



ICON College of Technology and Management

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



ICON College of Technology and Management

Pearson BTEC Level 5 Higher National Diploma in Computing (RQF) Course Code: ZLX05

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 Managing a Successful Computing Project (Pearson-set)	Core Unit Mandatory	15	4
10 Website Design & Development	From Optional Units	15	4
11 Maths for Computing	From Optional Units	15	4

Level 5 units: 120 credits			
13 Computing Research Project (Pearson-set)	Core Unit Mandatory	30	4
14 Business Intelligence	Core Unit Mandatory	15	4
15 Transport Network Design	From Optional Units	15	4
16 Cloud Computing	From Optional Units	15	4
19 Data Structures & Algorithms	From Optional Units	15	4
20 Advanced Programming/43 Internet of Things	From Optional Units	15	4
30 Application Development	From Optional Units	15	4

Total 240 Credits



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*	Managing a Successful Computing Project (Pearson-set) (L4)
Unit 3*	Professional Practice (L4)	Unit 10	Website Design & Development (L4)
Unit 4*	Database Design & Development (L4)	Unit 11	Maths for Computing (L4)
Semester Three		Semester Four	
Unit 13*	Computing Research Project (Pearson-set) (L5)	Unit 13*	Computing Research Project (Pearson-set) (L5)
Unit 14*	Business Intelligence (L5)	Unit 15	Transport Network Design (L5)
Unit 19	Data Structures & Algorithms (L5)	Unit 16	Cloud Computing (L5)
Unit 20	Advanced Programming (L5)/43 Internet of Things (L5)	Unit 30	Application Development (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.

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: 603/0471/6

Approval date: 01 August 2017

Expiry date: 31 August 2022

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

- equipping individuals with knowledge, understanding and skills for success in employment in the Computing industry
- enabling progression to an undergraduate degree or further professional qualification in Computing or a related area
- developing a range of skills and techniques, personal qualities and attributes essential for successful performance in working life and thereby enabling learners to make an immediate contribution to employment
- providing flexibility, knowledge, skills and motivation as a basis for future studies and career development in Computing
- developing 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 requiring the exercise of personal responsibility and decision-making.

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 Managing a Successful Computing Project (Pearson-set)	15	4
Optional Unit	10 Website Design & Development	15	4
Optional Unit	11 Maths for Computing	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	13 Computing Research Project (Pearson-set)	30	5
Core Unit Mandatory	14 Business Intelligence	15	5
Optional Unit	15 Transport Network Design	15	5
Optional Unit	16 Cloud Computing	15	5
Optional Unit	19 Data Structures & Algorithms	15	5
Optional Unit	20 Advanced Programming/43 Internet of Things	15	5
Optional Unit	30 Application Development	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 faculties 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, schedule of work, digital library materials, reading assignments, and PowerPoint presentations for each of their units.

Course evaluation by students 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 committee meetings, held each semester, to discuss course issues and concerns is another way to support the student.

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* Managing a Successful Computing Project (Pearson-set) (L4) Unit 10 Website Design & Development (L4) Unit 11 Maths for Computing (L4)
Semester Three	Semester Four
Unit 13* Computing Research Project (Pearson-set) (L5) Unit 14* Business Intelligence (L5) Unit 19 Data Structures & Algorithms (L5) Unit 20 Advanced Programming (L5)/43 Internet of Things (L5)	Unit 13* Computing Research Project (Pearson-set) (L5) Unit 15 Transport Network Design (L5) Unit 16 Cloud Computing (L5) Unit 30 Application Development (L5)

Appendix B

Unit syllabus

Unit 1: Programming

Unit code	D/615/1618
Unit type	Core
Unit level	4
Credit value	15

Introduction

Programming involves describing processes and procedures which 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 is 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 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 & 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 within a suitable Integrated Development Environment (IDE). This IDE will be used to develop and help track any issues with the code.

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

Learning Outcomes

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

- LO1. 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, conduct an analysis of a suitable Integrated Development Environment (IDE).
- 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. Conduct an analysis of a suitable Integrated Development Environment (IDE)**

Characteristics of code:

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

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

LO3 **Implement basic algorithms in code using an IDE**

Implementation:

Developing simple applications which implements basic algorithms covered in LO1, using the features of a suitable language and IDE. Consider possible security concerns and how these could be solved.

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.

How the debugging process can be used to help developers fix vulnerabilities, defects and bugs in their code.

What a coding standard is and its 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 Examine the implementation of an algorithm in a suitable language. Evaluate the relationship between the written algorithm and the code variant.
P1 Provide a definition of what an algorithm is and outline the process in building an application.	M1 Determine the steps taken from writing code to execution.		
LO2 Explain the characteristics of procedural, object-orientated and event-driven programming, conduct an analysis of a suitable Integrated Development Environment (IDE)			D2 Critically evaluate the source code of an application which implements the programming paradigms, in terms of the code structure and characteristics.
P2 Give explanations of what procedural, object-orientated and event-driven paradigms are; their characteristics and the relationship between them.	M2 Analyse the common features that a developer has access to in an IDE.		
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.
P3 Write a program that implements an algorithm using an IDE.	M3 Use the IDE to manage the development process of the program.		
LO4 Determine the debugging process and explain the importance of a coding standard			D4 Critically evaluate why a coding standard is necessary in a team as well as for the individual.
P4 Explain the debugging process and explain the debugging facilities available in the IDE. P5 Outline the coding standard you have used in your code.	M4 Evaluate 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 this content – this decision can be made by the tutor.

Examples of languages that are used in industry are C#, Python, Ruby, Java, but any language which will allow the student 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: Advanced Programming

Unit 28: Prototyping

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

L01 Examine networking principles and their protocols

Role of networks:

Purpose, benefits, resource implications, communications, 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:

Logical e.g. Ethernet, Token Ring; physical e.g. star, ring, bus, mesh, tree, ring.

Protocols:

Purpose of protocols; routed protocols e.g. IPv4, IPv6, IPv6 addressing, Global unicast, Multicast, Link local, Unique local, EUI 64, Auto configuration, FTP, HTTP, SMTP, POP3, SSL; management of protocols for addressing.

L02 Explain networking devices and operations

Networking devices:

Servers; hub, routers; switches; multilayer switch, firewall, HIDS, repeaters; bridges; wireless devices; access point (wireless/wired), content filter, Load balancer, Modem, Packet shaper, VPN concentrator.

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; permissions; system bus; local-system architecture e.g. memory, processor, I/O devices.

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.

Networking services and applications:

DHCP; static vs dynamic IP addressing, reservations, scopes, leases, options (DNS servers, Suffixes), IP helper, DHCP relay, DNS records, Dynamic DNS.

Communications:

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

Scalable:

Able to support device growth, able to support addition of communication devices, able to cope with bandwidth use and trend changes, protocol utilisation, addressing.

Selection of components:

Supporting infrastructure needs; supporting connectivity requirements.

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.

System monitoring:

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

Maintenance schedule:

Backups, upgrades, security, auditing.

Diagnose and resolve layer 1 problems:

Framing, CRC, Runts, Giants, Dropped packets, late collisions, Input/Output errors.

Policy review:

Bandwidth, resource availability.

Learning Outcomes and Assessment Criteria

Pass		Merit	Distinction
LO1 Examine networking principles and their protocols			LO1 & 2 D1 Considering a given scenario, identify the topology protocol selected for the efficient utilisation of a networking system.
P1 Discuss the benefits and constraints of different network types and standards. P2 Explain the impact of network topology, communication and bandwidth requirements.	M1 Compare common networking principles and how protocols enable the effectiveness of networked systems.		
LO2 Explain networking devices and operations			
P3 Discuss the operating principles of networking devices and server types. P4 Discuss the inter-dependence of workstation hardware with relevant networking software.	M2 Explore a range of server types and justify the selection of a server, considering a given scenario regarding cost and performance optimisation.		
LO3 Design efficient networked systems			D2 Design a maintenance schedule to support the networked system.
P5 Design a networked system to meet a given specification. P6 Test and evaluate the design to meet the requirements and analyse user feedback.	M3 Install and configure network services and applications on your choice.		
LO4 Implement and diagnose networked systems			D3 Use critical reflection to evaluate own work and justify valid conclusions.
P7 Implement a networked system based on a prepared design. P8 Document and analyse test results against expected results.	M4 Recommend potential enhancements for the networked systems.		

Recommended Resources

Textbooks

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

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

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

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

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

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

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

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

Journals

The Institute of Engineering and Technology

Links

This unit links to the following related units:

Unit 8: Computer Systems Architecture

Unit 15: Transport Network Design

Unit 17: Network Security

Unit 35: Network Management

Unit 36: Client/Server Computing Systems

Unit 3: Professional Practice

Unit code	Y/615/1620
Unit type	Core
Unit level	4
Credit value	15

Introduction

The need to be effective as a communicator, critical thinker, analyser, team worker and interpreter is essential. Within the workplace these skills are needed on a daily basis to show proficiency in designated tasks as part of a job role. The development of academic competence, and also the continuation of life-long learning and Continuing Professional Development (CPD), is 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 necessary skills to enable task resolution and facilitate effective decision-making. Working with others in a group environment academically or within 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 and working towards various goals is an area that is encouraged in the workplace through the appraisals framework. In addition, professional development extends into higher levels of learning and the need to demonstrate effective research skills and academic reporting skills is also required.

