BTEC
HIGHER NATIONALS

Computing

Specification

First Teaching from September 2021

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Higher National Certificate Lvl 4

Higher National Diploma Lvl 5

Pearson

8   Pearson BTEC Higher Nationals Computing Units

Unit 1: Programming

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

Introduction

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

Algorithms help to describe the solution to a problem or task; by identifying the data and the process needed to represent the problem or task *and* the set of steps needed to produce the desired result.

Programming languages typically provide the representation of both the data and the process; they provide control constructs and data types (which can be numbers, words, and objects, and be constant or variable).

The control constructs are used to represent the steps of an algorithm in a convenient yet unambiguous fashion. Algorithms require constructs that can perform sequential processing, selection for decision-making, and iteration for repetitive control. Any programming language that provides these basic features can be used for algorithm representation.

This unit introduces students to the core concepts of programming with an introduction to algorithms and the characteristics of programming paradigms.

Among the topics included in this unit are: introduction to algorithms, procedural, object-orientated & event-driven programming, security considerations, the integrated development environment and the debugging process.

On successful completion of this unit students will be able to design and implement algorithms in a chosen language within a suitable Integrated Development Environment (IDE). This IDE will be used to develop and help track any issues with the code.

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

Learning Outcomes

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

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

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

3   Implement basic algorithms in code using an IDE.

4   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 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 which implements basic algorithms including the features of a suitable language and IDE.

Consideration of security concerns and how these 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.

Understand coding standards and its benefits when writing code.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Define basic algorithms to carry out an operation and outline the process of programming an application		**LO1**
P1 Provide a definition of what an algorithm is 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		**LO2**
P2 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 which 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		**LO3**
P3 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		**LO4**
P4 Explain the debugging process and explain the debugging facilities available in the IDE. **P5** 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 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 this content – this decision can be made by the tutor.

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

Textbooks

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

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

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

Links

This unit links to the following related units:

Unit 19: Data Structures & Algorithms
Unit 20: Applied Programming and Design Principles
Unit 54: Prototyping

Unit 2:   Networking

Unit code   **H/615/1619**

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 anytime, anywhere using many applications like e-mail, audio and video transmission, including the World Wide Web, and this has opened the floodgates to the availability of information.

The aim of this unit is to provide students with 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 and the protocol methodologies related to IP data networks will be explored.

On successful completion of this unit students will gain knowledge and skills 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:

1   Examine networking principles and their protocols.

2   Explain networking devices and operations.

3   Design efficient networked systems.

4   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, ring.

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.

Be able to distinguish NB-IoT and Wi-Fi AT command sets.

LO2 **Explain networking devices and operations**

Networking devices:

Servers; hub, routers; switches; multilayer switch (including their operating systems e.g. CISCO IOS, etc), firewall, 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

Networking software:

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

Server type:

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

Server selection:

Cost, purpose, operating system requirement.

Workstation:

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

LO3 **Design efficient networked systems**

Bandwidth:

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

Users:

Quality expectations, concept of system growth.

Networking services and applications:

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

Communications:

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

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.

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.

System monitoring:

Utilisation, bandwidth needs, monitoring user productivity and security of the system. Review data of a network to optimise performance.

Network Automation:

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

Maintenance schedule:

Backups, upgrades, security, auditing.

Diagnose and resolve layer 1 problems:

Explore the E2E integrated development and testing process.

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

Policy review:

Bandwidth, resource availability.

Service level agreements (SLAs):

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

Learning Outcomes and Assessment Criteria

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

Recommended Resources

Textbooks

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

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.

Journals

The Institute of Engineering and Technology

Links

This unit links to the following related units:

Unit 12: 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	**Y/615/1620**
Unit type	**Core**
Unit level	**4**
Credit value	**15**

Introduction

The need to be effective as a communicator, critical thinker, analyser, team worker and interpreter is essential. Within the workplace these skills are needed on a daily basis to show proficiency in designated tasks as part of a job role. The development of academic competence, and also the continuation of life-long learning and Continuing Professional Development (CPD), is required to ensure that individuals have a valued set of interpersonal skills that can be applied to any situation or environment.

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

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

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

Learning Outcomes

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

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

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

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

4   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 whether the problem was solved or not; 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/strategy; problem-solving and short-term development projects; flexibility/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/work group roles; stages in team development e.g. team building, identity, loyalty, commitment to shared beliefs, professionalism, team health evaluation; 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 e.g. employment legislation, ethics, employment rights and responsibilities.

Performance objectives:

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

Continuing Professional Development: lifelong learning, training and development, personal development, professional development.

Evidence criteria:

Production data, personnel data, judgemental data; rating methods e.g. ranking, paired comparison, checklist, management by objectives; skills audit (personal profile using appropriate self-assessment tools); evaluating self-management; personal and interpersonal skills.

Motivation and performance:

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

Development plan:

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

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Demonstrate a range of interpersonal and transferable communication skills to a target audience		**LO1**
P1 Demonstrate, using different communication styles and formats, that you can effectively design and deliver a training event for a given target audience. **P2** Demonstrate that you have used effective time management skills in planning an event.	**M1** Design a professional schedule to support the planning of an event, to include contingencies and justifications of time allocated.	**D1** Evaluate the effectiveness and application of interpersonal skills during the design and delivery of a training event.
LO2 Apply critical reasoning and thinking to a range of problem-solving scenarios		**LO2**
P3 Demonstrate the use of different problem-solving techniques in the design and delivery of an event. **P4** Demonstrate that critical reasoning has been applied to a given solution.	**M2** Research the use of different problem-solving techniques used in the design and delivery of an event. **M3** Justify the use and application of a range of solution methodologies.	**D2** Critique the process of applying critical reasoning to a given task/activity or event.

Pass	Merit	Distinction
LO3 Discuss the importance and dynamics of working within a team and the impact of team working in different environments		**LO3**
P5 Discuss the importance of team dynamics in the success and/or failure of group work. **P6** Work within a team to achieve a defined goal.	**M4** Analyse team dynamics, in terms of the roles group members play in a team and the effectiveness in terms of achieving shared goals.	**D3** Provide a critical evaluation of 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		**LO4**
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 within 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. (2006) *Professional Development, Reflection and Enquiry*. Sage Publications.

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

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

Journals

Journal of Group Dynamics

Professional Development in Education

Websites

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

Links

This unit links to the following related units:

Unit 6: Planning a Computing Project

Unit 16: Computing Research Project

Unit 4:   Database Design & Development

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

Introduction

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

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

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

The aim of this unit is to give students opportunities to develop an understanding of the concepts and issues relating to database design and development, as well as to provide the practical skills to translate that understanding into the design and creation of complex databases.

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

On successful completion of this unit students will be able to use appropriate tools to design and develop a relational database system for a substantial problem. They will be able to test the system to ensure it meets user and system requirements and fully document the system by providing technical and user documentation. For practical purposes, this unit covers relational databases and related tools and techniques. A brief overview of object-oriented databases will also be covered.

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

Learning Outcomes

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

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

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

3   Test the system against user and system requirements.

4   Produce technical and user documentation.

Essential Content

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

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

Determining user and system requirements.

Design tools and techniques for a relational database system.

Logical design for relational databases e.g. tables, data elements, data types, indexes, primary/foreign keys, entity relationship modelling, referential integrity, data normalisation to third normal form.

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

User interface design.

Output designs for user requirements.

Overview of object-oriented databases and their design tools.

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.

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

Implementation of security elements in databases.

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

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

Consideration of interface links with other systems e.g. internet-based applications.

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

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

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

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 nation's 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.

The documentation can include diagrams showing movement of data through the system, and flowcharts describing how the system works. Documentation could also extend to user guides and any initial design and implementation plans.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Use an appropriate design tool to design a relational database system for a substantial problem		
P1 Design a relational database system using appropriate design tools and techniques, containing at least four interrelated tables, with clear statements of user and system requirements.	**M1** Produce a comprehensive design for a fully functional system which includes interface and output designs, data validations and data normalisation.	**D1** Evaluate the effectiveness of the design in relation to user and system requirements.
LO2 Develop a fully functional relational database system, based on an existing system design		
P2 Develop the database system with evidence of user interface, output and data validations, and querying across multiple tables. **P3** Implement a query language into the relational database system.	**M2** Implement a fully functional database system which includes system security and database maintenance. **M3** Assess whether meaningful data has been extracted through the use of query tools to produce appropriate management information.	**LO2 & 3** **D2** Evaluate the effectiveness of the database solution in relation to user and system requirements and suggest improvements.
LO3 Test the system against user and system requirements		
P4 Test the system against user and system requirements.	**M4** Assess the effectiveness of the testing, including an explanation of the choice of test data used.	
LO4 Produce technical and user documentation		
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

International Journal of Database Management Systems

Journal of Database Management

The Computer Journal

Journal of Systems Analysis and Software Engineering

Journal of Emerging Trends in Computing and Information Sciences

Websites

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

Links

This unit links to the following related units:

Unit 11: Strategic Information Systems

Unit 41: Database Management Systems

Unit 5: Security

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

Introduction

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

The aim of this unit is to provide students with knowledge of security, associated risks and how security breaches impact on business continuity. Students will examine security measures involving access authorisation, regulation of use, implementing contingency plans and devising security policies and procedures.

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

Among the topics included in this unit are Network Security design and operational topics, including address translation, DMZ, VPN, firewalls, AV and intrusion detection systems. Remote access will be covered, as will the need for frequent vulnerability testing as part of organisational and security audit compliance.

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

Learning Outcomes

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

1   Assess risks to IT security.

2   Describe IT security solutions.

3   Review mechanisms to control organisational IT security.

4   Manage organisational security.

Essential Content

LO1 Assess risks to IT security

IT security risks:

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

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.

LO2 Describe IT security solutions

IT security solution evaluation:

Network Security infrastructure: 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: explain asset management, image differential/incremental backups, Storage area network (SAN) servers.

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

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

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; Data Protection Act; Computer Misuse Act; ISO 31000 standards.

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

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

Controlling security risk assessments and compliance with security procedures and standards e.g. ISO/IEC 17799:2005 Information Technology (Security Techniques – code of practice for information security management); informing colleagues of their security responsibilities and confirming their understanding at suitable intervals; using enterprise risk management (as part of system management and lifecycle) for identifying, evaluating, implementing and follow up of security risks according to ISO 31000 standards.

Security tools e.g. user log-on profiles to limit user access to resources; online software to train and update staff; auditing tools to monitor resource access; security audits; penetration testing; ethical hacking; gathering and recording information on security; initiating suitable actions for remediation.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Assess risks to IT security		**LO1 & 2**
P1 Discuss types of security risks to organisations. **P2** Assess organisational security procedures.	**M1** Propose a method to assess and treat IT security risks.	**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** Analyse the benefits of implementing network monitoring systems with supporting reasons.	
LO3 Review mechanisms to control organisational IT security		**LO3**
P5 Review risk assessment procedures in an organisation. **P6** Explain data protection processes and regulations as applicable to an organisation.	**M3** Summarise the ISO 31000 risk management methodology and its application in IT security. **M4** Analyse possible impacts to organisational security resulting from an IT security audit.	**D2** Recommend how IT security can be aligned with an organisational policy, detailing the security impact of any misalignment.
LO4 Manage organisational security		**LO4**
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. (2008) *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 Pubs.

