Higher Nationals

Computing

UNIT DIRECTORY 2023/24

For use with the Higher National Certificate and Higher National Diploma in Computing

Higher National Certificate Lvl 4

Higher National Diploma Lvl 5

Pearson BTEC

Programme Structure 2022-24 (new spec)

Year 1 (120 Credits)

Unit Number	Unit Title	Credits	Level	Core/ Optional
1	Programming	15	4	Core
2	Networking	15	4	Core
3	Professional Practice	15	4	Core
4	Database Design & Development	15	4	Core
5	Security	15	4	Core
6	Planning a Computing Project (Pearson-set)	15	4	Core
7	Software Development Lifecycles	15	4	Specialist
14	Maths for Computing	15	4	Specialist

Year 2 (120 Credits)

Unit Number	Unit Title	Credits	Level	Core/ Optional
16	Computing Research Project (Pearson-set)	30	5	Core
17	Business Process Support	15	5	Core
42	Game Design Theory	15	5	Specialist
43	Games Development	15	5	Specialist
45	Internet of Things	15	5	Specialist
47	Emerging Technologies	15	5	Specialist
50	Operating Systems	15	5	Specialist

**please note specialist units may be subject to change*

Unit 1: Programming

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

Introduction

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

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

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

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

Learning Outcomes

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

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

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

LO3 Implement basic algorithms in code using an IDE

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

Essential Content

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

Algorithm definition:

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

The relationship between algorithms and code.

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

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

Characteristics of code:

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

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

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

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

Implementation:

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

Create logical and maintainable codes.

Consideration of security concerns and how they could be solved.

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

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

Review and reflection:

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

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

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

Understand coding standards and their benefits when writing code.

Learning Outcomes and Assessment Criteria

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

Recommended Resources

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

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

Textbooks

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

Hunt, A. et al. (2000) *The Pragmatic Programmer: From Journeyman to Master.*

1st Ed. Addison-Wesley.

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

Links

This unit links to the following related units:

Unit 19: Data Structures & Algorithms

Unit 20: Applied Programming and Design Principles

Unit 54: Prototyping.

Unit 2: Networking

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

Introduction

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

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

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

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

Learning Outcomes

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

LO1 Examine networking principles and their protocols

LO2 Explain networking devices and operations

LO3 Design efficient networked systems

LO4 Implement and diagnose networked systems.

Essential Content

LO1 **Examine networking principles and their protocols**

Introduction to networks:

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

Role of networks:

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

System types:

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

Networking standards:

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

Topology:

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

Protocols:

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

Wireless networks:

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

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

LO2 **Explain networking devices and operations**

Networking devices:

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

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

Networking software:

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

Server type:

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

Server selection:

Cost, purpose, operating system requirement.

Workstation:

Hardware, e.g. network card, cabling.

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

Permissions.

LO3 **Design efficient networked systems**

Bandwidth:

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

Users:

Quality expectations, concept of system growth.

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

Networking services and applications:

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

Calculate IP subnet address ranges in dotted decimal and binary.

Calculate subnet masks

Communications:

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

Scalability:

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

Selection of components:

Supporting infrastructure needs; supporting connectivity requirements.

Security:

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

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

LO4 **Implement and diagnose networked systems**

Devices:

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

Verification of configuration and connectivity:

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

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

System monitoring:

Utilisation, bandwidth needs, monitoring user productivity and security of the system. Factors affecting network performance.

Identify typical failure modes in protocols and approaches to error control.

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

Network automation:

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

Maintenance schedule:

Backups, upgrades, security, auditing.

Diagnose and resolve layer 1 problems:

Explore the E2E integrated development and testing process.

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

Policy review:

Bandwidth, resource availability.

Service level agreements (SLAs):

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

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Examine networking principles and their protocols</td><td rowspan="5">D1 Evaluate the topology protocol selected for a given scenario and how it demonstrates the efficient utilisation of a networking system.</td></tr>
<tr><td>P1 Discuss the benefits and constraints of different network types and standards.
P2 Explain the impact of network topology, communication and bandwidth requirements.</td><td>M1 Assess common networking principles and how protocols enable the effectiveness of networked systems.</td></tr>
<tr><td colspan="2">LO2 Explain networking devices and operations</td></tr>
<tr><td>P3 Discuss the operating principles of networking devices and server types.
P4 Discuss the interdependence of workstation hardware and relevant networking software.</td><td>M2 Explore a range of server types and justify the selection of a server for a given scenario, regarding cost and performance optimisation.</td></tr>
<tr><td colspan="2">LO3 Design efficient networked systems</td></tr>
<tr><td>P5 Design a networked system to meet a given specification.
P6 Design a maintenance schedule to support the networked system.</td><td>M3 Analyse user feedback on your designs with the aim of optimising your design and improving efficiency.</td><td rowspan="4">D2 Critically reflect on the implemented network, including the design and decisions made to enhance the system.</td></tr>
<tr><td colspan="2">LO4 Implement and diagnose networked systems</td></tr>
<tr><td>P7 Implement a networked system based on a prepared design.</td><td rowspan="2">M4 Recommend potential enhancements for the networked systems.</td></tr>
<tr><td>P8 Document and analyse test results against expected results.</td></tr>
</table>

Recommended Resources

Textbooks

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

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

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

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

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

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

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

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

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

Links

This unit links to the following related units:

Unit 9: Computer Systems Architecture

Unit 27: Transport Network Design

Unit 29: Network Security

Unit 39: Network Management

Unit 40: Client/Server Computing Systems.

Unit 3: Professional Practice

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

Introduction

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

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

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

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

Learning Outcomes

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

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

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

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

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

Essential Content

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

Effective communication:

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

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

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

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

Interpersonal skills:

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

Time-management skills:

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

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

Specification of the problem:

Definition of the problem; analysis and clarification.

Identification of possible outcomes:

Identification and assessment of various alternative outcomes.

Tools and methods:

Use of problem-solving methods and tools.

Demonstrate resourcefulness and creativity when solving problems.

Plan and implement:

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

Evaluation:

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

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

Working with others:

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

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

Individual responsibility when working as part of a team.

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

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

Teams and team building:

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

Identification of team and work group roles.

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

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

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

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

Responsibilities:

Own responsibilities, e.g. personal responsibility, direct and indirect relationships and adaptability, decision-making processes and skills, ability to learn and develop within the work role.

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

Maintaining a productive, professional and secure working environment.

Performance objectives:

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

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

Evidence criteria:

Production data, personnel data, judgemental data.

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

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

Personal and interpersonal skills.

Motivation and performance:

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

Development plan:

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

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Demonstrate a range of interpersonal and transferable communication skills to a target audience		
P1 Demonstrate effective design and delivery of a training event for a given target audience, using different communication styles and formats **P2** Demonstrate 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.	**D1** Evaluate the effectiveness and application of interpersonal skills used in the design and delivery of a training event.
LO2 Apply critical reasoning and thinking to a range of problem-solving scenarios		
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 the design and delivery of the event.	**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 methodologies in the design and delivery of an event.	**D2** Evaluate the overall success of the event delivered, in terms of how well critical reasoning and thinking were applied to achieve the end goal.

