS6	Evaluate the changing needs of the business environment and have confidence to self-evaluate and undertake additional CPD as necessary.
	TS17	Display emotional intelligence and sensitivity to diversity in relation to people and cultures.

Appendix 2: HNC/HND Computing Programme Outcomes for Students

Unit	Knowledge and Understanding													Cognitive skills						Applied skills								Transferable skills																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	1	2	3	4	5	6	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
1	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	X		X	X					
2	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				
3	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			
4	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	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		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	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	X	X			X		X	X	X	X		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	X	X	X	X	X	X		X	X	X	X		X	X			
9	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		X	X		
10	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	X	X		X	X	X		
11				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			X		X	X	X		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		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	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	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		X	X	X	X		X	X			
17	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		
18				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	X	X	X	X	X		X		X	X	X		X	X			
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	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	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	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		X	X	

Appendix 3: Transferable skills mapping

Level 5 Higher National Diploma in Computing: 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
1	X	X	X		X		X	X	X		X			
2	X	X	X		X		X	X	X	X	X			X
3		X	X	X			X	X	X	X	X	X	X	X
4	X	X	X		X	X	X	X	X	X	X			
5	X	X	X		X			X	X	X	X			
6	X	X	X	X	X		X	X	X	X	X	X	X	X
7	X	X	X		X	X		X	X	X	X			
8	X	X	X	X	X	X	X	X	X	X	X			
9	X	X	X	X	X	X	X	X	X	X	X	X	X	
10	X	X	X	X	X		X	X	X	X	X		X	
11	X	X	X			X		X	X	X				
12	X	X	X		X	X		X	X	X	X			
13	X	X	X	X	X		X	X	X	X	X		X	
14		X	X	X	X		X	X		X	X			X
15	X	X	X	X	X	X	X	X	X	X	X			
16	X	X	X	X	X	X	X	X	X	X	X			
17	X	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
18	X	X	X			X		X	X	X	X			
19	X	X	X	X	X	X	X	X	X	X	X		X	
20	X	X	X		X	X	X	X	X	X	X			
21	X	X	X			X	X	X	X	X	X			
22	X	X	X	X	X	X	X	X	X		X			
23		X		X	X	X			X	X	X			
24	X	X	X		X	X	X	X	X	X	X			
25	X	X	X	X	X			X	X	X	X		X	
26	X	X	X	X	X	X	X	X	X	X	X			
27	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
30	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
32	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			
34	X	X	X	X	X		X	X	X	X	X	X	X	X
35	X	X	X	X	X			X	X	X	X			
36	X	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
38	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
40	X	X	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	
43	X	X	X	X	X			X	X	X	X	X		X	X
44	X	X	X	X	X		X	X	X	X	X	X			
45		X	X	X	X					X	X	X			X
46	X	X	X	X	X		X	X	X	X	X	X	X	X	X
47	X	X	X	X	X			X	X	X	X	X	X	X	X
48	X	X	X			X			X	X	X	X			
49	X	X	X			X		X	X	X	X	X	X	X	

October 2021

For information about Pearson Qualifications, including Pearson Edexcel, BTEC and LCCI qualifications visit qualifications.pearson.com

Edexcel and BTEC are registered trademarks of Pearson Education Limited

**Pearson Education Limited. Registered in England and Wales No. 872828
Registered Office: 80 Strand, London WC2R 0RL.**

VAT Reg No GB 278 537121