Websites

www.bcs.org   British Computer Society (General Reference)

www.bsa.org.uk   Business Software Alliance (General Reference)

www.fast.org.uk   Federation Against Software Theft (General Reference)

www.ico.gov.uk   Information Commissioners Office (General Reference)

Links

This unit links to the following related units:

Unit 29: Network Security

Unit 30: Cryptography

Unit 31: Forensics

Unit 32: Information Security Management

Unit 6: Planning a Computing Project

Unit code	**K/618/5724**
Unit type	**Core unit**
Unit level	**4**
Credit value	**15**

Introduction

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

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

The aim of this unit is to offer students an opportunity to demonstrate the research skills required for developing 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 aid in the planning of a computer-based project and to support recommendations for how the identified business could utilise the tools and technologies identified as art 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 to enable them to investigate and examine relevant computing concepts within a work-related context, determine appropriate outcomes, decisions or solutions and present evidence to various stakeholders in an acceptable and understandable format.

Learning Outcomes

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

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

2   Explore the features and businesses requirements of organisations in an identified sector.

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

4   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 which support a coherent and logical argument.

Use of secondary research to inform a primary empirical study.

Qualitative and quantitative research methods.

Field work:

Selecting a sample of the consumer market, businesses or individuals (those who meet certain characteristics relevant to the research theme) 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 advantages and disadvantages of these.

Using analytical techniques such as trend analysis, coding or 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: Data has value; Data should be reusable; Data is manged according to its value; Data should be fit for purpose

Ethics, reliability and validity:

Ensure all research is conducted and 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 businesses 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 busines (sometimes called 'Business functions') and how they support the organisations purpose: human resources, research and development, sales, marketing, purchasing, production and quality, finance, customer service, IT, administration.

Stakeholders

How Internal Stakeholders (e.g. Management, employees, shareholders) and external stake holders (e.g. suppliers, customers, government agencies, communities) 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 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. 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 different operational and strategic information, amount of technical terminology or jargon used, levels of detail given and simplifying concepts as required.

Consider the methods e.g. written or verbal and the mediums e.g. report, online or presentation, to be used.
Understand how project research and intended audience will influence on method and medium.

Justification of decisions made

Present convincing arguments for the recommended project including use of key points from: cost/benefit analysis; deliverables; success criteria; impact analysis.

Present justifications of planning decisions made including chosen development methodology; work and resource allocation; key deadlines and timescales

Provide supported rationales for decisions made when producing the recommended solution and project plan including: use of research and data for the identified technology and business sector; convincing and logical conclusions that make assertions based on analysis of evidence and business requirements; contextual factors specific to the identified organisation.

Reflection on the quality of research

Secondary and primary data used to inform planning and make decisions should be critiqued and considered with an objective mindset.

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

Critically and objectively 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

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

Learning Outcomes and Assessment Criteria

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

Pass	Merit	Distinction
LO3 Produce project plans based on research of the chosen theme for an identified organisation		**LO3 & LO4**
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 organisation	**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 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
Qualitative Research Journal

Websites

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

Links

This unit links to the following related units:

Unit 3: Professional Practice

Unit 16: Computing Research Project

Unit 14: Business Process Support

Unit 35: Systems Analysis & Design

Unit 7:   Software Development Lifecycles

Unit code   **J/615/1631**

Unit type   **Core**

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 provide students with the knowledge and skills needed to understand software development lifecycles and to demonstrate their knowledge by implementing a software development lifecycle with a suitable methodology.

This unit introduces students to lifecycle decision-making at different stages of the software development process. Students will examine various lifecycle models and appreciate their particular characteristics to understand which project environments they are most appropriate for. Theoretical understanding will be translated into practical skills through an actual software development lifecycle project and 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.

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:

1   Describe different software development lifecycles.

2   Explain the importance of a feasibility study.

3   Undertake a software development lifecycle.

4   Discuss the suitability of software behavioural design techniques.

Essential Content

LO1 **Describe different software development lifecycles.**

Software development lifecycles:

Lifecycle models: understanding and use of predictive (Waterfall, Prototyping, RAD) and adaptive (Spiral, Agile, DSDM) sequential and iterative software development models. Describe different software development lifecycles

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

Test and integration: levels of testing, building test environments; developing test harnesses; black box/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 role of analysis artefacts within a software development 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 within a large scale software project development life cycle:

Identify the different individuals and how they contribute: e.g. project manager, business analyst, systems analyst, programmer, DevOps engineer, testing engineer, quality assurance etc. 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**

Importance of feasibility study:

Requirement gathering techniques: e.g., interviews, observation, investigation

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

Key drivers: performance and efficiency; legacy systems upgrade; automation; elimination of human error.

Feasibility criteria: issues e.g. legal, social, economic, technical, timescales; organisational constraints.

Components: purpose; structure; intended audience; outcomes.

Requirements: MosCow; Functional; non-functional; user; constraints.

LO3 **Undertake a software development lifecycle**

Carry out software development lifecycle:

Identify stakeholders' requirements.

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

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

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.

Use 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),

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.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Describe different software development lifecycles		**LO1**
P1 Describe two iterative and two sequential software lifecycle models. **P2** Explain how risk is managed in these models.	**M1** Discuss, with 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		**LO2** **D2** Assess the impact of different feasibility criteria on a software investigation.
P3 Explain the purpose of a feasibility report. **P4** Describe how technical solutions can be compared.	**M2** Discuss the components of a feasibility report.	
LO3 Undertake a software development lifecycle		**LO3** **M3** Evaluate the process of undertaking a systems investigation with regards to its effectiveness in improving a software quality.
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.	
LO4 Discuss the suitability of software behavioural design techniques		**LO4**
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 for both.	**D4** Present justifications of how data driven software can improve the reliability and effectiveness of software.

Recommended Resources

Textbooks

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

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.

Websites

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

Links
This unit links to the following related units:

Unit 6: Managing a Successful 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 8:   Data Analytics

Unit code   **K/615/1637**

Unit level   **4**

Credit value   **15**

Introduction

Like the physical universe, the digital universe is enormous and is doubling in size every two years. By 2020 the digital universe – the data we create and copy annually – is projected to reach 44 zettabytes or 44 trillion gigabytes.

Data is everywhere in the world. Without knowing how to interpret this data it would be difficult to understand its meaning or make use of the data to increase the productivity of an organisation. Data analytics is a range of processes that converts data into actionable insight using a range of statistical techniques. Data analytics is a relatively new term – it is an overarching term for all decision support and problem-solving techniques. Most of the time the term 'data analytics' and 'business analytics' are used interchangeably.

This unit will introduce the theoretical foundation of data analytics and a range of data analytic processes and techniques to provide hands-on experience for enhancing students' skills.

Topics included in this unit are: data analytic terminologies, types of data analytics, data exploration and visualisation, understanding data with descriptive, predictive and prescriptive analytics.

On successful completion of this unit students will be able to understand the theoretical foundation of data analytics, data analytic processes and techniques. Moreover, they will gain hands-on experience of implementing data analytic processes and techniques using a programming language such as Python, R, or a tool such as Weka, KNIME, PowerBI, Excel etc.

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

Learning Outcomes

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

1 Discuss the theoretical foundation of data analytics that determine decision-making processes in management or business environments.

2 Apply a range of descriptive analytic techniques to convert data into actionable insight using a range of statistical techniques.

3 Investigate a range of predictive analytic techniques to discover new knowledge for forecasting future events.

4 Demonstrate prescriptive analytic methods for finding the best course of action for a situation.

Essential Content

LO1 **Discuss the theoretical foundation of data analytics that determine decision-making processes in management or business environments**

Data analytics terminologies:

Population, sample, categorical data, nominal data, ordinal data, continuous data, discrete data etc.

Types of data analytics:

Descriptive data analytics, predictive data analytics and prescriptive data analytics.

Exploratory data analysis (EDA):

Variable identification, univariate and bi-variate analysis, missing values treatment, etc.

Data visualisation:

Graphs, charts, plots.

LO2 **Apply a range of descriptive analytic techniques to convert data into actionable insight using a range of statistical techniques**

Data analysis lifecycle:
Implement the stages of the data analysis lifecycle including Discovery, Data preparation, Model Planning, Model Building, Operationalise, Communicate results.

Descriptive statistics:

Measures of central tendency, measure of position and measures of dispersion.

Probability distribution:

Cumulate distribution, discrete distribution, continuous distribution.

Sampling and estimation:

Random sampling, systematic sampling, point estimate, interval estimate and so forth.

Statistical inferences:

Models and assumptions.

LO3 Investigate a range of predictive analytic techniques to discover new knowledge for forecasting future events

Regression analytics:

Linear regression, multiple linear regression and logistic regression.

Forecasting techniques:

Qualitative, average approach, naïve approach, time series methods, causal relationship and so forth.

LO4 Demonstrate prescriptive analytic methods for finding the best course of action for a situation

Optimisation:

Classical optimisation, linear programming techniques, nonlinear programming techniques, dynamic programming.

Decision analysis:

Models, justifiable decisions and defensible decisions.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Discuss the theoretical foundation of data analytics that determine decision-making processes in management or business environments		**LO1 & LO2**
P1 Identify data analytic activities, techniques, and tools. **P2** Demonstrate an ability to use a popular programming language or tool used in the data analytics industry.	**M1** Investigate the three types of data analytic methods and their use in industry.	**D1** Evaluate the importance of data analytical techniques to the decision-making process.
LO2 Apply a range of descriptive analytic techniques to convert data into actionable insight using a range of statistical techniques		
P3 Investigate descriptive analytic techniques and explain with appropriate examples. **P4** Apply an appropriate tool or programming language to demonstrate these descriptive analytics techniques.	**M2** Show how these descriptive analytic techniques contribute to decision-making.	

Pass	Merit	Distinction
LO3 Investigate a range of predictive analytic techniques to discover new knowledge for forecasting future events		**LO3**
P5 Identify predictive analytic techniques and describe these techniques with examples. **P6** Apply an appropriate tool or programming language to demonstrate these predictive analytic techniques.	**M3** Compare a range of predictive analytical techniques for forecasting purposes.	**D2** Evaluate how predictive analytic techniques can be used for forecasting purposes.
LO4 Demonstrate prescriptive analytic methods for finding the best course of action for a situation		**LO4**
P7 Analyse prescriptive analytic techniques with appropriate examples. **P8** Demonstrate these techniques using an appropriate programming language or tool.	**M4** Describe how these prescriptive analytic techniques are used to find the best course of action in a situation.	**D3** Apply an appropriate programming language or tool to demonstrate how these prescriptive analytic techniques are used to find the best course of action in a situation.

Recommended Resources

Textbooks

Evans, J. (2016) *Business Analytics.* 2nd Ed. Pearson.

Runkler, T. (2016) *Data Analytics: Models and Algorithms for Intelligent Data Analysis*. 2nd Ed. Vieweg+Teubner Verlag.

Websites

archive.ics.uci.edu/ml	University of California, Irvine "Machine Learning Repository" (Data sets)
www.lfd.uci.edu	University of California, Irvine – Laboratory for Fluorescence Dynamics "Binaries for Python Extension Packages" (Development Tool)
cran.r-project.org	The R Project for Statistical Computing "R Archive Network" (Development Tool)
www.cs.waikato.ac.nz	University of Waikato – Machine Learning Group "Data Mining Software in Java" (Development Tool)
www.knime.org	Konstanz Information Miner "KNIME" (Development Tool)
powerbi.microsoft.com	Microsoft Power BI "Power BI Desktop" (Development Tool)

Links

This unit links to the following related units:

Unit 17: Business Process Support

Unit 26: Big Data Analytics and Visualisation

Unit 9: Computer Systems Architecture

Unit code	**J/615/1628**
Unit level	**4**
Credit value	**15**

Introduction

As technology develops, it is important to have a working foundation on which to build your knowledge. Despite hardware and software being constantly updated and seemingly becoming more complex, students with a solid, underpinned knowledge about computer systems architecture will not only be able to answer questions like, "How does a central processor work?", "What does an operating system do?", "How is information stored?", "What is an instruction set?" and "How do I actually connect to the internet?", but will also be able to transfer and apply their knowledge and skill to many other areas.