Pass	Merit	Distinction
LO3 Discuss the importance and dynamics of working within a team and the impact of team working in different environments		
P5 Discuss the importance of team dynamics in the success and/or failure of group work. **P6** Work in a team to achieve a defined goal.	**M4** Analyse team dynamics, in terms of the roles that group members play in a team and the effectiveness in terms of achieving shared goals.	**D3** Critically evaluate your own role and contribution to a group scenario.
LO4 Examine the need for Continuing Professional Development (CPD) and its role within the workplace and for higher-level learning		
P7 Discuss the importance of CPD and its contribution to own learning and motivation. **P8** Review different motivational theories and the impact they can have on performance in the workplace. **P9** Produce a development plan that outlines responsibilities, performance objectives and required skills for future goals.	**M5** Justify the role of CPD and development planning in building motivation.	**D4** Evaluate a range of evidence criteria that is used as a measure for effective CPD.

Recommended Resources

Textbooks

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

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

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 - Japan Institute for Group Dynamics

Professional Development in Education - Taylor and Francis Online

Web

ipda.org.uk	International Professional Development Association (General reference)
www.thinkwatson.com	Critical Thinking Resources *Critical Thinking Correlation Studies* (Research)

Links

This unit links to the following related units:

Unit 6: Planning a Computing Project

Unit 16: Computing Research Project.

Unit 4: Database Design & Development

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

Introduction

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

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

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

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

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

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

Learning Outcomes

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

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

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

LO3 Test the system against user and system requirements

LO4 Produce technical and user documentation.

Essential Content

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

Principles and uses of relational and non-relational databases.

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

Determining user and system requirements.

Design tools and techniques for a relational database system.

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

Designs for data integrity, data validations, data security and data controls. User interface design.

Output designs for user requirements.

Overview of object-oriented databases and their design tools.

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

Consideration of database and platform options for system development.

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

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

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

Implementation of security elements in databases.

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

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

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

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

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

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

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

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

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

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

Match tests against user and system requirements.

Test procedures to be used: test plans, test models, e.g. white box, black box; testing documentation.

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

LO4 **Produce technical and user documentation**

Technical and user documentation and their contents.

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

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

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Use an appropriate design tool to design a relational database system for a substantial problem</td><td rowspan="2">D1 Evaluate the effectiveness of the design in relation to user and system requirements.</td></tr>
<tr><td>P1 Design a relational database system using appropriate design tools and techniques, containing at least four interrelated tables, with clear statements of user and system requirements.</td><td>M1 Produce a comprehensive design for a fully-functional system, which includes interface and output designs, data validations and data normalisation.</td></tr>
<tr><td colspan="2">LO2 Develop a fully-functional relational database system, based on an existing system design</td><td rowspan="4">D2 Evaluate the effectiveness of the database solution in relation to user and system requirements and suggest improvements.</td></tr>
<tr><td>P2 Develop the database system with evidence of user interface, output and data validations, and querying across multiple tables.
P3 Implement a query language into the relational database system.</td><td>M2 Implement a fully-functional database system, which includes system security and database maintenance.
M3 Assess whether meaningful data has been extracted through the use of query tools to produce appropriate management information.</td></tr>
<tr><td colspan="2">LO3 Test the system against user and system requirements</td></tr>
<tr><td>P4 Test the system against user and system requirements.</td><td>M4 Assess the effectiveness of the testing, including an explanation of the choice of test data used.</td></tr>
</table>

Pass	Merit	Distinction
LO4 Produce technical and user documentation		
P5 Produce technical and user documentation.	**M5** Produce technical and user documentation for a fully-functional system, including data flow diagrams and flowcharts, describing how the system works.	**D3** Evaluate the database in terms of improvements needed to ensure the continued effectiveness of the system.

Recommended Resources

Textbooks

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

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

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

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

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

Journals

The Computer Journal - Oxford Academic

International Journal of Database Management (IJDMS)

Journal of Emerging Trends in Computing and Information Sciences

Journal of Systems Analysis and Software Engineering

Systems Journal of Database Management

Web

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

Links

This unit links to the following related units:

Unit 11: Strategic Information Systems

Unit 41: Database Management Systems.

Unit 5: Security

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

Introduction

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

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

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

Learning Outcomes

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

LO1 Assess risks to IT security

LO2 Describe IT security solutions

LO3 Review mechanisms to control organisational IT security

LO4 Manage organisational security.

Essential Content

LO1 **Assess risks to IT security**

IT security risks:

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

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

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

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

LO2 **Describe IT security solutions**

IT security solution evaluation:

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

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

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

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

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

Educating staff and customers on IT security issues and prevention methods.

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

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

Mechanisms to control organisational IT security:

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

Probability of occurrence, e.g. disaster, theft.

Staff responsibilities.

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

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

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

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

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

LO4 **Manage organisational security**

Manage organisational security:

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

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

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

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

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

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

Investigate organisation policy on ethical hacking and bug bounties.

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

Learning Outcomes and Assessment Criteria

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

Pass	Merit	Distinction
LO4 Manage organisational security		
P7 Design a suitable security policy for an organisation, including the main components of an organisational disaster recovery plan. **P8** Discuss the roles of stakeholders in the organisation in implementing security audits.	**M5** Justify the security plan developed giving reasons for the elements selected.	**D3** Evaluate the suitability of the tools used in the organisational policy to meet business needs.

Recommended Resources

Textbooks

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

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

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

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

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

Web

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

Links

This unit links to the following related units:

Unit 29: Network Security

Unit 30: Applied Cryptography in the Cloud

Unit 31: Forensics

Unit 32: Information Security Management.

Unit 6: Planning a Computing Project (Pearson Set)

Unit code	**H/618/7407**
Unit type	**Core**
Unit level	**4**
Credit value	**15**

Introduction

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

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

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

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

Learning Outcomes

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

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

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

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

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

Essential Content

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

Project execution phase:

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

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

Qualitative and quantitative research methods.

Field work:

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

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

Analysing information and data:

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

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

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

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

Ethics, reliability and validity:

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

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

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

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

Features of businesses:

Types of business, their ownership and liability.

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

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

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

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

How some organisations provide both products and services.

The concept of diversification to aid business success.

Operational areas of businesses:

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

Stakeholders:

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

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

How stakeholders influence business processes and decisions.

The impact of stakeholders on an organisation's success.

Challenges to the success of a business:

Legislation and industry standards relevant to the organisation and sector.

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

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

Communication of need for change to stakeholders.

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

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

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

Security and privacy concerns relevant to the organisation and sector.

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

Project planning and initiation:

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

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

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

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

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

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

Consider approaches to continuous integration, version and source control.

Tools:

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

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

Presenting and communicating project recommendations:

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

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

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

Justification of decisions made:

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

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

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

Reflection on the quality of research:

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

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

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

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

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Conduct small-scale research, information gathering and data collection to generate knowledge on an identified subject</td><td rowspan="5">D1 Interpret findings to generate knowledge on how the research theme supports business requirements in the identified sector.</td></tr>
<tr><td>P1 Demonstrate qualitative and quantitative research methods to generate relevant primary data for an identified theme.

P2 Examine secondary sources to collect relevant secondary data and information for an identified theme.</td><td>M1 Analyse data and information from primary and secondary sources to generate knowledge on an identified theme.</td></tr>
<tr><td colspan="2">LO2 Explore the features and business requirements of organisations in an identified sector</td></tr>
<tr><td>P3 Discuss the features and operational areas of a businesses in an identified sector.