Among the topics included in this unit are: the development of communication skills and communication literacy; the use of qualitative and quantitative data to demonstrate analysis, reasoning and critical thinking; and tasks that require the integration of others within a team-based scenario and planning and problem-solving.

On successful completion of this unit students will be able to demonstrate leadership skills through the dynamics of team working, and through reflective practice be able to evaluate the contributions made as an individual and also of others. As a result they will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

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

- LO1 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

L01 **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.

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.

L02 **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.

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 whether the problem was solved or not; measurement of solution against specification and desired outcomes; sustainability.

L03 **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/strategy; problem-solving and short-term development projects; flexibility/adaptability; team player.

Teams and team building:

Selecting team members e.g. specialist roles, skill and style/approach mixes; identification of team/work group roles; stages in team development e.g. team building, identity, loyalty, commitment to shared beliefs, team health evaluation; action planning; monitoring and feedback; coaching skills; ethics; effective leadership skills e.g. setting direction, setting standards, motivating, innovative, responsive, effective communicator, reliability, consistency.

L04 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 e.g. employment legislation, ethics, employment rights and responsibilities.

Performance objectives:

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

Continuing Professional Development: 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 (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:

Current performance; future needs; opportunities and threats to career progression; aims and objectives; achievement dates; review dates; learning programme/activities; action plans; personal development plans.

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 during the design and delivery of a training event.
P1 Demonstrate, using different communication styles and formats, that you can effectively design and deliver a training event for a given target audience. P2 Demonstrate that you have used effective time management skills in planning an event.	M1 Design a professional schedule to support the planning of an event, to include contingencies and justifications of time allocated.	
LO2 Apply critical reasoning and thinking to a range of problem-solving scenarios		D2 Critique the process of applying critical reasoning to a given task/activity or event.
P3 Demonstrate the use of different problem-solving techniques in the design and delivery of an event. P4 Demonstrate that critical reasoning has been applied to a given solution.	M2 Research the use of different problem-solving techniques used in the design and delivery of an event. M3 Justify the use and application of a range of solution methodologies.	
LO3 Discuss the importance and dynamics of working within a team and the impact of team working in different environments		D3 Provide a critical evaluation of your own role and contribution to a group scenario.
P5 Discuss the importance of team dynamics in the success and/or failure of group work. P6 Work within a team to achieve a defined goal.	M4 Analyse team dynamics, in terms of the roles group members play in a team and the effectiveness in terms of achieving shared goals.	
LO4 Examine the need for Continuing Professional Development (CPD) and its role within the workplace and for higher level learning		

Pass	Merit	Distinction
<p>P7 Discuss the importance of CPD and its contribution to own learning.</p> <p>P8 Produce a development plan that outlines responsibilities, performance objectives and required skills, knowledge and learning for own future goals.</p>	<p>M5 Compare and contrast different motivational theories and the impact they can have on performance within the workplace.</p>	<p>D4 Evaluate a range of evidence criteria that is used as a measure for effective CPD.</p>

Recommended Resources

Textbooks

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

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

Megginson, 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

Professional Development in Education

Websites

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

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

Links

This unit links to the following related units:

Unit 6: Managing a Successful Computing Project

Unit 13: Computing Research Project

Unit 4: Database Design & Development

Unit code	H/615/1622
Unit type	Core
Unit level	4
Credit value	15

Introduction

Organisations depend on their databases to provide information 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.

Database systems continue to demand more complex data structures and interfaces, as applications get increasingly sophisticated. 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 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, as well as to provide the practical skills to translate that understanding into the design and creation of complex databases.

Topics included in this unit are: examination of different design tools and techniques; examination of different development software options; considering 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 this 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 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.

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

L01 Use an appropriate design tool to design a relational database system for a substantial problem

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

Determining user and system requirements.

Design tools and techniques for a relational database system.

Logical design for relational databases e.g. tables, data elements, data types, indexes, primary/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.

L02 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.

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, drop down lists, option buttons.

User interface for requirements, functionality, reliability, consistency and performance.

Consideration of interface links 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.

L03 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.

L04 Produce technical and user documentation

Technical and user documentation and their contents.

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 Assess 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			LO2 & 3 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. P3 Implement a query language into the relational database system.	M2 Implement a fully functional database system which includes system security and database maintenance. M3 Assess whether meaningful data has been extracted through the use of query tools to produce appropriate management information.		
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.		
LO4 Produce technical and user documentation			D3 Assess any future improvements that may be required to ensure the continued effectiveness of the database system.
P5 Produce technical and user documentation.	M5 Produce technical and user documentation for a fully functional system, including diagrams showing movement of data through the system, 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.

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

Paulraj, P (2008). *Database Design and Development: An Essential Guide for IT Professional*. Wiley.

Stephens, R. (2008) *Beginning Database Design Solutions*. Wrox.

Journals

International Journal of Database Management Systems

Journal of Database Management

The Computer Journal

Journal of Systems Analysis and Software Engineering

Journal of Emerging Trends in Computing and Information Sciences

Websites

www.lynda.com Database Training (Tutorials)

mva.microsoft.com Microsoft Virtual Academy "Database Development" (Training)

mva.microsoft.com/ebooks Microsoft Virtual Academy "Microsoft Press" (E-Books)

Links

This unit links to the following related units:

Unit 7: Strategic Information Systems

Unit 38: Database Management Systems

Unit 5: Security

Unit code	K/615/1623
Unit type	Core
Unit level	4
Credit value	15

Introduction

Security is one of the most important challenges modern organisations face. Security 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 provide students with knowledge of security, associated risks and how security breaches impact on business continuity. Students will examine security measures involving access authorisation, regulation of use, implementing contingency plans and devising security policies and procedures.

This unit introduces students to the detection of threats and vulnerabilities in physical and IT security, and how to manage risks relating to organisational security.

Among the topics included in this unit are 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.

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

L01 Assess risks to IT security

IT security risks:

Risks: unauthorised use of a system; 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.

Organisational security: business continuance; backup/restoration of data; audits; testing procedures e.g. data, network, systems, operational impact of security breaches, WANs, intranets, wireless access systems.

L02 Describe IT security solutions

IT security solution evaluation:

Network Security infrastructure: evaluation of NAT, DMZ, FWs.

Network performance: RAID, Main/Standby, Dual LAN, web server balancing.

Data security: explain asset management, image differential/incremental backups, SAN servers.

Data centre: replica data centres, virtualisation, secure transport protocol, secure MPLS routing and remote access methods/procedures for third-party access.

Security vulnerability: logs, traces, honeypots, data mining algorithms, vulnerability testing.

L03 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; Data Protection Act; Computer Misuse Act; ISO 3001 standards.

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

L04 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, 3rd party access, business continuity, responsibility matrix.

Controlling security risk assessments and compliance with security procedures and standards e.g. ISO/IEC 17799:2005 Information Technology (Security Techniques – code of practice for information security management); informing colleagues of their security responsibilities and confirming their understanding at suitable intervals; using enterprise risk management for identifying, evaluating, implementing and follow up of security risks according to ISO 3001 standards.

Security: tools 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; penetration testing; ethical hacking; gathering and recording information on security; initiating suitable actions for remediation.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Assess risks to IT security		LO1 & 2 D1 Investigate how a 'trusted network' may be part of an IT security solution.
P1 Identify types of security risks to organisations. P2 Describe organisational security procedures.	M1 Propose a method to assess and treat IT security risks.	
LO2 Describe IT security solutions		
P3 Identify the potential impact to IT security of incorrect configuration of firewall policies and third-party VPNs. P4 Show, using an example for each, how implementing a DMZ, static IP and NAT in a network can improve Network Security.	M2 Discuss three benefits to implement network monitoring systems with supporting reasons.	
LO3 Review mechanisms to control organisational IT security		D2 Consider how IT security can be aligned with organisational policy, detailing the security impact of any misalignment.
P5 Discuss risk assessment procedures. P6 Explain data protection processes and regulations as applicable to an organisation.	M3 Summarise the ISO 31000 risk management methodology and its application in IT security. M4 Discuss possible impacts to organisational security resulting from an IT security audit.	
LO4 Manage organisational security		D3 Evaluate the suitability of the tools used in an organisational policy.
P7 Design and implement a security policy for an organisation. P8 List the main components of an organisational disaster recovery plan, justifying the reasons for inclusion.	M5 Discuss the roles of stakeholders in the organisation to implement security audit recommendations.	

Recommended Resources

Textbooks

Alexander, D. et al. (2008) *Information Security Management Principles*. BSC.

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 Pubs.