This unit introduces students to the foundations of computer systems architecture together with the integrated hardware and software components and subsystems that enable and allow data to be input, processed and output. The unit further explores the concepts of operating systems, hardware management and computer networks together with the practical skills needed to diagnose, troubleshoot and maintain computer systems taking the security of these systems into consideration.

Among the topics included in this unit are: CPUs, memory, input & output devices, ALU operations, program execution, operating systems (including kernel, file systems, API and system calls), hardware management, installation, firmware, device drivers, networking (including OSI and TCP/IP models), error and information gathering, fault diagnostics, security and problem resolution.

On successful completion of this unit, students will be able to explain the purpose and role of operating systems, the relationship between the subsystems embedded within a central processing unit, the core hardware and software components associated with computer operations and be able to configure the hardware and systems needed to establish a computer network together with practical diagnostic and troubleshooting techniques. 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:

1 Explain the relationships between hardware components and the subsystems used in a computer system.

2 Categorise the key features and services provided by different computer operating systems and hardware.

3 Use network communication technology and the associated services to connect computer systems.

4 Demonstrate diagnostic and troubleshooting skills to solve hardware, software and networking related issues.

Essential Content

LO1 Explain the relationships between hardware components and the subsystems used in a computer system

Hardware components and subsystems:

Computers consist of four main subsystems (Von Neumann Architecture, Memory, CPU (Arithmetical & Logic Unit (ALU) and Control Unit), Input and output Systems).

Review Memory subsystems regarding programs and data (variable) storage (ROM, RAM, size, speed, operation and structure).

Explore Input/output systems and structure (communicating with other devices (screen, keyboard, printers, etc.), storage (Hard Disk Drives (HDD), DVD's, etc.), IO controllers & data transfer (speed, buffers, interrupts, etc.).

Discuss ALU subsystems (mathematical & logical operations, registers, bus, etc.).

Investigate how the Control Unit works (program code & language, fetch, decode, execute, halt) including an introduction to machine language instructions (reduced instruction and complex instruction sets: arithmetic, compare, branch, control, Program Counter (PC), Instruction Register (IR) and Instruction decoder.

LO2 Categorise the key features and services provided by different computer operating systems and hardware

Operating system types and hardware:

Introduce different operating systems and types (desktop & server/network, mobile, embedded systems (e.g. Windows 10, Windows Server 2012/2016, Linux, Unix, MacOS, IOS, Android, etc.).

Hardware management and connections including the hardware abstraction layer, firmware and device drivers (network cards, video cards, optical drives, magnetic disks, solid state drives, RAID, etc.).

Installing and configuring common peripheral devices (mouse, keyboard, scanners, biometrics, webcams, smartcards, motion sensor, printers, speakers, display devices, etc.).

Features and services:

Introduce Operating Systems Architecture (Kernel, File Systems, API).

Review how operating systems function and provide services (user interface, memory management (Direct Memory Access), file management).

LO3 Use network communication technology and the associated services to connect computer systems

Networking technology and services:

Network protocols HTTP, SMTP, TCP, UDP, Ports etc.

Layers of the TCP/IP Model: Application layer, transport layer, internet layer, network access layer.

7-layer OSI Model: purpose, architecture, functionality.

Hardware and network addresses: physical/MAC addresses, forward frame using MAC address tables, address resolution protocol (ARP), logical/IP addresses.

Network devices and components: network interface cards (NIC), network cables, switches, wireless access points, routers, network services.

Connecting computer systems to a network:

Introduce topologies including physical and logical: bus, star (extended star), ring and mesh.

Establishing network connections including wired/wireless client configuration.

Security of networking systems and the importance of this.

Explain characteristics of Cellular Mobile Networks.

Explore LPWA Communication Technology in comparison to WCT.

LO4 Demonstrate diagnostic and troubleshooting skills to solve hardware, software and networking related issues.

Hardware, software & networking issues and maintenance:

Different hardware and software related problems and the implication of choices with regards to system administration, impact on users and business operations.

Explore methods of maintenance with regard to hardware and software. Diagnostic and troubleshooting skills:

Discuss information gathering methods and techniques (such as: system documents, user information, error codes, error messages, failure domain, problem history, etc.).

Consider solutions to security problems.

Analyse evidence and establish possible problem domains, complexity, priority and impact; introduce 'Research, Determine, Implement, Review, Document (and Repeat)'.

Creating and updating system documentation.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Explain the relationships between hardware components and the subsystems used in a computer system		**LO1 & 2**
P1 Identify the main subsystems of a computer and explain how they are organised and connected. **P2** Explain the purpose of the Central Processing Unit (CPU) and include details on its operation.	**M1** Review the operation of the CPU and assess its dependency and performance with regards to associated systems and subsystems.	**D1** Evaluate the structure and functions of an operating system including memory, processor, device, file, security, performance and error management with regards to functionality, operation and dependency.
LO2 Categorise the key features and services provided by different computer operating systems and hardware		
P3 Describe a range of different operating systems including the purpose, use and hardware requirements of each. **P4** Discuss the key features associated with the architecture of an operating system.	**M2** Analyse the services provided by an operating system with regards to user interaction, memory management, file management and hardware support.	
LO3 Use network communication technology and the associated services to connect computer systems		**LO3**
P5 Explain the relationships between hardware and network addresses including their use with regards to networking devices and components. **P6** Setup, configure and document appropriate hardware and software systems to establish computer based network connectivity.	**M3** Compare common physical and logical networking topologies and explain the differences and purposes of each.	**D2** Evaluate the OSI and TCP/IP models with regards to hierarchy, layers and services including information on the associated protocols and hardware.

Pass	Merit	Distinction
LO4 Demonstrate diagnostic and troubleshooting skills to solve hardware, software and networking related issues.		**LO4**
P7 Use information gathering methods to assess, troubleshoot and document solutions to a number of different technical hardware, software and networking issues. **P8** Conduct and document a range of maintenance activities with regards to computer hardware and software.	**M4** Review different diagnostic and troubleshooting skills including data gathering methods and techniques.	**D3** Assess any future improvements that may be required to ensure the continued effectiveness of a computer system.

Recommended Resources

Textbooks

Docter, Q., Dulaney, E. and Skandier, T. (2015) *CompTIA A+ Complete Study Guide: Exams 220-901 and 220-902. USA*: John Wiley & Sons Inc.

Mueller, S. (2015) *Upgrading and Repairing PCs. USA*: Que Publishing.

Patterson, D. and Hennessy, J. (2013) *Computer Organization and Design*: The Hardware/Software Interface. USA: Elsevier.

Links

This unit links to the following related units:

Unit 2: Networking

Unit 27: Transport

Network Design Unit 29:

Network Security

Unit 39: Network Management

Unit 40: Client/Server Computing Systems

Unit 10:　　　　Cyber Security

Unit code	M/618/5661
Unit type	Core
Unit level	4
Credit value	15

Introduction

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

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

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

Learning Outcomes

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

1   Explore the nature of cybercrime and cyber threat actors
2   Investigate cyber security threats and hazards
3   Evaluate the effectiveness of information assurance concepts applied to ICT infrastructure
4   Investigate incident response methods to cyber security threats.

Essential Content

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

Cyber security – the importance to business and society:

Business and society reliance on technology.

Why technology is a target for cybercrime.

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

Impact of cyber security in protecting business and society.

Key definitions:

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

Cyber threat actors:

E.g. Cyber Terrorists, Government-Sponsored/State-Sponsored Actors, Organized Crime/Cybercriminals, Hacktivists, Insiders, Internal User Errors

Targets:

E.g. critical national nfrastructure, mainframes, data centres, mobile phones, consumers, individuals, business, websites,

The categorisation of activity:

Active attacks attempt to alter system resources.

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

Attacks can be initiatited from inside or outside the perimeters.

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

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

LO2 Investigate cyber security threats and hazards

Threats and hazards:

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

Threat behaviour

Missing data encryption.

Global threat landscape

Individual and business fraud, extortion, trolling, racketeering, 'black market' sales, embezzlement, cyberstalking, cyber-terrorism, industrial espionage, prostitution, gambling, suicide assistance.

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

Man-in-the-middle (MitM) attack.

Phishing and spear phishing attacks.

Drive-by attack.

Password attacks; brute-force, factionary etc

SQL injection attack.

Cross-site scripting (XSS) attack.

Eavesdropping attack.

Advanced Persistent Threats (APTs)

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

Cyber *Threat Intelligence:*

Importance of threat intelligence

CTI types: tactical, operational, and strategic.

Evidence-based CTI.

Attribution and signs of accountability

Risk of not acting on intelligence

Acting on threat intelligence.

Emerging threats:

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

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

Information Assurance and Governance Concepts:

Assurance, trustworthy versus trusted

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

Definitions and IA principles; Data, information and IT governance; IG roles and responsibilities;

Accountability, legal and regulatory applicability and requirements;

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

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

Records management and inventorying; IT and Data governance frameworks;

IG in the Cloud, Social media and mobile devices; Maintain an IG programme (challenges and opportunities).

ICT Infrastructure:

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

Common vulnerabilities in networks and systems.

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

Traditional, cloud or hyper converged IT Infrastructure.

IoT, IIoT, IoMT.

LO4 Investigate incident response methods to cyber security threats

Standards:

International Organization for Standardisation (ISO), e.g. ISO/IEC 27001 Information Security Management, ISO/IEC 27002:2013 Information technology — Security techniques — Code of practice for information security controls.

Encryption standards:

AES - Advanced Encryption Standard

RSA - Rivest Shamir Adleman

3DEA – Triple Data Encryption Algorithm

PGP – Pretty Good Privacy

Common international encryption laws and policies, e.g. General Right of Encryption, Mandatory Minimum or Maximum Encryption Strength,

Licensing/Regulation Requirements, Import/Export Controls, Obligations on Providers to Assist Authorities, Obligations on Individuals to Assist Authorities

Legislation:

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

Incident response methodology:
Preparation, Detection and Analysis, Containment, Eradication, and Recovery. Developing a containment strategy, identifying and mitigating the hosts and systems under attack, and having a plan for recovery.
Post-Incident Activity.
The principles and elements of Incident Management.
Guidelines for incident responders and computer forensic investigations together with legal aspects and relevant laws.
Intrusion detection and response methods,

Cryptography:
Contemporary use of cryptography, e.g. Data encryption in storage, in usage and in transit (disks, network), data hashing (verification of origin, passwords, look-up tables, software verification, MD5)
Future trends in cryptography, e.g. Blowfish, Twofish, Honey encryption, Quantum key distribution
Asymmetric and Symmetric cryptography

Organisations:

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

Learning Outcomes and Assessment Criteria

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

Recommended resources

Textbooks

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

GILLESPIE, A.A. (2015) Cybercrime. Oxon: Routledge. GRABOSKY, G. (2015) Cybercrime (Keynotes Criminology Criminal Justice). New York: Oxford University Press.

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

SUTTON, D. (2017) Cyber Security: A Practitioner's Guide. Swindon: BCS.

Web

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

Links

This unit links to the following related units:

Unit 5: Security

Unit 30: Cryptography

Unit 11: Strategic Information Systems

Unit code   **A/615/1626**

Unit level   **4**

Credit value   **15**

Introduction

Information is the most valuable resource that an organisation possesses. The effective gathering, protection, analysis, processing and dissemination of information is vital to the success of any organisation. As globalisation and the 24-hour economy develop and increase, organisations must ensure that their information systems are reliable, efficient and able to cope with rapid change.

This unit introduces students to the importance of information to organisations. It will examine how systems can be used to support core business functions and enable organisations to be more productive and competitive within the global marketplace.

Students will be required to analyse the information needs of an organisation at different levels and within different functional areas. It is important that computing professionals are able to understand how an organisation works and how it uses information in order to be able to design, implement, maintain and manage secure information systems to support its operations.