P4 Discuss the role of stakeholders and their impact on the success of a business.</td><td>M2 Analyse the challenges to the success of a business in an identified sector.</td></tr>
</table>

Pass	Merit	Distinction
LO3 Produce project plans based on research of the chosen theme for an identified organisation		
P5 Devise comprehensive project plans for a chosen scenario, including a work and resource allocation breakdown using appropriate tools.	**M3** Produce comprehensive project plans that effectively consider aims, objectives and risks/benefits for an identified organization.	**D2** Evaluate the project planning recommendations made in relation to the needs of the identified organisation and the accuracy and reliability of the research carried out.
LO4 Present your project recommendations and justifications of decisions made, based on research of the identified theme and sector		
P6 Communicate appropriate project recommendations for technical and non-technical audiences. **P7** Present arguments for the planning decisions made when developing the project plans. **P8** Discuss accuracy and reliability of the different research methods applied.	**M4** Assess the extent to which the project recommendations meet the needs of the identified organisation, including fully-supported rationales for planning decisions made.	

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 (IJQQRM) – EA Journala

Qualitative Research Journal (QRJ) – Sage Journals

Web

www.apm.org.uk	Association for Project Management
www.gov.uk/government/publications	Department of Business Innovations and Skills, *Guidelines for managing projects – How to organise, plan and control projects*. (Report)
www.hesa.ac.uk	Higher Education Statistics Agency (HESA) – data collection and analysis for higher education
www.ons.gov.uk	Office for National Statistics(ONS)
www.pmi.org.uk	Project Management Institute UK

Links

This unit links to the following related units:

Unit 3: Professional Practice

Unit 16: Computing Research Project

Unit 17: Business Process Support

Unit 35: Systems Analysis & Design.

Unit 7: Software Development Lifecycles

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

Introduction

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

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

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

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

Learning Outcomes

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

LO1 Describe different software development lifecycles

LO2 Explain the importance of a feasibility study

LO3 Undertake a software development lifecycle

LO4 Discuss the suitability of software behavioural design techniques.

Essential Content

LO1 **Describe different software development lifecycles.**

Software development lifecycles:

Describe different software development lifecycles.

Understand and use different lifecycle models, including predictive (Waterfall, Prototyping, RAD), adaptive (Spiral, Agile, DSDM), sequential and iterative software development models.

Lifecycle stage and connectivity, including feasibility study, analysis, design, implementation, testing, review or analysis, design, implementation, maintenance, planning, requirements traceability.

Testing and integration, including relationship between test activities and software development activities, levels of testing, building test environments, developing test harnesses, black box and white box testing, incremental testing, system testing, acceptance test and integration approaches, changeover strategies, trials and Go-Live prerequisites.

Understand the role and utilisation of analysis artefacts:

The creation of analysis artefacts in a software development project, e.g. software requirements specification, use case or user stories, user profiles, workflow model, wireframes, logical data model, data dictionary etc.

The purpose and activities of the gap analysis process.

Roles and responsibilities in a large-scale software project development lifecycle:

Identify the different individuals in a project, e.g. project manager, business analyst, systems analyst, programmer, DevOps engineer, testing engineer etc.

Contributions, including quality assurance, common core skills, tools and behaviours.

Explore how the psychology and mindset of testing differs to that development mindset and their possible influence on the overall success of a software project.

LO2 **Explain the importance of a feasibility study**

Requirement gathering:

Requirement gathering techniques, including how to categorise, validate and prioritise, e.g. MosCow method, functional requirements, non-functional requirements, users and constraints.

Interviews, observation, investigation.

Importance of feasibility study:

Feasibility criteria considerations, e.g. legal, social, economic, technical, timescales, organisational constraints.

Components of feasibility study, including purpose, structure, intended audience, outcomes.

The purpose of process modelling and the importance of an organisational view of business processes.

Key drivers for change, including performance and efficiency, legacy systems upgrade, automation, elimination of human error.

LO3 **Undertake a software development lifecycle**

Carry out software development lifecycle:

Follow company, team or client approaches to continuous integration, version and source control.

Apply an appropriate software development approach according to the relevant paradigm, e.g. object oriented, event driven or procedural.

Identify stakeholder requirements.

Scope of project, including inputs, outputs, processes and process descriptors, consideration of alternate solutions and security considerations, required quality assurance and testing.

Constraints specific to activity, e.g. costs, organisational policies, legacy systems, hardware requirements.

Create simple software designs to effectively communicate understanding of the program.

Follow agreed software designs and technical and functional specifications.

Follow organisational policies and procedures relating to the tasks being undertaken, e.g. the storage and treatment of GDPR sensitive data.

Report documentation, including structure, e.g. background information, problem statements, data collection process and summary, recommendations and appendices.

Use of appropriate systems analysis terminology and tools, including data stores and entities, data flows, process representation techniques relationships (1:1, 1:M and M:M).

Investigation, e.g. upgrading computer systems, designing new systems.

Techniques and documents for documenting business requirements and processes relevant to selected methodology, e.g. Context Diagrams, Data Flow Diagrams (DFDs), Entity Relationship Diagrams (ERDs), Business Systems Options (BSOs), Technical Systems Options (TSOs) and requirements traceability.

Analyse documented requirements to remove duplication, conflict and overlap.

Quality considerations, e.g. Total Quality Management (TQM).

LO4 **Discuss the suitability of software behavioural design techniques**

Evaluate suitability of software behavioural design techniques:

Flowcharts, pseudocode, formal specification methods, event/state/data driven, finite state machines extended-FSM/FSP.

Problem of e-FSM state explosion, reachability analysis, safety, liveness properties.

Automatic analysis and animation tools.

Understand the characteristics of software architecture that impact on software testing in the development lifecycle.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Describe different software development lifecycles		
P1 Describe two iterative and two sequential software lifecycle models. **P2** Explain how risk is managed in software lifecycle models.	**M1** Discuss using an example, why a particular lifecycle model is selected for a development environment.	**D1** Assess the merits of applying the Waterfall lifecycle model to a large software development project.
LO2 Explain the importance of a feasibility study		
P3 Explain the purpose of a feasibility report. **P4** Describe how technical solutions can be compared.	**M2** Discuss the components of a feasibility report.	**D2** Assess the impact of different feasibility criteria on a software investigation.
LO3 Undertake a software development lifecycle		
P5 Undertake a software investigation to meet a business need. **P6** Use appropriate software analysis tools/techniques to carry out a software investigation and create supporting documentation.	**M3** Analyse how software requirements can be traced throughout the software lifecycle. **M4** Discuss two approaches to improving software quality.	**D3** Evaluate the process of undertaking a systems investigation with regard to its effectiveness in improving a software quality.
LO4 Discuss the suitability of software behavioural design techniques		
P7 Discuss, using examples, the suitability of software behavioural design techniques.	**M5** Analyse a range of software behavioural tools and techniques. **M6** Differentiate between a finite state machine (FSM) and an extended FSM, providing an application of use for both.	**D4** Present justifications of how data-driven software can improve the reliability and effectiveness of software.

Recommended Resources

Textbooks

Dennis, A. and Haley, W. (2009) *Systems Analysis and Design*. John Wiley & Sons Ltd.

Lejk, M. and Deeks, D. (2002) *An Introduction to System Analysis Techniques*. 2nd Ed. Addison-Wesley.

Murch, R. (2012) *The Software Development Lifecycle: A Complete Guide*. Kindle.

Smart, J. F. (2014) *BDD in Action: Behavior-driven development for the whole software lifecycle*. Manning.

Web

www.freetutes.com	FreeTutes *Systems Analysis and Design – Complete Introductory Tutorial for Software Engineering* (Tutorial)
www.ijcsi.org	*IJCSI International Journal of Computer Science* Vol. 7, Issue 5, September 2010 *A Comparison Between Five Models Of Software Engineering* (Research)
www.ijcsi.org	*IJCSI International Journal of Computer Science* Vol. 6, Issue 1, 2015 *Software Development Life Cycle Models – Comparison, Consequences (Research)*

Links

This unit links to the following related units:

Unit 6: Planning a Computing Project

Unit 16: Computing Research Project

Unit 22: Application Development

Unit 35: Systems Analysis & Design

Unit 42: Game Design Theory

Unit 43: Games Development

Unit 54: Prototyping.