Websites

www.bcs.org	British Computer Society (General Reference)
www.bsa.org.uk	Business Software Alliance (General Reference)
www.fast.org.uk	Federation Against Software Theft (General Reference)
www.ico.gov.uk	Information Commissioners Office (General Reference)

Links

This unit links to the following related units:

Unit 17: Network Security

Unit 23: Cryptography

Unit 24: Forensics

Unit 25: Information Security Management

Unit 6: Managing a Successful Computing Project

Unit code	T/615/1625
Unit type	Core unit
Unit level	4
Credit value	15

Introduction

This unit is assessed by 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.

In order to ensure that client expectations are met in terms of requirements, deadlines and the estimated cost, the work to deliver new computer systems or services to business organisations, or to revamp the existing ones, is always organised in projects. Therefore, skilful, knowledgeable and experienced project managers have always been in demand. It is projected that 15.7 million new project management roles will be created around the world by 2020.

The aim of this unit is to offer students an opportunity to demonstrate the skills required for managing and implementing a project. They will undertake independent research and investigation for carrying out and executing a computing project which meets appropriate aims and objectives.

On successful completion of this unit students will have the confidence to engage in decision-making, problem-solving and research activities using project management skills. They will have the fundamental knowledge and skills to enable them to investigate and examine relevant computing concepts within 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:

- L01 Establish project aims, objectives and timeframes based on the chosen theme.
- L02 Conduct small-scale research, information gathering and data collection to generate knowledge to support the project.
- L03 Present the project and communicate appropriate recommendations based on meaningful conclusions drawn from the evidence findings and/or analysis.
- L04 Reflect on the value gained from conducting the project and its usefulness to support sustainable organisational performance.

Essential Content

L01 **Establish project aims, objectives and timeframes based on the chosen theme**

Project management:

What is project management and what does it involve?

The key stages of project management.

The advantages of using project management and why it is important.

Initiation of the project and project planning phase:

Scoping a project – defining objectives, scope, purpose and deliverables to be produced.

Steps and documentation required in the initiation phase.

Developing the project plan, including planning for timescales and time management, cost, quality, change, risk and issues.

The work breakdown structure.

Use of Bar and Gantt Charts for effective planning.

L02 **Conduct small-scale research, information gathering and data collection to generate knowledge to support the project**

Project execution phase:

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

The distinct phases which 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) is used to gather data (qualitative or quantitative).

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

Ethics, reliability and validity:

All research should be conducted ethically – how is this achieved and reported?

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

Analysing information and data:

Using data collection tools such as interviews and questionnaires.

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

LO3 Present the project and communicate appropriate recommendations based on meaningful conclusions drawn from the evidence findings and/or analysis

Communicating outcomes:

Consider the method (e.g. written, verbal) and the medium (e.g. report, online, presentation).

Both method and medium will be influenced by the project research and its intended audience.

Convincing arguments:

All findings/outcomes should be convincing and presented logically where the assumption is that the audience has little or no knowledge of the project process.

Developing evaluative conclusions.

Critical and objective analysis and evaluation:

Secondary and primary data should be critiqued and considered with an objective mindset.

Objectivity results in more robust evaluations where an analysis justifies a judgement.

LO4 Reflect on the value gained from conducting the project and its usefulness to support sustainable organisational performance

Reflection for learning and practice:

The difference between reflecting on performance and evaluating a project – the former considers the research process, information gathering and data collection, the latter the quality of the research argument and use of evidence.

The cycle of reflection:

To include reflection in action and reflection on action.

How to use reflection to inform future behaviour, particularly directed towards sustainable performance.

Reflective writing:

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

Generalisation:

Many studies result in generalised findings. Research which has its basis in a specific field such as Human Resource Management (HRM) and in a specific context should avoid generalised conclusions.

Outcomes should be specific and actionable.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<p>LO1 Establish project aims, objectives and timeframes based on the chosen theme</p>		<p>LO1 & 2</p> <p>D1 Critically evaluate the project management process and appropriate research methodologies applied.</p>
<p>P1 Devise project aims and objectives for a chosen scenario.</p> <p>P2 Produce a project management plan that covers aspects of cost, scope, time, quality, communication, risk and resources.</p> <p>P3 Produce a work breakdown structure and a Gantt Chart to provide timeframes and stages for completion.</p>	<p>M1 Produce a comprehensive project management plan, milestone schedule and project schedule for monitoring and completing the aims and objectives of the project.</p>	
<p>LO2 Conduct small-scale research, information gathering and data collection to generate knowledge to support the project</p>		
<p>P4 Carry out small-scale research by applying qualitative and quantitative research methods appropriate for meeting project aims and objectives.</p>	<p>M2 Evaluate the accuracy and reliability of different research methods applied.</p>	
<p>LO3 Present the project and communicate appropriate recommendations based on meaningful conclusions drawn from the evidence findings and/or analysis</p>		<p>LO3 & 4</p> <p>D2 Critically evaluate and reflect on the project outcomes, the decision-making process and changes or developments of the initial project management plan to support justification of recommendations and learning during the project.</p>
<p>P5 Analyse research and data using appropriate tools and techniques.</p> <p>P6 Communicate appropriate recommendations as a result of research and data analysis to draw valid and meaningful conclusions.</p>	<p>M3 Evaluate the selection of appropriate tools and techniques for accuracy and authenticity to support and justify recommendations.</p>	

Pass	Merit	Distinction
<p>LO4 Reflect on the value gained from conducting the project and its usefulness to support sustainable organisational performance</p>		
<p>P7 Reflect on the value of undertaking the research to meet stated objectives and own learning and performance.</p>	<p>M4 Evaluate the value of the project management process and use of quality research to meet stated objectives and support own learning and performance.</p>	

Additional Evidence Requirements

In addition to the above assessment criteria, students will also be required to complete a project logbook to record ideas, changes and developments as they progress and complete the project.

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
Qualitative Research Journal

Websites

www.gov.uk/government/publications

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

Links

This unit links to the following related units:

Unit 3: Professional Practice

Unit 13: Computing Research Project

Unit 14: Business Intelligence

Unit 34: Systems Analysis & Design

Unit 10: Website Design & Development

Unit code	R/615/1633
Unit level	4
Credit value	15

Introduction

Wireless, public hotspots, mobile broadband and unlimited network connections means 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 successfully use technology to deliver a high quality and consistent User Experiences (UX) through friendly and functional User Interfaces (UI). However, as the software and hardware evolves, so does the challenge of design.

This unit introduces students to the underpinning services required to host, manage and access a secure website before introducing and exploring the methods used by designers and developers to blend back-end technologies (server-side) with front-end technologies (client-side). To help ensure new designers are able to design and deliver a site that offers an outstanding User Experience (UX) supported by an innovative User Interface (UI) this unit also discusses the reasons, requirements, relationships, capabilities and features of the systems they will be using and gives them an opportunity to explore various tools, techniques and technologies with 'good design' principles 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 this unit students will be able to explain 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 they will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

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

- L01 Explain server technologies and management services associated with hosting and managing websites.
- L02 Categorise website technologies, tools and software used to develop websites.
- L03 Utilise website technologies, tools and techniques with good design principles to create a multipage website.
- L04 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, 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 regards 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:

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 standards and guidelines 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 guidelines to implement an appropriately branded, multipage site.

Discuss why and how the quality of content can affect the performance of a website.

L04 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
<p>LO1 Explain server technologies and management services associated with hosting and managing websites</p>		<p>LO1 & LO2 D1 Justify the tools and techniques chosen to realise a custom built website.</p>
<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 regards to designing, publishing and accessing a website.</p>	<p>M1 Evaluate the impact of common web development technologies and frameworks with regards 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>	
<p>LO2 Categorise website technologies, tools and software used to develop websites</p>		
<p>P3 Discuss the capabilities and relationships between front-end and back-end website technologies and explain how these relate to presentation and application layers.</p> <p>P4 Discuss the differences between online website creation tools and custom built sites with regards to design flexibility, performance, functionality, User Experience (UX) and User Interface (UI).</p>	<p>M3 Evaluate a range of tools and techniques available to design and develop a custom built website.</p>	

Pass	Merit	Distinction
<p>LO3 Utilise website technologies, tools and techniques with good design principles to create a multipage website</p>		<p>D2 Critically evaluate the design and development process against your design document and analyse any technical challenges.</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 your design document with appropriate principles, standards and guidelines to produce a branded, multipage website supported with realistic content.</p>	<p>M4 Compare and contrast the multipage website created to 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 Critically evaluate the results of your Test Plan and include a review of the overall success of your multipage website; use this evaluation to explain any areas of success and provide justified recommendations for areas that require improvement.</p>
<p>P7 Create a suitable Test Plan identifying key performance areas and use it to review the functionality and performance of your website.</p>	<p>M5 Evaluate the Quality Assurance (QA) process and review how it was implemented during your design and development stages.</p>	

Recommended Resources

Textbooks

Frain, B. (2012) *Responsive Web Design with HTML5 and CSS*. 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.