Among the topics included in this unit are understanding organisations in terms of their information needs and the variances within different functional areas.
Examination of different information systems at the operational, tactical and strategic levels will be required, in addition to evaluating their effectiveness and role in terms of decision making and gaining competitive advantage.

On successful completion of this unit students will have an insight into the types of systems and technologies available for effective information processing. Critical analysis will also be used to examine the integrated role that each of these play in contributing to the efficiency and competitiveness of 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:

1   Analyse the information requirements of organisations.

2   Discuss the types of information systems that are used within all levels of an organisation.

3   Demonstrate the use of an information system to produce management information.

4   Evaluate the effectiveness of strategic information systems.

Essential Content

LO1 **Analyse the information requirements of organisations**

Functional area information requirements:

Finance and accounts for payroll, pensions, supplier payments and invoicing etc., human resources e.g. employee records, personnel data, appraisals, CPD etc., stock control, sales, marketing, research and development, production, distribution, IT, customer service and administration.

Information needs:

How different functional areas use and process data effectively; the integration of data and information within an organisation.

Requirements analysis:

The inputs, outputs and processing activities; information distribution requirements e.g. by location, department, individual/customer.

LO2 **Discuss the types of information systems that are used within all levels of an organisation**

Information systems types:

Business information systems, decision support systems, management information systems, strategic/executive information systems, office information systems, transaction processing systems, expert systems, global information systems, data warehouse systems, enterprise systems, enterprise resource planning systems, integrated information systems.

Categories of information systems:

Operational, tactical and strategic information systems.

Information and data:

Definition of information and data, sources of information, information requirements and the needs for information at different levels within an organisation; storing information and its importance with regard to security, accuracy and relevance; outputs e.g. payroll, invoicing, ordering, bookings, stock control, personnel records, goods tracking, decision-making, marketing, customer service.

LO3 Demonstrate the use of an information system to produce management information

Management information:

Reports e.g. sales report, college enrolment statistics, marketing analysis (brick v click), trends in the market, competition and market share.

Gathering information:

Defining requirements; establishing sources of information; defining other factors to be considered e.g. constraints and access to information.

Selecting information:

Analysis of information in terms of validity, accuracy, currency and relevancy; identifying and rationalising meaningful information from data sets.

Quality risks inherent in data and how to mitigate or resolve these.

Uses:

Proficiency in terms of accessing quality information that can be used for decision-making, problem-solving, predictions, trending and forecasting.

Understanding tasks e.g. use of GDPR data, how organisations and industry will have policies and procedures relating to those tasks.

LO4 Evaluate the effectiveness of strategic information systems

Models for strategic information systems:

Porters Competitive Advantage and Wiseman's Strategic Planning Process.

Competitive advantage:

How can competitive advantage be measured and attributed to the implementation of a strategic information system?

Gaining competitive advantage:

Delivering a differentiated product or service; delivering a product or service at a lower cost; specific segmentation of the market e.g. targeted marketing to specific target audiences; innovative product or service design and implementation.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Analyse the information requirements of organisations		**LO1** **D1** Evaluate the inputs, outputs and processing activities of a selected organisation.
P1 Discuss the information needs and requirements for the functional departments of an organisation. **P2** Produce an input/output (I/O) diagram to represent the data and information requirements of a functional department.	**M1** Compare and contrast different processing activities that occur within functional departments within an organisation.	
LO2 Discuss the types of information systems that are used within all levels of an organisation		**LO2** **D2** Differentiate between the function and purpose of information systems at different levels within an organisation.
P3 Describe the function of different information systems. **P4** Discuss the information needs required at differing levels within an organisation.	**M2** Analyse the effectiveness of information systems at the operational, tactical and strategic levels within an organisation.	

Pass	Merit	Distinction
LO3 Demonstrate the use of an information system to produce management information		**LO3**
P5 Demonstrate the use of an information system for management reporting purposes. **P6** Discuss the importance of an organisation having data and information that is current, valid and accurate.	**M3** Analyse the constraints that an organisation can face when gathering data and information.	**D3** Critique, with examples, how a given organisation can use information for effective decision-making and forecasting.
LO4 Evaluate the effectiveness of strategic information systems		**LO4**
P7 Identify different models that can be applied to strategic information systems.	**M4** Justify the ways in which an organisation can obtain competitive advantage within a global market.	**D4** Evaluate how strategic information systems can contribute to the competitiveness of organisations.

Recommended Resources

Textbooks

Bradford, M (2014) *Modern ERP. Select, Implement, and Use Today's Advanced Business Systems* Lulu.com

Peppard, J. (2016) *The Strategic Management of Information Systems: Building a Digital Strategy*. 4th Ed. John Wiley & Sons.

Stair, R. Reynolds, G. (2017) *Fundamentals of Information Systems* 9th Ed. Course Technology

Whitely, D. (2013) *An Introduction to Information Systems*. Palgrave Macmillan.

Journals

The Journal of Strategic Information Systems

Information Systems Journal

Websites

| it.toolbox.com | ToolBox.com "Strategic Information System Toolbox" (Wiki) |
| www.mbaknol.com | MBA Knowledge Base "Strategic Information Systems" (Article) |

Links

This unit links to the following related units:

Unit 4: Database Design & Development

Unit 41: Database Management System

Unit 12: Management in the Digital Economy

Unit code	H/618/5690
Unit level	4
Credit value	15

Introduction

The Internet creates a borderless economy and over the last few decades has taken shape resulting from billions of everyday connections between people, business, data and processes. As the digital economy continues to evolve, each day it destabilises traditional norms and practices in organisations, therefore requiring managers to reinvent and consider new ways of working. The way in which an organisation structures and organises its workforce will affect the culture that develops within it. Its system of shared values and beliefs will determine and shape the accepted pattern of behaviour within the organisation. This structure and culture, along with the way that managers approach the workforce and motivate their staff, will directly affect performance. The management of structure and culture in digital sector organisations is now quite different to those in other sectors.

This unit introduces students to the concept of organisational behaviour and encourages them to apply this to the digital sector, developing an awareness of how organisations in the digital economy are organised and formed. It will explore topics including structures, culture, and the impact and influence stakeholders can have on digital organisations. Students will consider the use of communication and media channels to understand different stakeholders, discover a range of digital-led management styles and leadership skills to assess those most appropriate, before applying theories of motivation to digital teams.

On successful completion of this unit, students will have discussed different types of organisational structure and culture; evaluated the impact of stakeholders in a digital sector organisation; investigated digital-led approaches to management and leadership; and assessed the relationship between motivation, organisational behaviour, performance and reflection. Students will have the opportunity to progress to a range of roles within the digital sector, which could include, for example, the role of IT Manager, Team Leader, Digital Community Manager, or working within project management.

Learning Outcomes

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

1   Investigate types of organisational structures and cultures in the digital economy sector.

2   Explore the role, impact and influence of stakeholders in a digital economy organisation.

3   Investigate digital-led approaches to management and leadership.

4   Assess the relationship between motivation, organisational behaviour, performance and reflection in a digital team.

Essential Content

LO1 Investigate types of organisational structures and cultures in the digital economy

Digital economy organisations:

ICT-goods-producing and supporting infrastructure (i.e. hardware, software, telecoms) and ICT-service-producing, e-commerce and e-business (i.e. trading of goods or services).

Existing sectors increased use of digital products or services to include: government, retail, transport and logistics, financial services, manufacturing and agriculture, education, healthcare, broadcasting and media.

Supporting organisations, e.g. charities, social enterprises; and voluntary groups, e.g. third sector role in supporting delivery of services.

Key terminology and organisational structures:

Organisational terms, e.g. hierarchy, span of control, chain of command, line management, authority, delegation, empowerment, lines of communication, delayering, centralisation and decentralisation, collaboration and cross-collaboration, examples of organisational charts.

Structures including functional, product-based, geographically-based, divisional, multifunctional and multidivisional, matrix, project, tall, flat, holistic, bureaucratic and post-bureaucratic, parent, strategic business units (SBUs).

Archetypes of digital teams, e.g. centralised, hybrid, independent, informal.

Organisational culture:

Types of organisational culture, e.g. forward-looking, backward-looking, innovation, customer-centric, digital transformation.

Shared drivers of organisational culture to include: behaviours (e.g. assumptions, vision, norms, values and beliefs), systems (e.g. processes, decision-making, renumeration) and symbols (e.g. observations, language, stories).

Theories, e.g. Hofstede's Cultural Dimensions (6D's), Handy's Model of Organisational Culture (power, role, task and person), Schien's Model of Organisational Culture, Lewin's Force Field Analysis for change; and digital-led trends, e.g. social connectivity, communication speed, learning, automation.

LO2 Explore the role, impact and influence of stakeholders in a digital sector organisation

Size and scope of organisations in the digital sector:

Differences between small, medium and large-sized organisations including

objectives and goals, market share, profit share, growth and sustainability. Global digital growth and developments of transnational, international and global organisations.

Role and community impact of stakeholders:

Examples of organisational stakeholders, e.g. employees, communities, shareholders, creditors, investors, government, customers, owners, managers, suppliers, competitors, unions, trade groups, analysts and media.
Stakeholders and responsibilities of organisation to engage with different internal and external stakeholder interests, perspectives and expectations.
Importance of corporate communication strategy alignment to support business objectives, brand loyalty and community relationships.
Stakeholder communication and media channels, e.g. corporate website, online communities and forums, publications, meetings and visits, to communicate technical information to both technical and non-technical audiences.
The relationship with stakeholders and meeting stakeholder expectations in the context of encouraging, developing and sustaining community; sharing and delivering welcomed and unwelcomed information; conflict management techniques and understanding of community management best practice relevant in the industry..

Influence of stakeholders in the digital sector:
Central government, e.g. legislation, budget and spending review, economic growth, education and social welfare.
Private and public sector, e.g. digital innovation and change (new technologies, business processes, business models, domains and people development), labour force (elimination and creation of jobs) and transparency of business habits.
Customer, clients and users, e.g. law of supply-demand, accessibility of data and content, surveillance capitalism, consumer rights and brand reputation.

LO3 **Investigate digital-led approaches to management and leadership**

Digital-led approaches to management:
Quantitative or mathematical approach (i.e. management science).
Systems approach (i.e. systems management)
Contingency or situational approach (i.e. empirical case study).
Administrative or management process (i.e. 'traditional' or 'universalist')
Human relations (i.e. social and psychological factors)
Behavioural science (i.e. interpersonal behaviour)

Decision-theory (i.e. decision-making)

IT-led management (i.e. operational and management process)

Types of management styles:

Methods used by managers to organise people, e.g. directive, authoritative, visionary, affiliative, participative, pacesetting, autocratic, consultative, servant, persuasive, democratic, chaotic, laissez-faire, paternalistic or maternalistic, transactional, results-based, transformational.

Roles and responsibilities of managers, e.g. interpersonal, informational, decisional, planning, leading, organising, commanding, coordinating, coaching, controlling, decision making, conflict resolution, managing change, delegation, contingency planning.

Identify ways that managers elicit information from stakeholders to process information, identify business needs, validate requirements and document areas of interest and influence.

Digital-led leadership skills:

Adopted roles and characteristics, i.e. digital champions, digital investors, digital pioneers, digital transformers,

Leader capabilities, i.e. cognitive transformation, behaviour transformation and emotional transformation.

LO4 Assess the relationship between motivation, organisational behaviour, performance and reflection in a digital team

Motivation and performance:

Motivational theories including content theories (e.g. Maslow, Herzberg and Alderfer), process theories (e.g. Vroom, Adams, Latham and Locke) and applications of motivational theory on management and leadership.

The use of rewards and incentives (monetary and non-monetary), effective management, performance standards (goal setting, appraisals) and staff morale on digital team's performance management.