Unit 14: Maths for Computing

Unit code	**R/618/7421**
Unit level	**4**
Credit value	**15**

Introduction

In 1837, English mathematicians Charles Babbage and Ada Lovelace in collaboration, described a machine that could perform arithmetical operations and store data in 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 still rely fundamentally 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 in 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 have gained confidence in the mathematics that is needed in other computing units. They will have developed 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

LO1 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.

LO2 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.

LO3 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		
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.	**D1** Produce a detailed written explanation of the importance of prime numbers in the field of computing.
LO2 Analyse events using probability theory and probability distributions		
P3 Deduce the conditional probability of different events occurring in independent trials. **P4** Identify the expectation of an event occurring from a discrete, random variable.	**M2** Calculate probabilities in both binomially distributed and normally distributed random variables.	**D2** Evaluate probability theory to an example involving hashing and load balancing.
LO3 Determine solutions of graphical examples using geometry and vector methods		
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.	**D3** Construct the scaling of simple shapes that are described by vector co-ordinates.

Pass	Merit	Distinction
LO4 Evaluate problems concerning differential and integral calculus		
P7 Determine the rate of change in 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.	**D4** Justify, by further differentiation, that a value is a minimum.

Recommended Resources

Textbook

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

Journal

Journal of Computational Mathematics. Global Science Press.

Links

This unit links to the following related units:

Unit 18: Discrete Maths

Unit 33: Applied Analytical Models.

Unit 16: Computing Research Project (Pearson Set)

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

Introduction

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

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

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

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

Learning Outcomes

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

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

LO2 Conduct and analyse research relevant to a computing research project

LO3 Communicate the outcomes of a research project to identified stakeholders

LO4 Reflect on the application of research methodologies and concepts.

Essential Content

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

Developing a research proposition:

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

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

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

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

Literature review:

Conceptualisation of the research problem or hypothesis.

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

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

Qualitative, quantitative, and mixed method research methodologies:

Key theoretical frameworks for research.

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

LO2 Conduct and analyse research relevant to a computing research project

Research as a process:

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

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

Elicite information from stakeholders.

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

Selecting a sample:

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

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

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

Ethics, reliability and validity:

Conduct research ethically including reporting of findings.

Consider how to ensure reliable and valid research.

Analysing data:

Using data collection tools such as interviews and questionnaires.

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

LO3 **Communicate the outcomes of a research project to identified stakeholders**

Stakeholders:

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

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

Communicating research outcomes:

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

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

Convincing arguments:

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

The importance of developing evaluative conclusions.

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

Reflection for learning and practice:

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

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

The cycle of reflection:

To include reflection in action and reflection on action.

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

Reflective writing:

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

Learning Outcomes and Assessment Criteria

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

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

Recommended Resources

Textbooks

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

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

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

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

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

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

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

Journals

International Journal of Quantitative and Qualitative Research

Qualitative Research

Links

This unit links to the following related units:

Unit 3: Professional Practice

Unit 6: Planning a Computing Project

Unit 7: Software Development Lifecycles.

Unit 17: Business Process Support

Unit code	**A/618/7428**
Unit type	**Core**
Unit level	**5**
Credit value	**15**

Introduction

Data and information are core to any organisation and business process. Accurate data and meaningful information are of high value to an organisation and are key drivers for effective decision making and problem solving. Business intelligence relies on the use of data science, which makes use of a range of tools and methods, including data mining, data integration, data quality and data warehousing, in conjunction with other information management systems and applications.

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

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

On successful completion of this unit, students will appreciate the importance and value of data and information in terms of optimising decision making and performance. By exploring the tools, techniques and systems that support business processes, students will be aware of the role and contribution of these technologies and methodologies, and their importance to organisations. As a result, students will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

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

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

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

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

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

Essential Content

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

Data and information in organisations:

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

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

Impact on business processes in terms of elicitation and storage.

The importance of reliable data and impact on businesses.

Use of data and information to support business processes:

Analysing market trends to identify patterns.

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

Monitoring system performance metrics.

Monitoring and controlling the quality of a product or service.

Analysing levels of user or customer interaction and engagement.

Analysing trends in browsing and purchasing for targeted marketing purposes.

Mechanisms:

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

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

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

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

Social, legal and ethical implications:

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

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

Cybersecurity management:

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

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

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

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

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

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

Data science overview:

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

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

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

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

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

Using data:

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

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

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

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

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

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

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

Communicating information effectively to a range of stakeholders.

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

Solutions:

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

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

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

Design considerations:

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

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Discuss the use of data and information to support business processes and the value they have for an identified organisation</td><td rowspan="5"></td></tr>
<tr><td>P1 Discuss how data and information support business processes and the value they have for organisations.

P2 Discuss how data is generated and the tools used to manipulate it to form meaningful data to support business operations.</td><td>M1 Assess the value of data and information to individuals and organisations in relation to real-world business processes.</td></tr>
<tr><td colspan="2">LO2 Discuss the implications of the use of data and information to support business processes in a real-world scenario</td></tr>
<tr><td>P3 Discuss the social legal and ethical implications of using data and information to support business processes.

P4 Describe common threats to data and how they can be mitigated at on a personal and organisational level.</td><td>M2 Analyse the impact of using data and information to support business real-world business processes.</td></tr>
<tr><td colspan="2"></td></tr>
</table>

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

Recommended Resources

Textbooks

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

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

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

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

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

Journals

International Journal of Business Intelligence and Data Mining

International Journal of Business Intelligence Research (IJBIR)

Web

gartner.com/en	Research and Advisory (General reference)
datascience.codata.org	Data science (Online data science journal)

Links

This unit links to the following related units:

Unit 6: Planning a Computing Project

Unit 8: Data Analytics

Unit 33: Applied Analytical Models

Unit 34: Analytical Methods.

Unit 42: Game Design Theory

Unit code	**K/618/7473**
Unit level	**5**
Credit value	**15**

Introduction

What makes a great game? Although it's easy to say, 'This is a great game' when your character has just cleared a zone and your friend's voice buzzes in your headset letting you know that everybody is waiting for you to join the party – then another player interrupts, suggesting tactics to take down the next objective. It is a completely different story, however, when you (the designer) are sitting, staring at a blank sheet of paper and your producer is expecting you to present 'The next big title'.

This unit introduces students to an exploration of the practices, principles and skills needed to successfully design a game. The unit starts by establishing an overall history of games and reviews, and how they have evolved – and still are evolving. Students are introduced to assessing common game features and identifying the roles and responsibilities of people involved in game design, and its challenges. Students will become familiar with a range of standard documents associated with games design, including the 'Game Design Document'. Before they embark on defining, designing and documenting their own game ideas they are given opportunities to work in groups to debate and review the elements of game design. They will be introduced to the design process as well as the practices, principles, tools and techniques. As students progress, they are given opportunities to evolve their ideas through peer review, before finally presenting a 'High Concept' pitch. To help maximise student involvement, this unit should (where possible) simulate a real-world design experience.

Among the topics included in this unit are: design documentation, research, requirement gathering, idea generation, world design, storyboards, storytelling, characters, levels, gameplay, assets and asset management, tools and techniques, game engines and environments, genres, game mechanics, player motivation and challenge, rewards, game structure, game design vocabulary and preparing and presenting a pitch.