Links

This unit links to the following related units:

Unit 40: User Experience & Interface Design

Unit 11: Maths for Computing

Unit code	D/615/1635
Unit level	4
Credit value	15

Introduction

In 1837 English mathematicians Charles Babbage and Ada Lovelace collaboratively described a machine that could perform arithmetical operations and store data within memory units. This design of their 'Analytical Engine' is the first representation of modern, general-purpose computer technology. Although modern computers have advanced far beyond Babbage and Lovelace's initial proposal, they are still fundamentally relying on mathematics for their design and operation.

This unit introduces students to the mathematical principles and theory that underpin the computing curriculum. Through a series of case studies, scenarios and task-based assessments students will explore number theory within a variety of scenarios; use applicable probability theory; apply geometrical and vector methodology; and finally evaluate problems concerning differential and integral calculus.

Among the topics included in this unit are: prime number theory, sequences and series, probability theory, geometry, differential calculus and integral calculus.

On successful completion of this unit students will be able to gain confidence with the relevant mathematics needed within other computing units. As a result they will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

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

- LO1 Use applied number theory in practical computing scenarios.
- LO2 Analyse events using probability theory and probability distributions.
- LO3 Determine solutions of graphical examples using geometry and vector methods.
- LO4 Evaluate problems concerning differential and integral calculus.

Essential Content

L01 Use applied number theory in practical computing scenarios

Number theory:

Converting between number bases (Denary, Binary, Octal, Duodecimal and Hexadecimal).

Prime numbers, Pythagorean triples and Mersenne primes.

Greatest common divisors and least common multiples.

Modular arithmetic operations.

Sequences and series:

Expressing a sequence recursively.

Arithmetic and geometric progression theory and application.

Summation of series and the sum to infinity.

L02 Analyse events using probability theory and probability distributions

Probability theory:

Calculating conditional probability from independent trials.

Random variables and the expectation of events.

Applying probability calculations to hashing and load balancing.

Probability distributions:

Discrete probability distribution of the binomial distribution.

Continuous probability distribution of the normal (Gaussian) distribution.

L03 Determine solutions of graphical examples using geometry and vector methods

Geometry:

Cartesian co-ordinate systems in two dimensions.

Representing lines and simple shapes using co-ordinates.

The co-ordinate system used in programming output device.

Vectors:

Introducing vector concepts.

Cartesian and polar representations of a vector.

Scaling shapes described by vector co-ordinates.

LO4 Evaluate problems concerning differential and integral calculus

Differential calculus:

Introduction to methods for differentiating mathematical functions.

The use of stationary points to determine maxima and minima.

Using differentiation to assess rate of change in a quantity.

Integral calculus:

Introducing definite and indefinite integration for known functions.

Using integration to determine the area under a curve.

Formulating models of exponential growth and decay using integration methods.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Use applied number theory in practical computing scenarios		D1 Produce a detailed written explanation of the importance of prime numbers within the field of computing.
P1 Calculate the greatest common divisor and least common multiple of a given pair of numbers. P2 Use relevant theory to sum arithmetic and geometric progressions.	M1 Identify multiplicative inverses in modular arithmetic.	
LO2 Analyse events using probability theory and probability distributions		D2 Evaluate probability theory to an example involving hashing and load balancing.
P3 Deduce the conditional probability of different events occurring within independent trials. P4 Identify the expectation of an event occurring from a discrete, random variable.	M2 Calculate probabilities within both binomially distributed and normally distributed random variables.	
LO3 Determine solutions of graphical examples using geometry and vector methods		D3 Construct the scaling of simple shapes that are described by vector co-ordinates.
P5 Identify simple shapes using co-ordinate geometry. P6 Determine shape parameters using appropriate vector methods.	M3 Evaluate the co-ordinate system used in programming a simple output device.	
LO4 Evaluate problems concerning differential and integral calculus		D4 Justify, by further differentiation, that a value is a minimum.
P7 Determine the rate of change within an algebraic function. P8 Use integral calculus to solve practical problems involving area.	M4 Analyse maxima and minima of increasing and decreasing functions using higher order derivatives.	

Recommended Resources

Textbooks

Stroud, K. A. (2009) *Foundation Mathematics*. Basingstoke: Palgrave Macmillan.

Journals

Journal of Computational Mathematics. Global Science Press.

Links

This unit links to the following related units:

Unit 18: Discrete Maths

Unit 22: Applied Analytical Models

Unit 13: Computing Research Project

Unit code	T/615/1639
Unit type	Core
Unit level	5
Credit value	30

Introduction

This unit is assessed by 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 offer students the opportunity to engage in sustained research in a specific field of study. The unit enables students 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. The unit also encourages students to reflect on their engagement in the research process during which recommendations for future, 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 which are part of the function of a manager. Students will have the fundamental knowledge and skills to enable them to investigate workplace issues and problems, determine appropriate solutions and present evidence to various stakeholders in an acceptable and understandable format.

As a result they will develop 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

L01 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's 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:

Key theoretical frameworks for research.

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

L02 Conduct and analyse research relevant for a business research project

Research as a process:

Research has distinct phases which support a coherent and logical argument. This includes using secondary research to inform a primary, empirical, study.

Selecting a sample:

The importance of gathering 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 sampling.

Ethics, reliability and validity:

Research should be conducted ethically. How is this achieved and reported?

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

Analysing data:

Using data collection tools such as interviews and questionnaires.

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

LO3 Communicate the outcomes of a research project to identified stakeholders

Stakeholders:

Who are they?

Why would they be interested in the research outcomes?

What communication method do they expect?

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.

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
<p>LO1 Examine appropriate research methodologies and approaches as part of the research process</p>		<p>LO1 & LO2</p> <p>D1 Critically evaluate research methodologies and processes in application to a computing research project to justify chosen research methods and analysis.</p>
<p>P1 Produce a research proposal that clearly defines a research question or hypothesis supported by a literature review.</p> <p>P2 Examine appropriate research methods and approaches to primary and secondary research.</p>	<p>M1 Evaluate different research approaches and methodology and make justifications for the choice of methods selected based on philosophical/theoretical frameworks.</p>	
<p>LO2 Conduct and analyse research relevant for a business research project</p>		
<p>P3 Conduct primary and secondary research using appropriate methods for a computing research project that consider costs, access and ethical issues.</p> <p>P4 Apply appropriate analytical tools, analyse research findings and data.</p>	<p>M2 Discuss merits, limitations and pitfalls of approaches to data collection and analysis.</p>	
<p>LO3 Communicate the outcomes of a research project to identified stakeholders</p>		<p>D2 Communicate critical analysis of the outcomes and make valid, justified recommendations.</p>
<p>P5 Communicate research outcomes in an appropriate manner for the intended audience.</p>	<p>M3 Coherently and logically communicate outcomes to the intended audience demonstrating how outcomes meet set research objectives.</p>	

Pass	Merit	Distinction
<p>LO4 Reflect on the application of research methodologies and concepts</p>		<p>D3 Demonstrate reflection and engagement in the resource process leading to recommended actions for future improvement.</p>
<p>P6 Reflect on the effectiveness of research methods applied for meeting objectives of the computing research project.</p> <p>P7 Consider alternative research methodologies and lessons learnt in view of the outcomes.</p>	<p>M4 Provide critical reflection and insight that results in recommended actions for improvements and future research considerations.</p>	

Recommended Resources

Textbooks

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

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

Fink, A. (2009) *Conducting Research Literature Reviews: From the Internet to Paper*. 3rd Ed. Sage Inc.

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.

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 Journal

Links

This unit links to the following related units:

Unit 3: Professional Practice

Unit 6: Managing a Successful Computing Project

Unit 9: Software Development Lifecycles

Unit 14: Business Intelligence

Unit code	M/615/1641
Unit type	Core
Unit level	5
Credit value	15

Introduction

Data and information is core to any organisation and business process. The necessity of having meaningful information is the key driver for effective decision-making and problem-solving. Business intelligence has evolved from technologies such as decision support systems (DSS) to include tools and methods associated with data mining, data integration, data quality and data warehousing in conjunction with other information management systems and applications.

This unit introduces students to a range of tools, techniques and technologies for acquiring data and processing this into meaningful information that can be used to support business functions and processes.

Within this unit students will examine the concept of business processing in terms of data capture, conversion and information output. Students will also be required to define the tools and technologies associated with business intelligence functionality. The use of a business intelligence tool/s and techniques is also required to demonstrate an understanding of a given problem. Finally, students will be expected to evaluate the impact of business intelligence for effective decision-making.

On successful completion of this unit students will be able to appreciate the importance of business intelligence in terms of optimising decision-making and performance. By exploring the tools, techniques and systems that support business intelligence students will have an awareness of the role and contribution that these technologies and methodologies have and their importance to organisations.

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

Learning Outcomes

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

- LO1 Discuss business processes and the mechanisms used to support business decision-making.
- LO2 Compare the tools and technologies associated with business intelligence functionality.
- LO3 Demonstrate the use of business intelligence tools and technologies.
- LO4 Discuss the impact of business intelligence tools and technologies for effective decision-making purposes and the legal/regulatory context in which they are used.