Organisational behaviour and reflective practice:

Organisational psychology, personality and work behaviour, self and self-image, personality traits and types (e.g. Myers Briggs Type Indicator (MBTI)), group dynamics and inter-group behaviour (e.g. Belbin Team Roles).

Benefits of reflective practice on individual and organisation performance, recognition of paradigms (i.e. assumptions, frameworks, patterns of thought and behaviour, thinking and action).

Organisational learning, monitoring and evaluation.

Addressing issues of position, conflict, resistance and power relationships.
Reflective theory and models, e.g. Dewey, Schön, Gibbs' reflective cycle, Lawrence-Wilkes' REFLECT model, Rolfe et al's reflective model.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Investigate different types of organisational structures and cultures in the digital economy		**D1** Evaluate the structure, culture, role, impact of communication and influence of stakeholders in a digital sector organisation.
P1 Explain different types of organisational structures in the digital economy. **P2** Describe the concept of culture as it applies to digital sector organisations.	**M1** Discuss the different structures and cultures used in the digital economy, providing specific examples.	
LO2 Explore the role, impact and influence of stakeholders in a digital sector organisation		
P3 Explain the role of stakeholders, providing specific examples, in the digital sector. **P4** Review stakeholder communication and media channels to identify a threat or opportunity in a digital sector organisation.	**M2** Analyse how different stakeholders, and choice of communication and media channels, can impact and influence a digital sector organisation.	
LO3 Investigate digital-led approaches to management and leadership		**D2** Assess the management approach and leadership skills, in response to motivation theory and organisational behaviour, to improve performance of a digital team.
P5 Discuss different approaches to management styles, providing specific examples.	**M3** Analyse the roles, characteristics and capabilities of digital-led leaders.	
LO4 Assess the relationship between motivation, organisational behaviour, performance and reflection in a digital team		
P6 Describe the relationship between motivation, organisational behaviour and reflection, on performance.	**M5** Compare advantages and disadvantages, of using motivation and reflection theories, when applied to a digital team.	

Recommended resources

Textbooks

BEAMES, C. (2019) *How to Manage Your Workforce in the Digital Age.* Online: Blurb.

GARFIELD, S.A. (2020) *Handbook of Community Management: A Guide to Leading Communities of Practice.* Berlin: Walter de Gruyter.

HILL, A. (2016) *Leadership in the Headlines: Insider insights into how leaders lead.* London: Financial Times Publishing.

HUCZYNSKI, A. and BUCHANAN, D. (2013) *Organisational Behaviour*. 8th edn. Harlow: Pearson.

MULLINS, L.J. (2016) *Management and Organisational Behaviour*. 11th edn. Harlow: Pearson.

O'BRIEN, J. (2017) *The Power of Purpose: Inspire teams, engage customers, transform business.* Online: Pearson Business.

RASKINO, M. and WALLER, G. (2015) *Digital to the Core: Remastering Leadership for Your Industry, Your Enterprise and Yourself.* Oxon: Taylor & Francis.

ROLLINSON, D. (2008) *Organisational Behaviour and Analysis: An Integrated Approach*. 4th end. Harlow: Prentice Hall.

SCHEDLITZKI, D. and EDWARDS, G. (2014) *Studying Leadership: Traditional and Critical Approaches*. London: SAGE.

STOKES, P. et al (2016) *Organizational Management: Approaches and Solutions.* London: Kogan Page.

SZCZEPANSKA-WOSZCZYNA, K. (2020) *Management Theory, Innovation, and Organisation: A Model of Managerial Competencies.* Oxon: Taylor & Francis.

YUKI, G. and GARDENER, W.L. (2019) *Leadership in Organizations, Global Edition.* 9th edn. Online: Pearson.

Journals

Journal of Management, Online

Journal of Leadership and Organizational Studies, Online

Journal of Occupational and Organizational Psychology, Online

Web

myersbriggs.org	The Myers & Briggs Foundation (General reference)
belbin.com	The Nine Belbin Team Roles (General reference)

Links

This unit links to the following related units:

Unit 53: Digital Technologies as a Catalyst for Change

Unit 13:Website Design & Development

Unit code   **R/615/1633**

Unit level   **4**

Credit value   **15**

Introduction

Wireless, public hotspots, mobile broadband and unlimited network connections means that accessing and using the internet to request, use and post information has never been so easy, or so important. As public, organisational and business demand increases so does user expectation. Designers need to successfully use technology to deliver a high quality and consistent User Experiences (UX) through friendly and functional User Interfaces (UI). However, as the software and hardware evolve, so does the challenge of design.

This unit introduces students to the underpinning services required to host, manage and access a secure website before introducing and exploring the methods used by designers and developers to blend back-end technologies (server-side) with front-end technologies (client-side). To help ensure new designers are able to design and deliver a site that offers an outstanding User Experience (UX) supported by an innovative User Interface (UI) this unit also discusses the reasons, requirements, relationships, capabilities and features of the systems they will be using and gives them an opportunity to explore various tools, techniques and technologies with 'good design' principles to plan, design and review a multipage website.

Among the topics included in this unit are: domain structure, domain name systems, web protocols, database servers, development frameworks, website publishing, content management, search engine optimisation, web browsers, HTML standards, CSS and CSS pre-processing (LESS, SASS), presentation models, responsive design, integrated development environments, user requirements, interface design, user experience, branding, navigation, optimisation and validation.

On successful completion of this unit students will be able to explain server technologies and management services associated with the hosting and management of secure websites, categorise website technologies, tools and software used to develop websites, utilise website technologies, tools and techniques with good design principles to create a multipage website and create and use a Test Plan to review the performance and design of a multipage website.

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

Learning Outcomes

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

1   Explain server technologies and management services associated with hosting and managing websites.

2   Categorise website technologies, tools and software used to develop websites.

3   Utilise website technologies, tools and techniques with good design principles to create a multipage website.

4   Create and use a Test Plan to review the performance and design of a multipage website.

Essential Content

LO1 **Explain server technologies and management services associated with hosting and managing websites**

Hosting and website management:

Investigate relationships between domain names, DNS services and communication protocols used to access a website.

Overview of publishing and managing secure websites, including search engine indexing and ranking.

Different server technologies:

Differences between web server hardware, software and host operating systems.

Advantages of an integrated database system with regards to expanding website capability.

Common web development technologies and frameworks.

LO2 **Categorise website technologies, tools and software used to develop websites**

Website technologies:

Using front-end technologies, presentation layers and client-side programming to build a User Interface (UI) and effect User Experience (UX).

How back-end technologies, application layers and server-side programming can be used to enable personalisation and deliver dynamic content.

Tools, techniques and software used to develop websites e.g. Integrated development environments, code repositories, low code environments, front end and back end processing.

Improving User Experience (UX) through Rich Internet Application (RIA) design using JavaScript and CSS frameworks and packages.

Overview of online content management systems including possible advantages and limitations with regards to design.

Using web design and development software to design and build a secure website.

LO3 Utilise website technologies, tools and techniques with good design principles to create a multipage website

Establish the client and user requirements:

Differentiate client and user requirements from behaviours.

Consider how audience and purpose could influence the look and feel of a website.

Review accessibility and inclusivity standards and guidelines (e.g. W3C, Equality Act and other relevant legislation) and their possible impact on design and aesthetics.

Research and create good content combined with good design principles to create a multipage website:

Introduce and use recognised design principles, incorporating accessibility and inclusivity guidelines to implement an appropriately branded, multipage site.

Guidelines and recommended good practice to ensure the website and associated data is 'secure by design'.

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

LO4 Create and use a Test Plan to review the performance and design of a multipage website

Consider factors that influence website performance:

Review how intuitive interfaces and actions, user-friendly designs, appropriate graphics, effective navigation and good quality content can help establish user trust and deliver an improved User Experience (UX).

Consider the effects of good and bad search engine optimisation (SEO) and indexing on the performance of a website.

W3C Validation (HTML and CSS) and how it influences website design and performance.

Establish a Test Plan and use it to assess the performance of a website:

Assess the impact of poorly optimised website graphics.

Research and conduct Quality Assurance (QA) and usability testing on a multipage website.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Explain server technologies and management services associated with hosting and managing websites		**LO1 & LO2** **D1** Justify the technologies, management services, tools and software chosen to realise a custom-built website.
P1 Identify the purpose and types of DNS, including explanations on how domain names are organised and managed. **P2** Explain the purpose and relationships between communication protocols, server hardware, operating systems and web server software with regards to designing, publishing and accessing a website.	**M1** Analyse the impact of common web development technologies and frameworks with regards to website design, functionality and management. **M2** Review the influence of search engines on website performance and provide evidence-based support for improving a site's index value and rank through search engine optimisation.	
LO2 Categorise website technologies, tools and software used to develop websites		
P3 Discuss the capabilities and relationships between front-end and back-end website technologies and explain how these relate to presentation and application layers. **P4** Discuss the differences between online website creation tools and custom built sites with regards to design flexibility, performance, functionality, User Experience (UX) and User Interface (UI).	**M3** Analyse a range of tools and techniques available to design and develop a custom built website.	

Pass	Merit	Distinction
LO3 Utilise website technologies, tools and techniques with good design principles to create a multipage website		**LO3**
P5 Create a design document for a branded, multipage website supported with medium fidelity wireframes and a full set of client and user requirements. **P6** Use your design document with appropriate principles, standards and guidelines to produce a branded, multipage website supported with realistic content.	**M4** Compare and contrast the multipage website created to the design document.	**D2** Critically evaluate the design and development process against your design document and analyse any technical challenges.
LO4 Create and use a Test Plan to review the performance and design of a multipage website		**LO4**
P7 Create a suitable test plan identifying key performance areas to review the functionality and performance of your website.	**M5** Analyse the Quality Assurance (QA) process and review how it was implemented during your design and development stages.	**D3** Critically evaluate the results of your Test Plan and include a review of the overall success of your multipage website; use this evaluation to explain any areas of success and provide justified recommendations for areas that require improvement.

Recommended Resources

Textbooks

Frain, B. (2012) *Responsive Web Design with HTML5 and CSS. UK*: Packt Publishing.

Krug, S. (2013) *Don't Make Me Think: A Common Sense Approach to Web Usability*. USA: New Riders.

Lidwell, W., Holden, K. and Butler, J. (2010) *Universal Principles of Design, Revised and Updated: 115 Ways to Enhance Usability, Influence Perception, Increase Appeal, Make Better Design Decisions and Teach Through Design*. USA: Rockport Publishers.

Web Links

www.w3.org	World Wide Web Consortium (General Reference)
developers.google.com/web/tools	Goole web development tools (General Reference)
getbootstrap.com	Open Source web development tool kit (General Reference)

Links

This unit links to the following related units:

Unit 36: User Experience & Interface Design

Unit 14: Maths for Computing

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

Introduction

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

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

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

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

Learning Outcomes

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

1   Use applied number theory in practical computing scenarios.

2   Analyse events using probability theory and probability distributions.

3   Determine solutions of graphical examples using geometry and vector methods.

4   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		**LO1**
P1 Calculate the greatest common divisor and least common multiple of a given pair of numbers.	**M1** Identify multiplicative inverses in modular arithmetic.	**D1** Produce a detailed written explanation of the importance of prime numbers within the field of computing.
P2 Use relevant theory to sum arithmetic and geometric progressions.		
LO2 Analyse events using probability theory and probability distributions		**LO2**
P3 Deduce the conditional probability of different events occurring within independent trials.	**M2** Calculate probabilities within both binomially distributed and normally distributed random variables.	**D2** Evaluate probability theory to an example involving hashing and load balancing.
P4 Identify the expectation of an event occurring from a discrete, random variable.		
LO3 Determine solutions of graphical examples using geometry and vector methods		**LO3**
P5 Identify simple shapes using co-ordinate geometry.	**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.
P6 Determine shape parameters using appropriate vector methods.		
LO4 Evaluate problems concerning differential and integral calculus		**LO4**
P7 Determine the rate of change within an algebraic function.	**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.
P8 Use integral calculus to solve practical problems involving area.		