On successful completion of this unit, students will be able to critically assess the types, practices, principles and skills used in the design of games, analyse the concepts and elements required for the production of a Games Design Document, evaluate the game design process with regard to game development and production, and use game design practices and principles to create an original Game Design Document and present a High Concept pitch. 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 Critically assess the types, practices, principles and skills used in the design of games

LO2 Analyse the concepts and elements required for the production of a Games Design Document

LO3 Evaluate the game design process with regard to game development and production

LO4 Use game design practices and principles to create an original Game Design Document and present a High Concept pitch.

Essential Content

LO1 **Critically assess the types, practices, principles and skills used in the design of games**

Game design and game types:

Identify what game design is and explore the evolution of games over time.

Research and assess game types, trends, player features, control and technology.

Practices, principles and skills used in the design of games:

Identify the role of a games designer and introduce concepts related to the game design process (including High Concept, story and art bible, design document).

Discuss idea generation, world design, storytelling, characters, levels, gameplay, assets and asset management.

Assess the skills needed to successfully design a video game.

LO2 **Analyse the concepts and elements required for the production of a Games Design Document**

Games Design Document structure:

Review different Game Design Documents and identify common and shared factors.

Discuss, compare and synthesise your identified factors into an agreed format.

Concepts and elements required for a Games Design Document:

Examine the purpose of the Game Design Document (including game loops such as core, dual and compulsion as well as the principles of Metagame design) and identify the stakeholders and their possible expectations.

Debate the content, depth and quality of information expected in a Games Design Document (including age-appropriate content and content ratings).

Explain the strengths and possible weaknesses of a Games Design Document.

LO3 **Evaluate the game design process with regard to game development and production**

Roadmap for the game design process:

Roadmap to include concepts, planning and design, development, testing, distribution.

Debate the value of the concept stage including idea generation and establishing the audience, game world, narrative, style, features and gameplay, characters, storyboards and player motivation and challenges.

Recap why concepts are reviewed, synthesised and stored as a set of documents.

Investigate design tools and explore issues related to the planning and design stage including asset creation and management and possible redevelopment of agreed ideas.

Game development constraints and possible pitfalls, platforms commonly available to support development.

Testing methods, purpose of Quality Assurance (QA) and business and monetisation models, e.g. Steam, retail, Free-to-Play (F2P).

Techniques such as item-purchase, affiliate, advertising, freemium, restricted access, subscription,

Production and distribution, taking security issues into consideration.

LO4 **Use game design practices and principles to create an original Game Design Document and present a High Concept pitch.**

Game concept:

Gather and document a range of original game ideas using research on existing game types and styles for inspiration.

Peer-review and evaluation of feedback on game ideas.

Justify the selection of a specific game idea.

Apply game design practices and principles to develop a specific game idea into a full, well-structured concept.

Game Design Document and High Concept pitch:

Produce and quality check a Game Design Document and High Concept presentation, based on your selected concept.

Present and defend your High Concept pitch.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Critically assess the types, practices, principles and skills used in the design of games		
P1 Compare different video game types and explain key or influential titles as they were released over time. **P2** Research the skills needed to design, create and produce a video game, and compare the roles of games animator, producer, audio engineer, director, designer, programmer and artist.	**M1** Analyse the evolution of game technology and its impact on video game design and complexity.	**D1** Evaluate each section of a Game Design Document and explain the effect of game loops and Metagame design with regard to game play.
LO2 Analyse the concepts and elements required for the production of a Game Design Document		
P3 Examine the structure of a Game Design Document.	**M2** Determine the various needs and expectations of the Game Design Document stakeholders.	

Pass	Merit	Distinction
LO3 Evaluate the game design process with regard to game development and production		
P4 Create an illustrated guide explaining the video game design, development and production processes, including an evidence-based comparison between 'AAA' and 'Indie' (independent) budget allocation and development timelines. **P5** Compare different business and monetisation models used with games production and distribution.	**M3** Review different game distribution channels and marketing methods used in games production.	**D2** Evaluate the importance and issues related to idea generation, audience understanding, world design, narrative, style, features, gameplay, characters, storyboards and player motivation, and challenge, with regard to game design.
LO4 Use game design practices and principles to create an original Game Design Document and present a High Concept pitch		
P6 Create an original game concept and maintain organised evidence of giving appropriate and constructive feedback to others. **P7** Develop an original Game Design Document and High Concept presentation.	**M4** Conduct peer reviews using your original game concept and document any feedback given. **M5** Develop a detailed, original Game Design Document and formally present and defend your High Concept pitch.	**D3** Critically evaluate the strengths and weaknesses of your finished video game concept, Game Design Document and High Concept pitch, and fully justify opportunities for improvement and further development.

Recommended Resources

Textbooks

Gibson, J. (2021) *Introduction to Game Design, Prototyping, and Development. New Jersey:* Pearson Education.

Gregory, J. (2018) *Game Engine Architecture*. 3rd Ed. United States: Taylor.

Madhav, S. (2013) Game Programming Algorithms and Techniques. USA: Addison-Wesley.

Nystrom, R. (2014) *Game Programming Patterns*. USA: Genever Benning.

Rogers, S. (2014) *Level Up! The Guide to Great Video Game Design*. UK: John Wiley and Sons Ltd.

Schell, J. (2014) *The Art of Game Design: A Book of Lenses*. USA: A K Peters/CRC Press.

Links

This unit links to the following related units:

Unit 7: Software Development Lifecycles

Unit 43: Games Development

Unit 44: Games Engine & Scripting.

Unit 43: Games Development

Unit code	**L/618/7479**
Unit level	**5**
Credit value	**15**

Introduction

In the field of computing, games development is a multidisciplinary art form creating worlds that blend player psychology, problem solving and artificial intelligence with knowledge of dedicated hardware and software platforms. This level of ability can often require significant effort on the part of students, in terms of time and practice but as students gain more experience, their skills and abilities quickly improve. The capabilities and flexibility of a good games developer can easily be transferred to other roles in the business sector.

This unit introduces students to games development. It is designed to simulate the roles and responsibilities of a games developer working in a suitable games development studio with access to a small team of colleagues. Students will discuss and review a number of original game ideas before synthesising them into a single game concept. Once the game concept is defined, students will need to adopt appropriate methods and practices to analyse, break down and discuss the issues, then decide on, design, create and test a functional game. Students should be free to debate, evaluate and select different design and development methodologies depending on their own judgement and consideration.

Among the topics included in this unit are: game design and developer documentation, problem analysis, research, system and user requirements, design methodologies, development methodologies, unified modelling language (UML), games engines, hardware platforms, graphic manipulation, physics, maths for games, sound, networking, collision detection, teamwork, peer review, 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 develop a Game Design Document by synthesising game ideas into an original video game concept, select and use different design and development methodologies with tools and techniques associated with the creation of a video game, work individually and as part of a team to plan, prepare and produce a functional video game including support documentation, and assess and plan improvements to a video game by evaluating its performance against its Game Design Document and original concept. As a result, they will develop skills such as communication literacy, critical thinking, analysis, reasoning and interpretation.

Learning Outcomes

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

LO1 Develop a Game Design Document by evaluating and synthesising game ideas into an original video game concept

LO2 Use different design and development methodologies with tools and techniques associated with the creation of a video game

LO3 Work individually and as part of a team to plan and produce a functional video game, including support documentation

LO4 Evaluate the performance of a video game against its Game Design Document and original concept.

Essential Content

LO1 **Develop a Game Design Document by evaluating and synthesising game ideas into an original video game concept**

Different game genres and ideas:

Discuss and compare common game elements such as type, story, characters, environment, levels, gameplay, loops, art, sound, user interface and controls.