Essential Content

L01 **Discuss business processes and the mechanisms used to support business decision-making**

Business process model:

Data input and capture, data processing/conversion and information output, security considerations; unstructured and semi-structured data.

Tactical and operational decisions, the business process model, business intelligence functionality.

Analyse and compare the systems and technologies associated with business intelligence.

Mechanisms:

Application software, databases, which are used to collect and store intelligence.

Systems that are used to manage, analyse and display business intelligence to support the decision-making process; the importance of reliable data; impacts of reliable data in businesses.

Business processes:

Management e.g. supporting decision-making, problem-solving; operational e.g. sales, purchasing and marketing; support e.g. accounting, technical supporting processes; improving the efficiency of a business process e.g. forecasting, decision-making, predictive reasoning; automating processes e.g. print runs, salary slips etc.

L02 **Compare the tools and technologies associated with business intelligence functionality**

Support for business decisions:

Operational tactical and strategic. Operational examples could include product positioning or pricing. Tactical decisions could include financial outlays to gain competitive advantage. Strategic business decisions could include priorities, goals setting and forecasting for the future, global diversification etc.

Business intelligence functionality:

Analysing data, decision-making, problem-solving, designing more intuitive/innovative systems.

Systems and technologies:

Information systems at an operational, tactical and strategic level. Transaction processing, management information systems, decision support systems, expert systems.

L03 Demonstrate the use of business intelligence tools and technologies

Tools and techniques:

Descriptive and predictive analysis, predictive modelling e.g. forecasting, use of statistical models to predict and identify trends. Data mining techniques to find anomalies, cluster patterns and/or relationships between data sets. Converting data into visual information using charts, graphs, histograms and other visual mediums.

Solutions:

Supporting a business process e.g. end user requirements, systems requirement, application to automate procedures. Designing a tool, program or package that can perform a specific task to support problem-solving or decision-making at an advanced level.

Uses:

For example, designing an application to solve a specific user need or system requirement. Create an e-commerce function for a website to support a specific business process, design a program for a specific end user that will support another application or process.

Design considerations:

Addressing a user or system requirement; designing a user-friendly and functional interface; considering user engagement and interaction with the designed solution; customisation of the solution to satisfy the user and system requirements.

L04 Discuss the impact of business intelligence tools and technologies for effective decision-making purposes and the legal/regulatory context in which they are used

Recognise the legal, social, ethical and professional issues involved in the exploitation of computer technology.

Cybersecurity management:

Understanding the personal, organisational and legal/regulatory context in which these tools could be used, the risks of such use and the constraints (such as time, finance and people) that may affect how cybersecurity is implemented.

Evaluation criteria:

Enhanced or improved operations e.g. more efficient, faster results, more user-friendly, higher productivity, extended target audience, more competitive, more profitable, improved customer service.

Learning Outcomes and Assessment Criteria

Pass		Merit	Distinction
LO1 Discuss business processes and the mechanisms used to support business decision-making			D1 Evaluate the benefits and drawbacks of using application software as a mechanism for business processing.
P1 Examine, using examples, the terms 'Business Process' and 'Supporting Processes'.	M1 Differentiate between unstructured and semi-structured data within an organisation.		
LO2 Compare the tools and technologies associated with business intelligence functionality			D2 Compare and contrast a range of information systems and technologies that can be used to support organisations at operational, tactical and strategic levels.
P2 Compare the types of support available for business decision-making at varying levels within an organisation.	M2 Justify, with specific examples, the key features of business intelligence functionality.		
LO3 Demonstrate the use of business intelligence tools and technologies			D3 Provide a critical review of the design in terms of how it meets a specific user or business requirement and identify what customisation has been integrated into the design.
P3 Determine, with examples, what business intelligence is and the tools and techniques associated with it. P4 Design a business intelligence tool, application or interface that can perform a specific task to support problem-solving or decision-making at an advanced level.	M3 Customise the design to ensure that it is user-friendly and has a functional interface.		

Pass	Merit	Distinction
<p>LO4 Discuss the impact of business intelligence tools and technologies for effective decision-making purposes and the legal/regulatory context in which they are used</p>		
<p>P5 Discuss how business intelligence tools can contribute to effective decision-making.</p> <p>P6 Explore the legal issues involved in the secure exploitation of business intelligence tools.</p>	<p>M4 Conduct research to identify specific examples of organisations that have used business intelligence tools to enhance or improve operations.</p>	

Recommended Resources

Textbooks

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

Jeston, J. and Nelis, J. (2014) *Business Process Management*. 3rd Ed. Routledge.

Kolb, J. (2013) *Business Intelligence in Plain Language: A practical guide to Data Mining and Business Analytics*. CreateSpace Independent Publishing Platform.

Marr, B. (2015) *Big Data: Using Smart Big Data, Analytics and Metrics to Make Better Decisions and Improve Performance*. 1st Ed. John Wiley & Sons, Ltd.

Journals

International Journal of Business Intelligence and Data Mining

International Journal of Business Intelligence Research (IJBIR)

Websites

businessintelligence.com Business Intelligence (General Reference)

business-intelligence.ac.uk Business Intelligence Project for HE
(General Reference)

Links

This unit links to the following related units:

Unit 6: Managing a Successful Computing Project

Unit 12: Data Analytics

Unit 22: Applied Analytical Models

Unit 33: Analytical Methods

Unit 15: Transport Network Design

Unit code	T/615/1642
Unit level	5
Credit value	15

Introduction

The exponential growth of the World Wide Web has put unprecedented demands on private and public networking infrastructures. The traffic generated by private and commercial networks has become dominated by Voice-over-IP and video on demand. These developments require existing infrastructures to be adapted and that the design of new networks mitigate best-effort delivery issues, avoid low bandwidths and high latency problems and be based on traffic priority. In order for enterprise networks and internet infrastructures to meet expected demands, 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 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 the 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, the students are expected to apply network design principles in the design and implementation of redundant networks to provide Layer 2 and Layer 3 redundant solutions. The students are also expected to evaluate Wide Area Network (WAN) technologies and make choices based on specific enterprise requirements, and to implement a range of WAN connections and protocols such as Point-to-Point, Frame Relay and VPN with IPSec using network simulators or network lab equipment. In addition, 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, 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 they will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

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

- LO1 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

L01 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).

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.

L02 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 modularity, stackability, port density, multi-layer switching and router requirements in the selection process.

Configuring LAN devices:

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

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.

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, latency, QoS, 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.

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: analyse, compare and configure Syslog, Network Time Protocol (NTP), NetFlow and Simple Network Management Protocol (SNMP).

Network troubleshooting: establishing network baselines, troubleshooting methods with a systematic approach, 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, denying and allowing errors, ACL misconfigurations, NAT, DNS and DHCP related issues.

Learning Outcomes and Assessment Criteria

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

Pass	Merit	Distinction
<p>LO3 Produce an appropriate WAN solution to a set of organisational requirements</p>		<p>LO3 & 4</p> <p>D2 Evaluate troubleshooting methods and their effectiveness in solving enterprise-wide networking issues.</p>
<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 Evaluate features and benefits of different VPN types based on organisational needs.</p>	
<p>LO4 Solve a range of network related problems using appropriate troubleshooting techniques and methods</p>		
<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.

Links

This unit links to the following related units:

Unit 2: Networking

Unit 8: Computer Systems Architecture

Unit 17: Network Security

Unit 35: Network Management

Unit 36: Client/Server Computing Systems

Unit 16: Cloud Computing

Unit code	F/615/1644
Unit level	5
Credit value	15

Introduction

Cloud Computing has revolutionised the way IT services are delivered and has become an important part of the computing sector. Cloud Computing is internet-hosted computing, which means it uses the internet to deliver data and other IT services such as storage, printing, server facilities and so forth. In other words, the end users or organisations no longer need to have their own extensive network environment on the premises, but can get the same services provided virtually over the internet.

The fundamental difference between traditional networking and Cloud Computing is that the technical details of the system are hidden from the end user. That means the networking infrastructure does not have to be on the premises as it would be hosted off-site in the cloud. However, the end user can use the services without the fear of technical difficulties or disasters as it would be managed by the cloud service provider. Cloud Computing is a natural evolution of networking and is adapting the modern network-oriented technologies such as virtualisation, service-oriented architecture, utility computing and ubiquitous computing among others.

This unit is designed to develop an understanding of the fundamental concept of Cloud Computing, cloud segments, and cloud deployment models, the need for Cloud Computing, an appreciation of issues associated with managing cloud service architecture and to develop a critical awareness of Cloud Computing based projects.

Topics included in the unit are the paradigms of networking, fundamentals of Cloud Computing, Cloud Computing architecture, deployment models, service models, security, technological drivers, and cloud service providers.

On successful completion of this unit, students will understand the concept, architecture, and services of Cloud Computing and will gain hands-on experience of configuring a cloud service from major providers such as ECM, Google, Amazon, Microsoft, IBM etc., and implementing a simple cloud platform using open source software with an appropriate networking platform.