Recommended Resources

Textbooks

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

Journals

Journal of Computational Mathematics. Global Science Press.

Links

This unit links to the following related units:

Unit 18: Discrete Maths

Unit 33: Applied Analytical Models

Unit 15: Fundamentals of Artificial Intelligence (AI) & Intelligent Systems

Unit code	K/618/5660
Unit level	4
Credit value	15

Introduction

Intelligent Systems are revolutionising industry and changing the way we accomplish daily routines. They help to introduce flexibility, quality and energy efficiency to name a few to an increasing range of applications. For example, transportation, healthcare, education, and the defence sector. Intelligent Systems are enabled by various underpinning technologies, especially Artificial Intelligence (AI). AI offers opportunities to gain insights from data or perceive the environment to take intelligent actions that maximize the chances of performing a task faster or not previously possible. The growth in AI potential offers companies opportunities to reduce costs, increase productivity and introduce new products to the market. Therefore, people skilled in AI and its applications are in high demand.

This unit is designed to introduce the science behind machine intelligence and the philosophical debate around the ambitions of simulating human intelligence to solve real-world problems. Students will be guided to appreciate AI types and applications and develop a better understanding of aspects related to intelligent agents. Other topics included in the unit covers Artificial Narrow Intelligence (ANI), Artificial General Intelligence (AGI), Ambient Intelligence, the major differences between top-down and bottom-up approaches to AI, and understanding Machine Learning (ML) algorithms (e.g. SVM, Naïve Bayes, Random Forest and KNN) and processes including dataset preparation.

On successful completion of this unit, students will be able to investigate AI fundamentals including data gathering, validation, and processing. Additionally, how the results can be visualised and explained. They will also develop their skillset to study deployed Intelligent Systems and evaluate technical and ethical challenges and opportunities.

Learning Outcomes

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

1   Discuss the theoretical foundation of Artificial Intelligence and its impact on users and organisations.
2   Analyse the approaches, techniques and tools to deploy Intelligent Systems in an organisation
3   Modify an AI-based system to improve how exhibits intelligence in response to a real-world problem.
4   Evaluate the technical and ethical challenges and opportunities of Intelligent Systems.

Essential Content

LO1 **Discuss the theoretical foundation of Artificial Intelligence and its impact on users and organisations**

AI Fundamentals:

Understanding what defines Artificial/Machine Intelligence; philosophical debates around the ambitions of simulating human intelligence; and the phenomenon of the "AI effect".

AI and the phenomenon of combinatorial explosion.

The requirements of the underlying Data and its influence on AI outcomes.

How to handle large (big data) versus small datasets.

Understanding what "Learning from experience" means for Intelligent Agents and Intelligent Systems.

Appreciating the difference between AI and its subfields such as Machine Learning and related interdisciplinary research areas such as Robotics

How AI leverages other disciplines such as computer science, mathematics, psychology, software engineering, and linguistics.

Recognising traditional problems (goals) of AI such as reasoning, planning, learning, natural language processing, and perception.

Decision-Making: basics of utility theory, sequential decision problems, elementary game theory, decision theory.

Understanding Intelligent agents: reactive, deliberative, goal-driven, utility-driven, and learning agents.

AI Types:

The difference between weak AI and strong AI.

Artificial Narrow Intelligence (ANI), also referred to as weak AI with applications focused on singular tasks; e.g. Alexa, Siri, prediction tools, spam filters.

Artificial General Intelligence (AGI), also known as strong AI or deep AI; e.g. Recognition, Recall, Hypothesis testing, Imagination, Analogy, Implication.

Artificial Super-intelligence (ASI), a hypothetical concept.

AI Applications:

The role of AI on the principles of a Universal Design.

Ambient Intelligence; enabling electronic environments that are sensitive and responsive to the presence and preferences of people.

Finance; e.g. to detect anomalies in charges outside of the norm, flagging these for human investigation.

Agriculture; e.g. predicting the time it takes for a crop to be ripe and ready for picking, harvesting robot, predicting and extending storage and shelf life.

Business and eCommerce; e.g. chatbots, visual searches, intelligent virtual assistants.

Engineering; e.g. Computer Aided Design (CAD) and automation in factories.

Healthcare; e.g. care of the elderly, heart beats analysis, computer-aided interpretation of medical images, drug discovery.

Cybersecurity; e.g. profiling anomalous user behaviour, automating response against large-scale attacks.

Logistics and Supply Chain; e.g. autonomous trucks and robotic picking systems.

Other examples include any application which exhibit intelligence via AI techniques such as strategy games, autopilot in autonomous cars, intelligent routing in computer networks, and military simulations.

LO2 **Analyse the approaches, techniques and tools to deploy Intelligent Systems in an organisation**

Approaches:

The major differences between top-down and bottom-up approaches to AI.

Explainable AI (XAI).

Statistical methods, computational intelligence, and traditional symbolic AI

AI Tools, Libraries, Platforms, and Frameworks:

Options include but not limited to Tensorflow, Torch, Theano, Azure Machine Learning, MathWorks Matlab (plus Simulink), CNTK (Computational Network Toolkit), Deeplearning4j, Scikit-Learn, Swift AI IBM Watson, Keras, Pybrain, Google ML kit, Caffe, H20: open source AI platform.

Algorithms and techniques:

Understanding Machine Learning algorithms and processes including dataset preparation.

Linear Regression, Logistic Regression, Decision Tree, K-Nearest Neighbour, SVM (Support Vector Machine), Naïve Bayes, KNN (K- Nearest Neighbours), K-Means, Random Forest, Dimensionality Reduction Algorithms, Gradient Boosting & AdaBoost.

LO3 **Modify an AI-based system to improve how it exhibits intelligence in response to a real-world problem.**

Modification:

Identifying the need to make modifications

Modifying existing AI-based system

Modifying commands

Impact of modification on cost and quality

Improvement identification, e.g. accuracy, efficiency, speed

Application selection:

Criteria for AI-based application selection, e.g. any application software, system or agent which exhibits intelligence as part of its problem-solving approach; e.g. open-source projects from Google and GitHub

AI Analysis:

Overfitting

Underfitting

Data collection, data sources and assessment of data reliability to modify AI-based system

LO4 **Evaluate the technical and ethical challenges and opportunities of Intelligent Systems**

Challenges:

Overfitting; AI lack of reasoning; e.g. naïve physics, folk psychology.

The impact of data quality and quantity; e.g. on the accuracy of an AI algorithm.

Job automation; risks of mass unemployment.

Intelligent Systems and Intelligent Agents have no emotions or out-of-the-box thinking.

Limited understanding of the AI decision making process; e.g. deep learning.

Ethical use of AI, e.g. use of deep learning in recruiting new employees, Deepfake,

Challenges related to the lack of compliance frameworks while considering legal and emerging legal factors, e.g. GDPR, Data Protection and governance.

Risks; privacy and security; e.g. Deepfake technology, emerging technology, aligning AI goals with objective(s)

AI bias and the ethical dilemma: e.g. potential to widen socio-economic inequality, AI powered hiring processes (employment opportunities), access to skilling, health/life extension, algorithmic quantitative trading.

Challenges related to readiness; e.g. Lack of understanding of AI (and the value of data) among non-technical employees, lack of business alignment, robust testing,

alignment of AI goals with defined objectives

Autonomous weapons (mass casualties); AI arms race. Ethical implications of autonomous weapons

AI and Intelligent Systems are emerging technologies; not fully tested.

The environmental footprint of AI; e.g. the carbon impact of AI.

Myth and fiction around AI; e.g. mythical worry: "AI turning conscious" vs actual worry: "AI turning competence with objectives misaligned with ours".

Opportunities:

Artificial cognitive abilities could make faster and more accurate decisions; e.g. intelligence advice in health care.

Enabling affordability of services; e.g. automation reduces operational costs.

Meeting demand; e.g. the optimisation of routine processes increases productivity.

Inform strategic decision making; e.g. profiling and risk assessment based on large datasets to predict high-risk events/actors.

Mitigate physical harm; e.g. an AI-driven robot replaces a human in a dangerous location.

Availability; an AI system can work 24x7.

Introducing new innovations; e.g. AI as a competitor advantage (AI is an emerging technology with growing potential enabled by increasing processing power).

Collaborative work with human input; e.g. AI and humans work together to reduce false positives.

Collaborative Robots (Cobots) and use in industry, healthcare, etc.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Discuss the theoretical foundation of Artificial Intelligence and its impact on users and organisations		
P1 Describe the fundamental aspects of Artificial Intelligence. **P2** Describe the types and areas of application to solve current real-world problems.	**M1** Analyse the advantages and disadvantages of using Artificial Intelligence to an area of application.	**LO1 & 2** **D1** Critique the potential impact of deploying several types, approaches and tools of AI and Intelligent Systems on both users and organisations.
LO2 Analyse the approaches, techniques and tools to deploy Intelligent Systems in an organisation		
P3 Investigate options around the approaches, techniques and tools for the deployment of modern Intelligent Systems. **P4** Compare the advantages and challenges of several tools and techniques for the development of Intelligent Systems.	**M2** Demonstrate how different approaches and tools work together for the deployment of Intelligent System.	
LO3 Modify an AI-based system to improve how it exhibits intelligence in response to a real-world problem.		
P5 Investigate the technical implementation of an AI-Based system. **P6** Explore the technical options to enhance the performance on an AI-based system. **P7** Modify an AI-based system to enhance performance.	**M3** Demonstrate a technical modification, to an existing deployment of an AI based system, using benchmarking to enhance its performance.	**D2** Evaluate your own role to improve the performance of an AI-based system.
LO4 Evaluate the technical and ethical challenges and opportunities of Intelligent Systems.		
P8 Investigate the security and ethical issues with Intelligent Systems. **P9** Discuss the technical challenges involved in managing and maintaining Intelligent Systems.	**M4** Review the legal implications and security risks to both users and organisations of using Intelligent Systems.	**D3** Analyse the technical and ethical challenges while appreciating the opportunities of Intelligent Systems.

Recommended resources

Textbooks

Géron, A. (2019). Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems. O'Reilly Media.

Marcus, G., & Davis, E. (2019). Rebooting AI: Building artificial intelligence we can trust. New York, USA: Pantheon.

Russell, S., & Norvig, P. (2019). Artificial intelligence: a modern approach. (4). Pearson.

Lauterbach, A., & Bonime-Blanc, A. (2018). The artificial intelligence imperative: a practical roadmap for business. ABC-CLIO.

Zaccone, G., & Karim, M. R. (2018). Deep Learning with TensorFlow: Explore neural networks and build intelligent systems with Python. Packt Publishing Ltd.

Python Machine Learning By Example: Implement machine learning algorithms and techniques to build intelligent systems

Journals

https://www.journals.elsevier.com/artificial-intelligence	Artificial Intelligence. Elsevier.
https://cis.ieee.org/publications/ieee-transactions-on-artificial-intelligence	IEEE Transactions on Artificial Intelligence.
https://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=9670	IEEE Intelligent Systems.
https://www.mdpi.com/journal/ai	AI, MDPI.
https://dl.acm.org/journal/tist	ACM Transactions on Intelligent Systems and Technology

Web

https://opensource.google/projects/list/machine-learning	Google's Open-source Machine Learning projects

Links

This unit links to the following related units:

Unit 25: Machine Learning

Unit 45: Emerging Technologies

Unit 48: Robotics

Unit 47: Emerging Technologies

Unit 48: Virtual and Augmented Reality Development

Unit 16: Computing Research Project

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

Introduction

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

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

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

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

Learning Outcomes

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

1   Examine appropriate research methodologies and approaches as part of the research process.

2   Conduct and analyse research relevant to a computing research project.

3   Communicate the outcomes of a research project to identified stakeholders.

4   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's Research Onion as a guide to establishing a methodological approach.