Determine possible game ideas including predicting the overall success of fully developing the game.

Game Design Document:

Review the value of Game Design Documents in terms of games development.

Evaluate and synthesise game ideas to describe game concept.

Research and use information relating to games testing in order to create a suitable test plan.

LO2 **Use different design and development methodologies with tools and techniques associated with the creation of a video game**

Design and development methodologies:

Present overviews on current design and development methodologies.

Understand strengths and weaknesses commonly associated with each methodology.

Select or synthesise a design and development methodology.

Tools and techniques:

Evaluate different tools and techniques available to create a video game.

Establish development plan, including the advantages and disadvantages of preferred or selected tools and techniques.

LO3 **Work individually and as part of a team to plan and produce a functional video game, including support documentation**

Team working to plan and prepare a functional video game:

Peer review and debate development plan and Game Design Document, including communicating effectively and defending ideas and reasoning.

Discuss differences with regard to the possible strengths and weaknesses of each Game Design Document and development plan.

Modify design document or plans to reflect any new insight or considerations.

Functional video game:

Use a Game Design Document with a development plan to produce a functional video game.

Create and quality check appropriate support documents.

LO4 **Evaluate the performance of a video game against its Game Design Document and original concept**

Performance of a video game:

Factors that influence the performance of a video games system requirements.

Critical review of the performance and development of video game against identified factors and adopted design and development methodologies.

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

Improvements to a video game:

Evaluate the overall strengths and weaknesses against original concept.

Plan revisions to implementation to improve video game's performance.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Develop a Game Design Document by evaluating and synthesising game ideas into an original video game concept		
P1 Explore different game-based ideas, blending them into an original video game concept. **P2** Examine any areas of risk related to the successful completion of a video game.	**M1** Analyse common game design elements and combine with the original video game concept to create a suitable Game Design Document.	**D1** Evaluate common game design elements and justify their use when designing a suitable Game Design Document.
LO2 Use different design and development methodologies with tools and techniques associated with the creation of a video game		
P3 Research the use of different design and development methodologies, tools and techniques, and determine which have been selected for the development of the video game.	**M2** Compare the differences between the various design and development methodologies, tools and techniques researched, and justify a preferred selection.	**D2** Evaluate any new insight, ideas or potential improvements to the concept, methodology or use of tools and justify the reasons why they have been included (or not included) as part of the development.

Pass	Merit	Distinction
LO3 Work individually and as part of a team to plan and produce a functional video game, including support documentation		
P4 Review the video game concept, preferred design, and development methodologies and selected tools and techniques. **P5** Develop a functional video game based on a specified game concept and gather feedback.	**M3** Interpret the peer-review feedback and identify opportunities not previously considered. **M4** Develop a functional video game based on a specific Game Design Document with supportive evidence of using the preferred design and development methodologies, and selected tools and techniques.	
LO4 Evaluate the performance of a video game against its Game Design Document and original concept		
P6 Evaluate the performance of a video game against the original concept.	**M5** Analyse the factors that influence the performance of a video game and use them to undertake a critical review of the design, development, game elements and testing stages of a video game. Conclude the review by discussing previously identified risks reflectively.	**D3** Critically evaluate the strengths and weaknesses of the video game and fully justify opportunities for improvement and further development.

Recommended Resources

Textbooks

Gibson, J. (2021*) Introduction to Game Design, Prototyping, and Development*. New Jersey: Pearson Education.

Gregory, J. (2018) *Game Engine Architecture*. 3rd Ed. United States: Taylor.

Madhav, S. (2013) *Game Programming Algorithms and Techniques*. USA: Addison-Wesley.

Nystrom, R. (2014) *Game Programming Patterns*. USA: Genever Benning.

Rogers, S. (2014) *Level Up! The Guide to Great Video Game Design*. UK: John Wiley and Sons Ltd.

Schell, J. (2014) *The Art of Game Design: A Book of Lenses*. USA: A K Peters/CRC Press.

Links

This unit links to the following related units:

Unit 7: Software Development Lifecycles

Unit 42: Game Design Theory

Unit 44: Games Engine & Scripting.

Unit 45: Internet of Things

Unit code	**J/618/7481**
Unit level	**5**
Credit value	**15**

Introduction

The Internet of Things (IoT) is a network of physical objects – devices, vehicles, drones and other objects embedded with electronics, software, sensors and network connectivity – that enables those objects to collect and exchange data. The objective of the IoT is to enable almost any object to become smart, accessible and data capable, thereby benefitting from advances in communications, computation and interconnectivity. IoT explores the mixture of hardware, software, data, platforms and services that can be combined to create innovative opportunities for more direct integration of the physical world and objects into computer-based systems, resulting in improved efficiency, accuracy, social and economic benefit to people.

This unit introduces students to the role, basic concepts and benefits of IoT in the design and development process of computer applications. The aim of the unit is to enhance understanding of the methodology, terminology and benefits of IoT in the design and development of software applications.

Among the topics included in this unit are: classification and terminology of IoT, the hardware, software, data, platforms and services used to enable IoT, common architecture, frameworks, tools, hardware and APIs that can be utilised to design IoT-enabled objects, problems and solutions resulting from widespread deployment and adoption of IoT, software application methodology for IoT-specific software application design and development, data models, network complexity, security, privacy, enabling technologies and how to simulate and test an IoT concept.

On successful completion of this unit, students will be able to explain the basic concepts of IoT; design, build and simulate an IoT application using any combination of hardware, software, data, platforms and services; be able to discuss the problems that IoT applications solve; the potential impact on society, business and the end user, and the problems encountered when integrating into the wider IoT ecosystem. As a result, students will develop skills such as communication literacy, design thinking, team working, critical thinking, analysis, reasoning and interpretation and computer software literacy, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

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

LO1 Analyse what aspects of IoT are necessary and appropriate when designing software applications

LO2 Outline a plan for an appropriate IoT application, using common architecture, frameworks, tools, hardware and APIs

LO3 Develop an IoT application using any combination of hardware, software, data, platforms and services

LO4 Evaluate your IoT application and the problems it might encounter when integrating into the wider IoT ecosystem.

Essential Content

LO1 Analyse what aspects of IoT are necessary and appropriate when designing software application

Identify role, formats and characteristics of IoT:

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

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

Explore NB-IoT and eLTE-IoT, including standards evolution and industry development; related technologies, differences, and similarities between NB-IoT and eLTE-IoT.

Appropriateness of various architecture, frameworks, tools, hardware and APIs for different problem-solving requirements, including architecture of NB-IoT solution and eLTE-IoT solutions, NB-IoT physical Layer, key NB-IoT Features, open Modules for integration, E2E Ecosystems, lightweight devices.

Describe application scenarios of NB-IoT and eLTE-IoT.

Recognise the various forms of IoT by researching its history, current trends and use in relation to, and in conjunction with, traditional computer-based systems and networks.

Define the characteristics of IoT by investigating how it can be used and how it can interact with existing computer-based networks and the physical world.

Recognise the use of appropriate IoT applications to solve specific problems.

Research specific forms of IoT functionality:

Explore various forms of IoT functionality.

Research, debate and agree current functionality, technology and trends for IoT. Investigate the advantages and disadvantages of using IoT.

Common problems in smart campuses and cities, pain points, corresponding solutions.

Requirements of IoT technologies, including: ensuring appropriate functionality; the need to reduce power consumption of the smart grid and how this achieved, smart

Driving forces of IoT development and corresponding solutions.