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. Demonstrate an understanding of the fundamentals of Cloud Computing and its architectures.
- LO2. Evaluate the deployment models, service models and technological drivers of Cloud Computing and validate their use.

- LO3. Develop Cloud Computing solutions using service provider's frameworks and open source tools.
- LO4. Analyse the technical challenges for cloud applications and assess their risks.

Essential Content

L01 **Demonstrate an understanding of the fundamentals of Cloud Computing and its architectures**

Networking Paradigm: Peer-to-peer Computing, Client-Server Computing, Distributed Computing, Cluster Computing, High-Performance Computing, Parallel Computing, Grid Computing

Cloud Computing Fundamentals: What is cloud computing? Definition of Cloud Computing, Principles of Cloud Computing, Cloud Ecosystem, Cloud Architecture, Network Connectivity in Cloud Computing, Managing the Cloud, Migrating Application to Cloud

L02 **Evaluate the deployment models, service models and technological drivers of Cloud Computing and validate their use**

Deployment models:

Private Cloud, Public Cloud, Community Cloud, Hybrid Cloud.

Service models:

IaaS, PaaS, SaaS, AaaS.

Technological drivers:

SOA, Virtualisation, Multicore Technology, Memory and Storage Technology, Networking Technology, Web 2.0, & 3.0, Software Process Models for Cloud, Programming Models, Pervasive Computing, Application Environment.

L03 **Develop Cloud Computing solutions using service provider's frameworks and open source tools**

Cloud Service Providers:

EMC, Google, Amazon Web Services, Microsoft, IBM, VMware.

Open Source:

Open Source Tools for IaaS, Open Source Tools for PaaS, Open Source Tools for SaaS, Distributed Computing Tools: Cassandra, Hadoop, MongoDB, NGrid, Ganglia.

LO4 Analyse the technical challenges for cloud applications and assess their risks

Security aspects:

Data Security, Virtualisation, Network Security.

Platform related security:

SaaS Security issues, PaaS Security Issues, IaaS Security Issues, Audit and Compliance.

Learning Outcomes and Assessment Criteria

Pass		Merit	Distinction
LO1 Demonstrate an understanding of the fundamentals of Cloud Computing and its architectures			LO1 & LO2 D1 Justify the tools chosen to realise a Cloud Computing solution.
P1 Analyse the evolution and fundamental concepts of Cloud Computing. P2 Design an appropriate architectural Cloud Computing framework for a given scenario.	M1 Discuss why an organisation should migrate to a Cloud Computing solution.		
LO2 Evaluate the deployment models, service models and technological drivers of Cloud Computing and validate their use			
P3 Define an appropriate deployment model for a given scenario. P4 Compare the service models for choosing an adequate model for a given scenario.	M2 Demonstrate these deployment models with real world examples.		
LO3 Develop Cloud Computing solutions using service provider's frameworks and open source tools			D2 Critically discuss how one can overcome these issues and constraints.
P5 Configure a Cloud Computing platform with a cloud service provider's framework. P6 Implement a cloud platform using open source tools.	M3 Discuss the issues and constraints one can face during the development process.		

Pass	Merit	Distinction
<p>LO4 Analyse the technical challenges for cloud applications and assess their risks</p>		<p>D3 Critically discuss how an organisation should protect their data when they migrate to a cloud solution.</p>
<p>P7 Analyse the most common problems which arise in a Cloud Computing platform and discuss appropriate solutions to these problems.</p> <p>P8 Assess the most common security issues in cloud environments.</p>	<p>M4 Discuss how to overcome these security issues when building a secure cloud platform.</p>	

Recommended Resources

Textbooks

Chandrasekaran, K. (2015) *Essentials of Cloud Computing*, CRC Press.

Kapadia, A., Varma, S. and Rajana, K. (2014) *Implementing Cloud Storage with OpenStack*. Packt Publishing.

Patawari, A. (2013) *Getting Started with own Cloud*. Packt Publishing.

Rhoton, J. and De Clercq, J. (2014) *OpenStack Cloud Computing: Architecture*, Recursive Press.

Thomas Eri, T. and Ricardo Puttin, R. (2013) *Cloud Computing: Concept, Technology and Architecture*. Prentice Hall.

Zhu, S-Y. and Hill, R. (2016) *Guide to Security Assurance for Cloud Computing*, Springer.

Links

This unit links to the following related units:

Unit 48: Systems Integration

Unit 19: Data Structures & Algorithms

Unit code	D/615/1649
Unit level	5
Credit value	15

Introduction

The knowledge 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 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. The unit introduces the specification of abstract data types and explores their use in concrete data structures. Based on 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 the student 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 of studying this unit students will develop 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 & conquer, branch & 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:

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.

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 and, with justification, state whether you agree.
<p>P3 Using an imperative definition, specify the abstract data type for a software stack.</p>	<p>M3 Examine the advantages of encapsulation and information hiding when using an ADT.</p>		
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>		

Pass	Merit	Distinction
<p>LO4 Assess the effectiveness of data structures and algorithms</p>		<p>D4 Evaluate three benefits of using implementation independent data structures.</p>
<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. (1990) *Introduction to Algorithms*. MIT Labs.
- Cormen, T. (2002) *Instructors Manual: Introduction to Algorithms*. MIT Labs.
- Heineman, G. (2009) *Algorithms in a Nutshell*. O'Reilly Publishing.
- Larmouth, J. (1999) *ASN.1 Complete*. Kaufman Publishing.
- Leiss, E. (2007) *A Programmer's Companion to Algorithm Analysis*. Chapman & Hall.
- Sedgewick, R. (1983) *Algorithms*. Addison-Wesley.
- Wirth, N. (2004) *Algorithms and Data Structures*. Oberon.

Links

This unit links to the following related units:

Unit 1: Programming

Unit 20: Advanced Programming

Unit 23: Cryptography

Unit 20: Advanced Programming

Unit code Y/615/1651

Unit level 5

Credit value 15

Introduction

Features of programming languages that are considered advanced are used to develop software that is efficient; it can affect the performance of an application as well as the readability and extensibility of the code, improving productivity and therefore reducing cost. Many commercial applications available today, whether for productivity or entertainment, will have used one or more design pattern in their development. A design pattern is a description of how to solve a problem that can be used in many different situations and can help deepen the understanding of object-orientated programming and help improve software design and reusability.

The aim of this unit is to familiarise students with these features and their best practices to ensure that their code is in line with industry standards.

Among the topics included in this unit are: object-orientated programming; polymorphism, encapsulation, class aggregation/association, constructors/destructors, inheritance, abstract classes, interfaces, containers, generics, introduction to design patterns and Unified Modelling Language (UML).

On successful completion of this unit students will be able to write code in an object-orientated fashion using design patterns where necessary and be able to model their code structure in UML class diagrams. As a result they will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

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

- LO1. Examine the key components related to the object-orientated programming paradigm, analysing design pattern types.
- LO2. Design a series of UML class diagrams.
- LO3. Implement code applying design patterns.
- LO4. Investigate scenarios with respect to design patterns.

Essential Content

L01 **Examine the key components related to the object-orientated programming paradigm, analysing design pattern types**

Outline the object-orientated paradigm characteristics:

Encapsulation, polymorphism, constructors/destructors, sub objects, abstract/concrete, interface, method redefinition, generics/templates, containers.

Object-orientated class relationships:

Generalisation/inheritance, realisation, dependency, aggregation, composition.

Design patterns:

Creational, structural and behavioural.

L02 **Design a series of UML class diagrams**

UML class design:

Analyse a code scenario and utilise a suitable UML tool to develop class diagrams.

L03 **Implement code applying design patterns**

Implementation:

Using an appropriate language & IDE to develop code that implements design patterns and utilises techniques to produce secure code.

L04 **Investigate scenarios with respect to design patterns**

Review the usage of design patterns:

Relating design patterns to a range of given scenarios

Learning Outcomes and Assessment Criteria

Pass		Merit	Distinction
LO1 Examine the key components related to the object-orientated programming paradigm, analysing design pattern types			D1 Analyse the relationship between the object-orientated paradigm and design patterns.
P1 Examine the characteristics of the object-orientated paradigm as well as the various class relationships.	M1 Determine a design pattern from each of the creational, structural and behavioural pattern types.		
LO2 Design a series of UML class diagrams			D2 Define/refine class diagrams derived from a given code scenario using a UML tool.
P2 Design and build class diagrams using a UML tool.	M2 Define class diagrams for specific design patterns using a UML tool.		
LO3 Implement code applying design patterns			D3 Evaluate the use of design patterns for the given purpose specified in M3.
P3 Build an application derived from UML class diagrams.	M3 Develop code that implements a design pattern for a given purpose.		
LO4 Investigate scenarios with respect to design patterns			D4 Critically evaluate a range of design patterns against the range of given scenarios with justification of your choices.
P4 Discuss a range of design patterns with relevant examples of creational, structural and behavioural pattern types.	M4 Reconcile the most appropriate design pattern from a range with a series of given scenarios.		