Literature review:

Conceptualisation of the research problem or hypothesis.

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

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

Qualitative, quantitative, and mixed method research methodologies:

Key theoretical frameworks for research.

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

LO2 Conduct and analyse research relevant for a business research project

Research as a process:

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

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

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:

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

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

Analysing data:

Using data collection tools such as interviews and questionnaires.

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

LO3 Communicate the outcomes of a research project to identified stakeholders

Stakeholders:

Stakeholder analysis to determine approaches to communications including: who the stake holders 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		**LO1 & LO2**
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 for a business 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		**LO3**
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 judgments effectively for the intended audience	**D2** Evaluate outcomes and make valid, justified recommendations.
LO4 Reflect on the application of research methodologies and concepts		**LO4**
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. (2005) *Project Research in Information Systems*: *A Student's Guide*. Paperback. Macmillan.

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

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

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

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

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

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

Journals

International Journal of Quantitative and Qualitative Research

Qualitative Research Journal

Links

This unit links to the following related units:

Unit 3: Professional Practice

Unit 6: Planning a Computing Project

Unit 7: Software Development Lifecycles

Unit 17: Business Process Support

Unit code	**M/618/5725**
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 for acquiring data and processing this into meaningful information that can be used to support business functions and processes.

Within this unit students will examine how data and information support business processes, the mechanisms to source and utilise data and turn it in to useable, and valuable, information output. Students will also be required to explore real world business problems, the emergence of data science, 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 be able to 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 have an awareness of the role and contribution that these technologies and methodologies have and their importance to organisations.

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

Learning Outcomes

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

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

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

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

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

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 and 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 can is collected and used.

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

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

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

Sub-disciplines within 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.

Turing data into useable 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 and other visual mediums.

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

Effectively communicating information 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 e.g. end user requirements, systems requirement, application to automate procedures.

Designing a tool, program or package that can perform a specific task to support problem-solving or decision-making 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.

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.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Discuss the use of data and information to support business processes and the value they have in a real-world scenario		**LO1 & LO2** **D1** Evaluate the wider implications of using data and information to support business processes in an identified organisation.
P1 Discuss how data and information support business processes and the value they have for organisations. **P2** Discuss how data is generated and the tools used to manipulate it to form meaningful data to support business operations.	**M1** Assess the value of data and information to individuals and organisations in relation to real-world business processes.	
LO2 Discuss the implications of the use of data and information to support business processes in a real-world scenario		
P3 Discuss the social legal and ethical implications of using data and information to support business processes. **P4** Describe common threats to data and how they can be mitigated at on a personal and organisational level.	**M2** Analyse the impact of using data and information to support business real-world business processes.	

Pass	Merit	Distinction
LO3 Explore the tools and technologies associated with data science and how it supports business processes		**LO3 & LO4**
P3 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.	**D4** 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		
P5 Design a data science solution to support decision making related to a real-world problem. **P6** 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.	
		LO3 & LO4

Recommended Resources

Textbooks

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

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

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

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

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)

Websites

businessintelligence.com	Business Intelligence
	(General Reference)
usiness-intelligence.ac.uk	Business Intelligence Project for HE
	(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 18: Discrete Maths

Unit code   Y/615/1648

Unit level   5

Credit value   15

Introduction

Digital computer technologies operate with distinct steps, and data is stored within as separate bits. This method of finite operation is known as 'discrete', and the division of mathematics that describes computer science concepts such as software development, programming languages, and cryptography is known as 'discrete mathematics'. This branch of mathematics is a major part of computer science courses and ultimately aids in the development of logical thinking and reasoning that lies at the core of all digital technology.

This unit introduces students to the discrete mathematical principles and theory that underpin software engineering. Through a series of case studies, scenarios and tasked-based assessments students will explore set theory and functions within a variety of scenarios; perform analysis using graph theory; apply Boolean algebra to applicable scenarios; and finally explore additional concepts within abstract algebra.

Among the topics included in this unit are: set theory and functions, Eulerian and Hamiltonian graphs, binary problems, Boolean equations, Algebraic structures and group theory.

On successful completion of this unit students will be able to gain confidence with the relevant discrete mathematics needed to successfully understand software engineering concepts. 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:

1   Examine set theory and functions applicable to software engineering.

2   Analyse mathematical structures of objects using graph theory.

3   Investigate solutions to problem situations using the application of Boolean algebra.

4   Explore applicable concepts within abstract algebra.

Essential Content

LO1 **Examine set theory and functions applicable to software engineering**

Set theory:

Sets and set operations.

Algebra within set theory.

Set identities and proof of identities.

Bags manipulation functions.

Functions:

Domain, range and mappings.

Inverse relations and the inverse function. Injective and surjective functions and transitive relations

LO2 **Analyse mathematical structures of objects using graph theory**

Graph theory:

Structure and characterisation of graphs.

Spanning trees and rooted trees.

Eulerian and Hamiltonian graphs.

Vertex and edge colourings of graphs.

Directed graphs:

Directed and undirected graphs.

Walks, trails, paths and shortest paths.

LO3 **Investigate solutions to problem situations using the application of Boolean algebra**

Boolean algebra:

Binary states (e.g. on/off; 1/0; open/closed; high/low).

Identification of binary problems and labelling inputs and outputs.

Produce a truth table corresponding to a problem situation.

Equations:

Express a truth table as a Boolean equation.

Simplify a Boolean equation using algebraic methods.

Represent a Boolean equation using logic gates.

LO4 **Explore applicable concepts within abstract algebra**

Algebraic structures:

Binary operations and associated properties.

Commutative and associative operations.

Algebraic structures and substructures.

Groups:

Introduction to groups, semigroups and monoids.

Families of groups and group codes.

Substructures and morphisms.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Examine set theory and functions applicable to software engineering		
P1 Perform algebraic set operations in a formulated mathematical problem. **P2** Determine the cardinality of a given bag (multiset).	**M1** Determine the inverse of a function using appropriate mathematical techniques.	**D1** Formulate corresponding proof principles to prove properties about defined sets.
LO2 Analyse mathematical structures of objects using graph theory		
P3 Model contextualised problems using trees, both quantitatively and qualitatively. **P4** Use Dijkstra's algorithm to find a shortest path spanning tree in a graph.	**M2** Assess whether a Eulerian and Hamiltonian circuit exists in an undirected graph.	**D2** Construct a proof of the Five Colour Theorem.

Pass	Merit	Distinction
LO3 Investigate solutions to problem situations using the application of Boolean algebra		
P5 Diagram a binary problem in the application of Boolean Algebra. **P6** Produce a truth table and its corresponding Boolean equation from an applicable scenario.	**M3** Simplify a Boolean equation using algebraic methods.	**D3** Design a complex system using logic gates.
LO4 Explore applicable concepts within abstract algebra		
P7 Describe the distinguishing characteristics of different binary operations that are performed on the same set. **P8** Determine the order of a group and the order of a subgroup in given examples.	**M4** Validate whether a given set with a binary operation is indeed a group.	**D4** Explore with the aide of a prepared presentation the application of group theory relevant to your course of study.

Recommended Resources

Textbooks

Attenborough, M. (2003) *Mathematics for Electrical Engineering and Computing*. Oxford: Newnes.

Piff, M. (2008) *Discrete Maths Software Engineers: An Introduction for Software Engineers*. Cambridge: Cambridge University Press.

Journals

Journal of Graph Theory. Wiley

Journal of Mathematical Modelling and Algorithms in Operations Research. Springer

Links

This unit links to the following related units:

Unit 14: Maths for Computing

Unit 33: Applied Analytical Models

Unit 19: Data Structures & Algorithms

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

Introduction

The knowledge to implement algorithms and data structures that solve real problems, and knowing the purpose, complexity and use of algorithms is part of an essential toolkit for software engineers. An algorithm is a sequence of instructions used to manipulate data held in a structured form and together constitute design patterns for solving a diverse range of computer problems, including network analysis, cryptography, data compression and process control.

This unit introduces students to data structures and how they are used in algorithms, enabling them to design and implement data structures. The unit introduces the specification of abstract data types and explores their use in concrete data structures. Based on this knowledge, students should be able to develop solutions by specifying, designing and implementing data structures and algorithms in a variety of programming paradigms for an identified need.

Among the topics included in this unit are abstract data types specification, formal data notations, data encapsulation, complex data structures, programming language implementations using handles, pointers, classes and methods, algorithm types, data structure libraries, algorithm complexity, asymptotic testing and benchmarking.

On completion of this unit the student should be able to identify program data requirements, specify abstract data types using a formal notation, translate into concrete data structures and be able to develop, using a programming paradigm, different sorting, searching and navigational algorithms that implement complex data structures and evaluate their effectiveness.

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

Learning Outcomes

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

1.   Examine abstract data types, concrete data structures and algorithms.

2   Specify abstract data types and algorithms in a formal notation.

3   Implement complex data structures and algorithms.

4   Assess the effectiveness of data structures and algorithms.

Essential Content

LO1 Examine abstract data types, concrete data structures and algorithms

Abstract Data Types (ADTs):

Specification of ADTs with formal notation.

Data structures:

Array; set; stack; queue; list; tree; types e.g. active, passive, recursive.

Algorithm types:

Recursive, backtracking, dynamic, divide & conquer, branch & bound, greedy, randomised, brute force.

Algorithms:

Sort; insertion, quick, merge, heap, bucket, selection; search linear, binary, binary search tree, recursive e.g. binary tree traversals; find path; travelling salesman.

LO2 Specify abstract data types and algorithms in a formal notation

Design specification:

Specify ADTs using formal notation e.g. ASN.1; use non-executable program specification language e.g. SDL, VDM; issues e.g. complexity in software development; design patterns, parallelism; interfaces; encapsulation, information hiding, efficiency.

Creation:

Pre-conditions, post-conditions, error-conditions.

LO3 Implement complex data structures and algorithms

Implementation:

Data structures; multidimensional arrays, linked lists, stacks, queues, trees, hash table, heap, graph Algorithms; sorting, searching, tree traversal, list traversal, hash functions, string manipulation, scheduling and recursive algorithms; using handle, pointer, class, methods; using an executable programming language.

Testing and debugging:

Test code to ensure it is secure and can handle user errors, identify and create test scenarios, apply structured techniques to problem solving, debug code, understand the

structure of programmes to identify and resolve issues.

LO4 **Assess the effectiveness of data structures and algorithms**

Use of data structure libraries (DSL):

Limitations of DSL; manual selection of data structures; theoretical analysis; asymptotic analysis; size of N, Big O notation.

Algorithm effectiveness:

Run time benchmark, compiler/interpreter dependencies, resource usage, degree of parallelism, time, space, power performance, efficiency of garbage collection.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Examine abstract data types, concrete data structures and algorithms		
P1 Create a design specification for data structures explaining the valid operations that can be carried out on the structures. **P2** Determine the operations of a memory stack and how it is used to implement function calls in a computer.	**M1** Illustrate, with an example, a concrete data structure for a First In First out (FIFO) queue. **M2** Compare the performance of two sorting algorithms.	**D1** Analyse the operation, using illustrations, of two network shortest path algorithms, providing an example of each.
LO2 Specify abstract data types and algorithms in a formal notation		
P3 Using an imperative definition, specify the abstract data type for a software stack.	**M3** Examine the advantages of encapsulation and information hiding when using an ADT.	**D2** Discuss the view that imperative ADTs are a basis for object orientation and, with justification, state whether you agree.