Define standard architecture, frameworks, tools, hardware and APIs available for use in IoT application development:

Review architecture, frameworks, tools, hardware and APIs available to develop IoT applications.

The advantages and disadvantages of IoT architecture, frameworks, tools, hardware and APIs.

How various architecture, frameworks, tools, hardware and APIs can be used to create IoT applications.

Explore key technologies that enable and support mobile/cellular communications, e.g. 3G, 4G, 5G.

LO2 **Outline a plan for an appropriate IoT application using common architecture, frameworks, tools, hardware and APIs**

Identify a problem to be solved and select appropriate IoT techniques to solve a problem:

Specific problem to solve using IoT.

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

Review different architecture, frameworks, tools, hardware and API techniques that can be used.

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

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

Outline the problem to solve including how IoT and a planned application addresses this problem.

Select an appropriate IoT application to achieve desired results.

Apply IoT architecture, frameworks, tools, hardware and API techniques appropriate to the problem identified.

Use selected techniques to create an IoT application development plan.

LO3 **Develop an IoT application using any combination of hardware, software, data, platforms and services**

Utilise appropriate tools and techniques to develop an IoT application:

Employ an appropriate set of tools to develop plan into an IoT application.

Run end user experiments and examine feedback.

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

LO4 **Evaluate your IoT application and the problems it might encounter when integrating into the wider IoT ecosystem**

Assess the success of an IoT application:

Assemble and appraise end user feedback from IoT application.

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

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

Critique the overall success an IoT application including how well it solved problem, potential impact on people, business, society and the end user, possible problems when integrating into the wider IoT ecosystem.

Learning Outcomes and Assessment Criteria

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

Pass	Merit	Distinction
LO4 Evaluate your IoT application and the problems it might encounter when integrating into the wider IoT ecosystem		
P7 Review the IoT application, detailing the problems it solves. **P8** Investigate the potential problems the IoT application might encounter when integrating into the wider system.	**M6** Compare the final application with the original plan.	**D3** Critically evaluate the overall success of the application including the potential impact of the IoT application on people, business and society, and the end user.

Recommended Resources

Textbooks

Bahga, A. and Madisetti, V. (2014) *Internet of Things: A Hands-On Approach*. 1st Ed. VPT.

McEwen, A. (2013) *Designing the Internet of Things.* 1st Ed. John Wiley and Sons.

Links

This unit links to the following related units:

Unit 21: Application Program Interfaces

Unit 47: Emerging Technologies.

Unit 47: Emerging Technologies

Unit code	**R/618/7483**
Unit level	**5**
Credit value	**15**

Introduction

Emerging technologies have the ability to disrupt industries, radically change the progress and thinking of humankind, affect society at large and solve huge problems. Computing underpins many emerging technologies, it allows rapid development and the sharing of ideas, products and scientific understanding across multiple fields in shorter and shorter timeframes. The objective and effect of emerging technologies is usually to change the status quo. This change might be to solve problems, increase performance, improve efficiency, or to create entirely new scientific fields and novel technologies by converging different systems, technology, thinking and disciplines. Emerging technologies include changing technologies that display radical novelty, have the potential for significant commercial or social impact and fast growth and scalability, and which affect the future in uncertain ways.

This unit introduces students to the role, benefits, disadvantages and potential outcomes that emerging technologies have in the development of software applications and business practices. The aim of the unit is to enhance students' understanding of the current types, terminology, advantages, disadvantages, potential impact and benefits of emerging technologies.

Among the topics included in this unit are classification and terminology of emerging technologies, review of the most promising and impactful emerging technologies, trends of convergence, the impact of emerging technologies on software development and an understanding of the scale, scope that emerging technologies may have on organisations their employees and the individuals served by them.

On successful completion of this unit, students will be able to explain some of the most promising and impactful emerging technologies and the advantages and disadvantages. Students will also understand the impact that emerging technologies have on the development of software applications. As a result, they will develop skills such as communication literacy, design thinking, team working, critical thinking, analysis, reasoning, interpretation and computer software literacy, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

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

LO1 Review which emerging technologies are necessary and appropriate when designing software applications for the future

LO2 Research an emerging technology and its impact on a given end-user group

LO3 Develop multiple iterations of an emerging technology solution based on requirements

LO4 Consider the ethical, social, economic and legal factors that play a role in the success of emerging technologies

Essential Content

LO1 Review which emerging technologies are necessary and appropriate when designing software applications for the future

Formats, characteristics and trends of emerging technologies:

Overview of emerging technologies and their appropriate use in software development.

Emerging technology role, purpose and terminology.

Recognise the various forms of emerging technology e.g. educational technology, information technology, nanotechnology, biotechnology, cognitive science, robotics and artificial intelligence.

History and current trends in emerging technologies.

Characteristics of emerging technologies, how they can be used and how they differ from and converge with developed technology.

Recognise specific emerging technologies:

Current trends in emerging technologies and their use in software development and computing e.g. AI, blockchain, IoT, Virtual Reality (VR), Augmented Reality (AR).

Advantages of emerging technologies e.g. efficiency gains, increased effectiveness, new and innovative approach.

Risks of emerging technologies e.g. security and data breach risks, fairness and equity due to bias, costs could be high, ethical and legal compliance.

Emerging technologies versus disruptive technologies.

Appropriateness of using of emerging technologies to disrupt the status quo in industries, markets, user adoption and established practices.

LO2 Research an emerging technology and its impact on a given end-user group

Emerging technology impact:

Investigate specific emerging technology that will have the most impact on software application design and development.

Selection of a specific industry and end-user group that will be the most influenced by emerging technology e.g. doctors in diagnostic health setting, bankers in finance and predictive modelling.

Features of selected emerging technology:

Examination of features based on a specifically selected emerging technology to include key characteristics, area(s) of application, impact on user group and working practices e.g. change of job roles, automation, use of systems, working policies.

Contrast the features, advantages and disadvantages of chosen Emerging Technology.

Convergence:

Technologies cohabiting in a single device, sharing resources and interacting, creating new technology and convenience.

How chosen Emerging Technologies can converge with existing technologies or replace them e.g. blend of the mobile telephone and the Internet, design of hybrid vehicles.

LO3 **Develop multiple iterations of an emerging technology solution based on requirements**

Emerging technology solution:

Small scale prototype solution for a specific user need e.g. AI chatbot, VR video experience, IoT smart solution, 3D printing solution.

Iteration:

Understand end-user requirements by conducting a needs analysis.

Developing an initial prototype based on end user needs.

Iteration based on user feedback and testing.

LO4 **Consider the ethical, social, economic and legal factors that play a role in the success of emerging technologies**

Social, economic, and legal factors:

Understanding emerging technologies can produce unintended consequences.

Ability of emerging technologies to transform cultural mores and traditions, economic trends and structures, political behaviour, legal processes and principles, environmental systems and conditions.

The governance challenges associated with emerging technologies e.g. regulations, policies, laws, and constitutions staying abreast of technological advances.

Organisational decision-making process behind technological implementation including the choice between human capital and technology.

Balancing technology risks and rewards including achieving tangible benefits from emerging technologies and predicting threats associated with new innovations.