Recommended Resources

Textbooks

Freeman, E. et al. (2008) *Head First Design Patterns*. 4th Ed. United States of America: O'Reilly Media.

Gamma, E. et al. (1995) *Design Patterns: Elements of Reusable Object-Oriented Software*. 1st Ed. New Jersey: Addison-Wesley.

McLaughlin, B.D. et al. (2007). *Head First Object-Oriented Analysis and Design*. 1st Ed. United States of America: O'Reilly Media.

Links

This unit links to the following related units:

Unit 1: Programming

Unit 19: Data Structures & Algorithms

Unit 28: Prototyping

Unit 41: Analytic Architecture Design

Unit 30: Application Development

Unit code	H/615/1670
Unit level	5
Credit value	15

Introduction

Software drives business and developers drive software – the world is reliant on software, and programming is at the heart of this. Professionalism and critical thinking, supported by an ability to work independently and as part of a team are core skills of a developer. If you can think logically and you enjoy exploring and dismantling problems, working with others to consider requirements and creating ideas and possible solutions you can gain the experience and learn the skills needed to excel as an Application Developer.

This unit introduces students to Application Development and 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. On completion, students will be expected to formally evaluate their final application against their design plans and initial requirements.

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; Unified Modelling Language (UML), 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, select and use design and development methodologies with tools and techniques associated with the creation of a business application, 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 they will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

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

- LO1. Produce a Software Design Document by analysing a business-related problem and deduce an appropriate solution including a set of initial requirements.
- LO2. Use design and development methodologies with tools and techniques associated with the creation of a business application.
- LO3. Work individually and as part of a team to 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

L01 **Produce a Software Design Document by analysing a business-related problem and deduce an appropriate solution including a set of initial requirements**

Analyse a business-related problem and assess possible solutions:

Discuss and produce a problem definition statement to highlight and describe the issues that need to be addressed.

Research and consider possible solutions and predict the overall success of the application.

Produce a Software Design Document:

Review and discuss the value of Software Design Documents with regards to application development.

Evaluate your possible solutions and synthesise the ideas into a single document that identifies and attempts to solve the business-related problem.

Research and use information relating to software testing to create a suitable test plan for your business application.

L02 **Use design and development methodologies with tools and techniques associated with the creation of a business application**

Discuss different design and development methodologies:

Present overviews on current design and development methodologies.

Debate various strengths and weaknesses commonly associated with each methodology.

Select or synthesise a design and development methodology for use with the creation of your application.

Consider the security implications of design and development methodologies.

Use appropriate tools and techniques:

Evaluate different tools and techniques available to create a business application.

Debate the advantages and disadvantages of your preferred or selected tools and techniques.

L03 Work individually and as part of a team to plan and produce a functional business application with support documentation

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

Peer-review and debate your development plan by effectively communicating and defending the ideas in your Software Design Document.

Discuss differences with regards to the possible strengths and weakness of each Software Design Document.

Modify your Software Design Document to reflect any new insights or considerations.

Prepare and produce a functional business application:

Use your Software Design Document with your preferred design and development methodology and your selected tools and techniques to develop a functional business application.

Create and quality check appropriate support documents for your application.

L04 Evaluate the performance of a business application against its Software Design Document and initial requirements

Assess the performance of a business application:

Analyse factors that influence the performance of a business application with regard to its system requirements.

Undertake a critical review of the performance and development of your application against all identified factors and any adopted design and development methodologies.

Measure the overall success of the application against your original prediction and identify any new areas of personal insight.

Plan improvements to a business application:

Evaluate the overall strengths and weaknesses of your business application against its Software Design Document and initial requirements.

Discuss and plan in detail possible revisions (including implementation) with regard to improving your application's performance.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<p>LO1 Produce a Software Design Document by analysing a business-related problem and deduce an appropriate solution including a set of initial requirements</p>		<p>LO1 & LO2</p> <p>D1 Justify the tools and techniques chosen to realise a custom built website. Justify your preferred selection of tools and techniques in deducing an appropriate solution to a business related problem.</p>
<p>P1 Explore a business-related problem and produce a well-defined Problem Definition Statement supported by a set of user and system requirements.</p> <p>P2 Determine any areas of risk related to the successful completion of your application.</p>	<p>M1 Analyse a business-related problem using appropriate methods and produce a well-structured Software Design Document that defines a proposed solution and includes relevant details on requirements, system analysis, system design, coding, testing and implementation.</p>	
<p>LO2 Use design and development methodologies with tools and techniques associated with the creation of a business application</p>		
<p>P3 Research the use of software development tools and techniques and identify any that have been selected for the development of this application.</p>	<p>M2 Compare the differences between the various software development tools and techniques researched and justify your preferred selection as well as your preferred software development methodology.</p>	
<p>LO3 Work individually and as part of a team to plan and produce a functional business application with support documentation</p>		<p>D2 Evaluate any new insights, ideas or potential improvements to your system and justify the reasons why you have chosen to include (or not to include) them as part of this business application.</p>
<p>P4 Create a formal presentation that effectively reviews your business application, problem definition statement, proposed solution and development strategy. Use this presentation as part of a peer-review and document any feedback given.</p>	<p>M3 Interpret your 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>	

Pass	Merit	Distinction
<p>P5 Develop a functional business application based on a specified business problem.</p>		
<p>LO4 Evaluate the performance of a business application against its Software Design Document and initial requirements</p>		
<p>P6 Review the performance of your business application against the Problem Definition Statement and initial requirements.</p>	<p>M5 Analyse the factors that influence the performance of a business application and use them to undertake a critical review of the design, development and testing stages of your application. Conclude your review by reflectively discussing your previously identified risks.</p>	<p>D3 Critically evaluate the strengths and weaknesses of your business application and fully justify opportunities for improvement and further development.</p>

Recommended Resources

Textbooks

Carmen, 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: Managing a Successful Computing Project

Unit 9: Software Development Lifecycles

Unit 43: Internet of Things

Unit code T/615/1690

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 these 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 the student's 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 problem IoT applications solves; the potential impact on society, business and the end user and the problems encountered when integrating into the wider IoT ecosystem.

As a result they will develop skills such as communication literacy, design thinking, team working, critical thinking, analysis, reasoning and interpretation, 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 detail the problem your IoT application solves, the potential impact on people, business, society and the end user and the problems it might encounter when integrating into the wider IoT ecosystem.

Essential Content

L01 Analyse what aspects of IoT are necessary and appropriate when designing software applications

Identify role, formats and characteristics of IoT:

Present an overview of IoT and its appropriate use in software development.

Investigate what IoT is by researching its role, purpose, terminology and methodology.

Recognise the various forms of IoT by researching its history, current trends and use in relation to, and 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.

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.

Appropriateness of various architecture, frameworks, tools, hardware and APIs for different problem-solving requirements.

L02 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 this problem:

Choose a specific problem to solve using IoT.

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

Review different architecture, frameworks, tools, hardware and API techniques you could apply to solve this problem.

Select the most appropriate IoT architecture, frameworks, tools, hardware and API techniques to include in an application to solve this problem.

Describe a plan for an IoT application to solve this problem:

Outline the problem you intend to solve and how IoT and your application addresses this problem.

Select an appropriate IoT application to achieve desired results.

Apply IoT architecture, frameworks, tools, hardware and API techniques to solve this problem.

Use your 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 your plan into an IoT application.

Run end user experiments and examine feedback.

Reconcile and evaluate end user feedback and determine advantages and disadvantages of your chosen IoT techniques.

LO4 Evaluate your IoT application and detail the problem your IoT application solves, the potential impact on people, business, society and the end user and the problems it might encounter when integrating into the wider IoT ecosystem

Assess the success of your IoT application:

Assemble and appraise end use feedback from your IoT application.

Undertake a critical review and compare your final application with the original plan.

Evaluate the advantages, disadvantages, strengths and weaknesses of your IoT techniques.

Critique the overall success of your application. Did it solve your problem? What is the potential impact on people, business, society and the end user? What problems might it encounter when integrating into the wider IoT ecosystem?

Discusses your insight using IoT.

Learning Outcomes and Assessment Criteria

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

Pass	Merit	Distinction
<p>L04 Evaluate your IoT application and detail the problem your IoT application solves, the potential impact on people, business, society and the end user and the problems it might encounter when integrating into the wider IoT ecosystem</p>		
<p>P7 Evaluate end user feedback from your IoT application.</p>	<p>M6 Undertake a critical review and compare your final application with the original plan.</p>	<p>D3 Critique the overall success of your application. Did it solve your problem? What is the potential impact on people, business, society and the end user? What problems might it encounter when integrating into the wider IoT ecosystem?</p>

Recommended Resources

Textbooks

Arshdeep, B. (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 29: Application Program Interfaces

Unit 45: Emerging Technologies

Appendix 1:

Calculation of the final qualification grade

Conditions for the Award

To achieve a Pearson BTEC 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;
- achieved at least a pass in 105 credits at level 4.