Replacing existing technologies or change ways of working:

Changes in practice e.g. AI and deep learning replacing traditional medical diagnosis methods, predictive maintenance in IT and industry versus scheduled processes. autonomous or self-driving vehicles replacing human drivers.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Review which emerging technologies are necessary and appropriate when designing software applications for the future		
P1 Review various forms of emerging technologies, focusing on their relevance to software development and computing. **P2** Explore the benefits and risks of emerging technologies.	**M1** Assess formats, characteristics and trends of emerging technologies. **M2** Justify the ability of emerging technologies to disrupt the status quo in industries, markets, user adoption and established practices.	**D1** Evaluate emerging technologies and justify their use when designing software applications for the future.
LO2 Research an emerging technology and its impact on a given end-user group		
P3 Research a specific industry and end-user group that will be the most influenced by a selected emerging technology.	**M3** Examine the features, of the selected emerging technology.	**D2** Evaluate the solution developed including its impact on a given end user group and their current systems and working practices.
LO3 Develop multiple iterations of an emerging technology solution based on requirements		
P4 Develop a solution using an emerging technology for a given end-user group	**M4** Make multiple iterations of your solution based on feedback gathered from user-user group.	
LO4 Consider the ethical, social, economic and legal factors that play a role in the success of emerging technologies.		
P5 Summarise the importance of considering ethics in the development of emerging technologies.	**M5** Analyse the regulatory challenges in keeping up with the pace of development of emerging technologies.	**D3** Defend the adoption of emerging technologies despite the ethical, social, economic, and legal challenges.

Pass	Merit	Distinction
P6 Discuss the influence of social, economic, and legal factors on the development and deployment of emerging technologies.		

Recommended Resources

Textbooks

Christensen, C. M. (2015) *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail (Management of Innovation and Change)*. Harvard Business Review Press.

Thiel, P. and Masters, B. (2014) *Zero to One: Notes on Startups, or How to Build the Future.* Virgin Digital.

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

Web

frontiersin.org	Frontiers Politics of Technology—Specialty Grand Challenge (Article)
cipd.co.uk	CIPD – The Professional Body for HR and People Development The impact of emerging technologies on work (Article)

Links

This unit links to the following related unit:

Unit 17: Business Process Support.

Unit 50: Operating Systems

Unit code	**H/618/7486**
Unit level	**5**
Credit value	**15**

Introduction

Although many computer users do not interact directly with systems software and hardware, it is important that computing students have the opportunity to learn about these underlying systems.

MS-DOS, Windows, UNIX, Linux, Android, OS2, MacOS are just a few examples of different types of both modern and legacy operating systems. The foundation of most, if not all of them, is MS-DOS (Microsoft Disk Operating System). Way back in the 1980s, this was used as the first operating system for personal computers (PCs). In the 1990s, MS-DOS was transformed to a GUI (Graphic User Interface) WSWIG (What You See Is What You Get) operating system through the release of Windows 3.11/Windows for Workgroups. That has led to several iterations of the Windows Operating System.

This unit introduces students to different operating systems such as DOS, Windows, UNIX and Linux. The topics covered are: the tasks of operating systems such as controlling and allocating memory, prioritising system requests, controlling input and output devices, facilitating data networking and managing files, including security and protection.

Among the topics included in this unit are: the history and evolution of operating systems; the definition of an operating system; why operating systems are needed; how operating systems started and developed; operating systems management roles; management of memory, processes, processors, devices and files; security and protection: user security, device, application and process protection; inter-process communication; comparison of operating systems; distributed and networked systems; concurrent systems; multi-user systems; graphical interface systems; and practical application of operating systems: user interface commands of major operating systems; installations and extensions of operating systems.

On successful completion of this unit, students will be able to operate any given operating system competently and undertake routine maintenance and optimisation of operating systems. 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 Investigate different operating systems, their functions and user interfaces

LO2 Explore the processes managed by an operating system

LO3 Demonstrate the use of DOS, Windows, UNIX and Linux.

LO4 Analyse appropriate techniques and technologies used in distributed and concurrent systems.

Essential Content

LO1 **Investigate different operating systems, their functions and user interfaces**

The history and evolution of operating systems:

How operating systems started and developed.

The history of operating systems from legacy operating systems to current operating systems including the development from batch files to modern operating systems.

Operating system role:

What is meant by an operating system.

Understand why operating systems are needed.

Similarities and differences between operating systems and firmware.

LO2 **Explore the processes managed by an operating system**

Operating systems management:

Memory management including virtual memory.

Scheduling and process scheduling in operating systems including various CPU scheduling algorithms.

Concurrent processing.

Device management.

File management.

Resource management.

The functions of IoT operating systems including overview of IoT operating systems and firmware.

LO3 **Demonstrate the use of different operating systems with a range of commands**

Operating system knowledge:

Commands for manipulating a range of different operating systems, e.g. MS-DOS, Windows, UNIX, Linux.

Demonstration of operating systems tasks e.g. creating or removing a directory.

Operating systems' environments, including distributed operating systems concurrent operating systems.

Security and communications:

How secure different operating systems are including different environments and the conditions of use.

Functional and logical architecture of IoT Platforms, e.g. Huawei's OceanConnect, Amazon Web Services (AWS), Google Cloud Platform,
IBM Watson IoT, Microsoft Azure.

Common IoT communication protocols, CIG functions and architecture, features of IoT platforms.

LO4 **Examine how operating systems will function in the future and the implications on security**

Future of operating systems:

Consider desktops, laptops, smartphones and other devices in terms of operating systems development environment.

Introduction of artificial intelligence and impact on operating systems development e.g. mobile operating systems like Android and iOS equipped with AI-based voice assistants,

Connectivity e.g. Internet of things

Support for cloud computing and outsourcing of operating system functions in the cloud.

Open source operating systems and their impact on future development projects.

Review trends in virtualisation, emulation and use of sophisticated operating systems in mobile systems.

Security e.g. biometrics

Multi-modal interaction e.g. touch, type, speech.

User centred design

Automation of common tasks based on user habits

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Investigate different operating systems, their functions and user interfaces		
P1 Summarise what an operating system is and how it works with reference to different examples. **P2** Research the evolution of operating systems.	**M1** Discuss the importance of operating systems.	**D1** Evaluate the functionality, interface design and processes of a range of operating systems.
LO2 Explore the processes managed by an operating system		
P3 Research the process of memory management in an operating system. **P4** Investigate the process of job scheduling.	**M2** Illustrate the importance of resource management in an operating system to aid its efficiency.	
LO3 Demonstrate the use of different operating systems with a range of commands		
P5 Demonstrate common commands on different operating systems. **P6** Compare how different commands are carried out on different operating systems.	**M3** Analyse the security of different operating systems	**D2** Evaluate the role of different operating system in meeting the needs of future technologies and the implications on security.
LO4 Examine how operating systems will function in the future and the implications on security		
P7 Explore the core features modern operating systems will require to meet future needs.	**M4** Assess how the features of modern operating systems will support the development of future needs.	

Recommended Resources

Textbooks

Arpaci-Dusseau R.H., Arpaci-Dusseau, A.C. (2018) *Operating Systems, Three Easy Pieces.* CreateSpace Independent Publishing Platforms.

Davis, W. S. and Rajkumar, T. M. (2005) *Operating Systems: A Systematic View*. 6th Ed. Harlow, Addison-Wesley.

McHoes, A. M. and Flynn, I. M. (2017) *Understanding Operating Systems*. 8th Ed. Course Technology.

Tanenbaum, A. S. (2016) *Modern Operating Systems*. 4th Ed. India. Pearson.

Tomsho, T. (2016) *Guide to Operating Systems*. 5th Ed. Boston. Cengage Learning

Woodhull, A. S. and Tanenbaum, A. S. (2006) *Operating Systems: Design and Implementation*. 3rd Ed. Upper Saddle River. Prentice Hall.

Links

This unit links to the following related unit:

Unit 40: Client/Server Computing Systems.