To achieve a Pearson BTEC Higher National Certificate qualification a student must have:

- completed units equivalent to 120 credits at level 4;
 - achieved at least a pass in 105 credits at level 4.
-

Compensation Provisions

Compensation Provisions for the HND

A student can still be awarded an HND if they have not achieved a minimum of a Pass in one of the 15 credit units at Level 4 and one of the 15 credit units at Level 5 but they have otherwise fulfilled all the above conditions.

Compensation Provisions HNC

A student can still be awarded an HNC if they have not achieved a minimum of a Pass in one of the 15 credit units but they have otherwise fulfilled all the above conditions.

The calculation of the **overall qualification grade** is based on the student's performance in all units to the value of 120 credits. Students are awarded a Pass, Merit or Distinction qualification grade using the points gained through all 120 credits, at Level 4 for the HNC or Level 5 for the HND, based on unit achievement.

- All units in valid combination must be attempted (120 credits)
- At least 105 credits must be Pass or above
- All 120 credits count in calculating the grade
- The overall qualification grade is calculated in the same way for the HNC and for the HND
- The overall qualification grade for the HND will be calculated based on student performance in Level 5 units only.

Points per credit:

Pass: 4

Merit: 6

Distinction: 8

Point boundaries

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

Modelled Learner Outcomes

Level 5 Higher National Diploma

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

Appendix 2: Glossary of terms used for internally assessed units

This is a summary of the key terms used to define the requirements within units.

Term	Definition
Analyse	<p>Present the outcome of methodical and detailed examination either:</p> <ul style="list-style-type: none"> • breaking down a theme, topic or situation in order to interpret and study the interrelationships between the parts and/or • of information or data to interpret and study key trends and interrelationships. <p>Analysis can be through activity, practice, written or verbal presentation.</p>
Apply	<p>Put into operation or use.</p> <p>Use relevant skills/knowledge/understanding appropriate to context.</p>
Arrange	Organise or make plans.
Assess	Offer a reasoned judgement of the standard/quality of a situation or a skill informed by relevant facts.
Calculate	Generate a numerical answer with workings shown.
Compare	<p>Identify the main factors relating to two or more items/situations or aspects of a subject that is extended to explain the similarities, differences, advantages and disadvantages.</p> <p>This is used to show depth of knowledge through selection of characteristics.</p>
Compose	Create or make up or form.
Communicate	<p>Convey ideas or information to others.</p> <p>Create/construct skills to make or do something, for example a display or set of accounts.</p>
Create/Construct	Skills to make or do something, for example, a display or set of accounts.
Critically analyse	Separate information into components and identify characteristics with depth to the justification.
Critically evaluate	Make a judgement taking into account different factors and using available knowledge/experience/evidence where the judgement is supported in depth.

Term	Definition
Define	State the nature, scope or meaning.
Describe	Give an account, including all the relevant characteristics, qualities and events.
Discuss	Consider different aspects of a theme or topic, how they interrelate, and the extent to which they are important.
Demonstrate	Show knowledge and understanding.
Design	Plan and present ideas to show the layout/function/workings/object/system/process.
Develop	Grow or progress a plan, ideas, skills and understanding
Differentiate	Recognise or determine what makes something different.
Discuss	Give an account that addresses a range of ideas and arguments.
Evaluate	<p>Work draws on varied information, themes or concepts to consider aspects, such as:</p> <ul style="list-style-type: none"> • strengths or weaknesses • advantages or disadvantages • alternative actions • relevance or significance. <p>Students' inquiries should lead to a supported judgement showing relationship to its context. This will often be in a conclusion. Evidence will often be written but could be through presentation or activity.</p>
Explain	To give an account of the purposes or reasons.
Explore	Skills and/or knowledge involving practical research or testing.
Identify	Indicate the main features or purpose of something by recognising it and/or being able to discern and understand facts or qualities.
Illustrate	Make clear by using examples or provide diagrams.
Indicate	Point out, show.
Interpret	State the meaning, purpose or qualities of something through the use of images, words or other expression.
Investigate	Conduct an inquiry or study into something to discover and examine facts and information.
Justify	<p>Learners give reasons or evidence to:</p> <ul style="list-style-type: none"> • support an opinion • prove something is right or reasonable.
Outline	Set out the main points/characteristics.
Plan	Consider, set out and communicate what is to be done.

Term	Definition
Produce	To bring into existence.
Reconstruct	To assemble again/reorganise/form an impression.
Report	Adhere to protocols, codes and conventions where findings or judgements are set down in an objective way.
Review	<p>Make a formal assessment of work produced.</p> <p>The assessment allows learners to:</p> <ul style="list-style-type: none"> • appraise existing information or prior events • reconsider information with the intention of making changes, if necessary.
Show how	Demonstrate the application of certain methods/theories/concepts.
Stage and manage	Organisation and management skills, for example, running an event or a business pitch.
State	Express.
Suggest	Give possible alternatives, produce an idea, put forward, for example, an idea or plan, for consideration.
Undertake/ carry out	Use a range of skills to perform a task, research or activity.

This is a key summary of the types of evidence used for BTEC Higher Nationals:

Type of evidence	Definition
Case study	A specific example to which all students must select and apply knowledge.
Examination	This technique covers all assessment that needs to be done within a centre-specified time constrained period on site. Some units may be more suited to an exam-based assessment approach, to appropriately prepare students for further study such as progression on to Level 6 programmes or to meet professional recognition requirements.
Project	A large scale activity requiring self-direction of selection of outcome, planning, research, exploration, outcome and review.
Independent research	An analysis of substantive research organised by the student from secondary sources and, if applicable, primary sources.
Written task or report	Individual completion of a task in a work-related format, for example, a report, marketing communication, set of instructions, giving information.
Simulated activity/role play	A multi-faceted activity mimicking realistic work situations.
Team task	Students work together to show skills in defining and structuring activity as a team.
Presentation	Oral or through demonstration.
Production of plan/business plan	Students produce a plan as an outcome related to a given or limited task.
Reflective journal	Completion of a journal from work experience, detailing skills acquired for employability.
Poster/leaflet	Documents providing well-presented information for a given purpose.

Appendix 3: Professional Body Memberships

Qualification	Membership/Specialist Group
Higher National Certificate in Computing	Student Membership
Higher National Diploma in Computing	Student Membership Associate Membership (on completion) Business Information Systems Specialist Group
Higher National Diploma in Computing (Network Engineering)	Student Membership Associate Membership (on completion) Distributed and Scalable Computing Specialist Group
Higher National Diploma in Computing (Software Engineering)	Student Membership Associate Membership (on completion) Advanced Programming Specialist Group Open Source Specialist Group Software Testing Specialist Group
Higher National Diploma in Computing (Systems Data & Analysis)	Student Membership Associate Membership (on completion) Data Management Specialist Group Information Risk Management and Assurance Specialist Group
Higher National Diploma in Computing (Security)	Student Membership Associate Membership (on completion) Cybercrime Forensics Specialist Group Information Security Specialist Group
Higher National Diploma in Computing (Intelligent Systems)	Student Membership Associate Membership (on completion) Artificial Intelligence Specialist Group Cybernetic Machine Specialist Group

Qualification	Membership/Specialist Group
Higher National Diploma in Computing (Applications Development)	Student Membership Associate Membership (on completion)
Higher National Diploma in Computing (All Pathways)	Project Management Specialist Group Quality Specialist Group Requirements engineering Specialist Group

Appendix 4: Vendor Accredited Certifications

CompTIA	
Server+	Unit 36: Client/Server Computing Systems
	Unit 48: Systems Integration
Linux+	Unit 36: Client/Server Computing Systems
	Unit 49: Operating Systems
Network+	Unit 2: Networking
	Unit 35: Network Management
Security+	Unit 5: Security
	Unit 17: Network Security
	Unit 23: Cryptography
	Unit 24: Forensics
Cloud+	Unit 16: Cloud Computing
A+	Unit 8: Computer Systems Architecture
CISCO	
IT Essentials	Unit 8: Computer Systems Architecture
CCNA Routing & Switching	Unit 2: Networking
	Unit 8: Computer Systems Architecture
	Unit 15: Transport Network Design
	Unit 35: Network Management

CCNA Security	Unit 2: Networking
	Unit 8: Computer Systems Architecture
	Unit 15: Transport Network Design
	Unit 17: Network Security
	Unit 35: Network Management
Microsoft	
Microsoft Office Specialist (MOS) certification	Throughout
Oracle	
Java SE 8 Fundamentals	Unit 1: Programming
	Unit 20: Advanced Programming
Introduction to SQL	Unit 4: Database Design & Development
	Unit 19: Data Structures & Algorithms
	Unit 38: Database Management Systems
Oracle Database 12c Administration	Unit 8: Computer Systems Architecture
	Unit 19: Data Structures & Algorithms
	Unit 38: Database Management Systems

AXELOS	
Prince2 Foundation Qualification	Unit 13: Computing Research Project
Cyber Resilience Qualification (RESILIA)	Unit 5: Security
	Unit 17: Network Security
	Unit 23: Cryptography
	Unit 24: Forensics