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

Recommended Resources

Textbooks

Cormen, T. (1990) *Introduction to Algorithms*. MIT Labs.

Cormen, T. (2002) *Instructors Manual: Introduction to Algorithms*. MIT Labs.

Heineman, G. (2009) *Algorithms in a Nutshell*. O'Reilly Publishing.

Larmouth, J. (1999) *ASN.1 Complete*. Kaufman Publishing.

Leiss, E. (2007) *A Programmer's Companion to Algorithm Analysis*. Chapman & Hall.

Sedgewick, R. (1983) *Algorithms*. Addison-Wesley.

Wirth, N. (2004) *Algorithms and Data Structures*. Oberon.

Links

This unit links to the following related units:

Unit 1: Programming

Unit 20: Applied Programming and Design Principles

Unit 30: Cryptography

Unit 20: Applied Programming and Design Principles

Unit code	**T/618/4902**
Unit level	**5**
Credit value	**15**

Introduction

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

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

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

The aim of this unit is to familiarise students with these concepts and their best practices to ensure that their code is in line with industry standards. Among the topics included in this unit are object-orientated programming, introduction to design patterns and SOLID, including its version of five principles of object-oriented programming and automated software testing.

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

Learning Outcomes

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

1   Investigate the impact of SOLID development principles on the OOP paradigm
2   Design a large dataset processing application using SOLID principles and clean
       coding techniques
3   Build a data processing application based on a developed design
4   Perform automatic testing on a data processing application.

Essential Content

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

Object-orientated programming (OOP) paradigm characteristics:
Understand the OO characteristics and their application in developing code, including encapsulation, polymorphism, constructors and destructors, sub-objects, abstraction, interface, method overriding and redefinition, templates and containers.

Object-orientated class relationships:
Understand the elements of the OO relationships, including generalisation and inheritance, realisation, dependency, aggregation and composition.

Design patterns:
Aims and benefits of reusable design patterns, e.g. general reusable solution, represent an idea and language independent.
Grouping of design patterns into creational, structural and behavioural groups.

Clean coding techniques:
Simple design, e.g. keeping configurable data at high levels, polymorphism, consistency in methods, meaningful variable and constant names and encapsulate boundary conditions.
Creating small functions by including single action, minimal parameters, descriptive names, comments to explain code and warn of consequences.
Structure source code to separate concepts vertically, declare variables close to usage and keep lines short.
Develop objects and data structures for one action so that they are small.
Understand why non-static methods are preferable to static methods.
Design tests to ensure they are readable, fast and independent.
Understand bad test design, e.g. rigid, fragile, immobile, complex, repetitive.

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

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

Large datasets (public domain):
Design of application that can accommodate pre-existing large (500+) datasets, e.g. list of members of parliament, register of members' interests (Commons and

Lords), list of public domain films (e.g. in the USA), list of public domain books, list of public domain music.

Data structures:

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

Apply tree types, including active, passive and recursive.

Operations:

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

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

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

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

Implementation:

Utilise an appropriate language and development tools.

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

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

Types of automatic testing:

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

Tool automation parameters:

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

How automated testing features support unattended test runs.

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

Common frameworks:

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

Tools:

Investigate a range of tools that are commercially available.

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

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

Self-built testing tools:

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

Learning Outcomes and Assessment Criteria

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

LO3 Build a data processing application based on a developed design		**LO2**
P5 Build a large dataset processing application based on the design produced.	**M3** Assess the effectiveness of using SOLID principles, clean coding techniques and programming patterns on the application developed.	**D2** Analyse the benefits and drawbacks of different forms of automatic testing of applications and software systems, with examples from the developed application.
LO4 Perform automatic testing on a data processing application		
P6 Examine the different methods of implementing automatic testing as designed in the test plan. **P7** Implement automatic testing of the developed application.	**M4** Discuss the differences between developer-produced and vendor-provided automatic testing tools for applications and software systems.	

Recommended Resources

Textbooks

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

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

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

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

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

Journal

academic.oup.com   *Oxford Academic*

                                         ITNow: British Computer Society

                                         (general reference)

Web

baeldung.com   Baeldung

                                         A Solid Guide to SOLID Principles

                                         (general reference)

tutorialspoint.com   *Software Testing Dictionary*

                                         (general reference)

Links

This unit links to the following related units:

Unit 1: Programming

Unit 7: Software Development Lifecycles

Unit 19: Data Structures and Algorithms

Unit 22: Application Development

Unit 24: Advanced Programming for Data Analysis

Unit 21: Application Program Interfaces

Unit code	**T/618/5726**
Unit level	**5**
Credit value	**15**

Introduction

Many applications in use today are a composite of other software. This is true of an application, be it web based, mobile or on a desktop where the functionality of another is used to build upon. Think of an application that locates nearby restaurants – this may utilise an already existing map service as its basis. Or a game application that enables players to invite other players, chat, and post high scores to social media all within the game environment. How an application interacts with another is through an Application Program Interface (API).

Typically, APIs consist of methods and tools which are developed by the software author and can provide services and functionality to other application developers without having to 'reinvent the wheel'. Existing APIs provide a huge range of functionality which can be integrated into an application by following the rules of the relevant API. One of the benefits in using APIs is access to existing and proven services that can help speed up development and help standardisation.

The aim of this unit is to introduce students to the nature of APIs by developing proof-of-concept application that utilises existing APIs for common tasks that can include communication, displaying interactive visuals, audio playback and handling a range of user inputs.

Among the topics included in this unit are: identifying what an API is and the need for APIs; types of APIs; application design and development utilising relevant APIs in a suitable development environment; testing of the application; and a critical review of the APIs used.

On successful completion of this unit students will be able to identify and select relevant APIs to use within an application from a given scenario, in addition to testing and documenting the results against the initial design requirement.

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

Learning Outcomes

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

1   Examine the role of an API and its suitability for a given scenario

2   Design a solution that extends an existing application using relevant APIs for a given scenario

3   Implement an application in a suitable development environment based on a designed solution

4   Test an API developed for a given scenario to determine security vulnerabilities

Essential Content

LO1 Examine the role of an API and its suitability for a given scenario

Research existing APIs, their role and the need for an API.

Identify types of API uses e.g. visual, social media, device manipulation.

Evaluate suitable APIs for use in an application (web/mobile/desktop) for a given scenario.

Examine security issues of API's e.g. inefficient coding, inadequate authentication and authorisation.

LO2 Design a solution that extends an existing application using relevant APIs for a given scenario

Investigate an existing application and identify ways that it could be extended e.g. adding social media integration; linking to a webstore/payment handling; integrating stock control/stock levels with webstore; reactive layouts for different platforms

Develop relevant wireframes diagrams, concept the design of the application. Consider the application design/its purpose.

Consider the target platform (web/mobile/desktop). Identify the scope of the application.

Justify the selection/relevancy/purpose of the chosen APIs for the application. Take the security of APIs into consideration.

LO3 Implement an application in a suitable development environment based on a designed solution

Select suitable implementation processes to understanding the stages involved in development of the APIs.

Consider the use of a suitable development environment.

Utilise tools and features available in a range of development environments for developing code and integrating APIs.

Utilise best practices for implementing the API.

LO4 Test an API developed for a given scenario to determine security vulnerabilities

Document the testing procedure carried out to satisfy the design requirements/purpose of application.

Apply white box testing techniques.

Apply common black box Techniques to derive test conditions and test cases e.g. Equivalence Partitioning, Boundary Value Analysis, Decision Table Testing and State

Transition Testing.

Reflect on the application development process including identifying the chosen APIs strengths, weaknesses, security concerns, ease of use and access to features within the APIs.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Examine the role of an API and its suitability for a given scenario		**LO1**
P1 Examine the relationship between an API and a software development kit (SDK). **P2** Review a range of API's for different platforms.	**M1** Asses a range of APIs that covers a variety of uses and are suitable for a given scenario.	**D1** Evaluate a selected API for a given scenario including potential security issues.
LO2 Design a solution that extends an existing application using relevant APIs for a given scenario		**LO2**
P3 Investigate an existing application that could be extended with a suitable API.	**M2** Design a solution that extends the existing application using an API for a given purpose.	**D2** Critically review the designed solution to inform improvements including utilising a range of APIs.
LO3 Implement an application in a suitable development environment based on a designed solution		**LO3 & LO4**
P4 Build upon an existing application framework to implement an API.	**M3** Refine an application framework utilising multiple API's based on a designed solution.	**D3** Evaluate the APIs used within your application based on the test results including a data security report of the application.
LO4 Test an API developed for a given scenario to determine security vulnerabilities		
P5 Conduct 'white box' and 'black box' testing of the application, recording the results.	**M4** Refine the application based on the results of testing.	

Recommended Resources

Textbooks

Guinard, D D. Trifa, V M. (2016) *Building the Web of Things* Manning Publications

Pandian, P. (2018) *Building Node.js REST API with TDD Approach* Independently published

Spencer, T. et al. (2015) *Securing the API Stronghold: The Ultimate Guide to API Security.* 1st Ed. Kindle. Amazon.

Websites

www.khronos.org	The Khronos Group "Vulkan API" (Development Tool)
developers.google.com	Google Developers (Development Tools)
www.outsystems.com	Developer community, tools and knowledge bases

Links

This unit links to the following related units:

Unit 7: Software Development Lifecycles

Unit 30: Application Development

Unit 22: Application Development

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

Introduction

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

This unit introduces students to Application Development and is designed to simulate the roles and responsibilities of a commercial developer working in a suitable business environment with access to a small team of colleagues. Initially, students are introduced to a business-related problem and will need to adopt and use appropriate methods and practices to analyse, break down and discuss the issues – then, decide, design, create and test a possible solution. Students should be free to debate, evaluate and select different design and development methodologies depending on their own judgement and consideration. On completion, students will be expected to formally evaluate their final application against their design plans and initial requirements.

Among the topics included in this unit are: design and developer documentation; problem analysis; research, system and user requirements; design methodologies and principles; security considerations; development methodologies; Unified Modelling Language (UML), software development lifecycles; teamwork, peer-reviews, development tools and techniques; integrated development environments; debugging, testing, software versions and quality assurance.

On successful completion of this unit students will be able to produce a Software Design Document by analysing a business-related problem and deduce an appropriate solution, including a set of initial requirements, select and use design and development methodologies with tools and techniques associated with the creation of a business application, work individually and as part of a team to plan, prepare and produce a functional business application with support documentation and assess and plan improvements to a business application by evaluating its performance against its Software Design Document and initial requirements.

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

Learning Outcomes

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

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

2   Use design and development methodologies with tools and techniques associated with the creation of a business application.

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

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

Essential Content

LO1 Produce a Software Design Document by analysing a business-related problem and deduce an appropriate solution including a set of initial requirements

Analyse a business-related problem and assess possible solutions:

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

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

Produce a Software Design Document:

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

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

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

LO2 Use design and development methodologies with tools and techniques associated with the creation of a business application

Discuss different design and development methodologies:

Present overviews on current design and development methodologies.

Debate various strengths and weaknesses commonly associated with each methodology.

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

Consider the security implications of design and development methodologies.

Use appropriate tools and techniques:

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

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

LO3 Work individually and as part of a team to plan and produce a functional business application with support documentation

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

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

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

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

Prepare and produce a functional business application:

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

Build, manage and deploy code for the business application into a relevant environment

Create and quality check appropriate support documents for your application.

LO4 Evaluate the performance of a business application against its Software Design Document and initial requirements

Assess the performance of a business application:

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

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

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

Plan improvements to a business application:

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

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

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Produce a Software Design Document by analysing a business-related problem and deduce an appropriate solution including a set of initial requirements		
P1 Explore a business-related problem and produce a well-defined Problem Definition Statement supported by a set of user and system requirements. **P2** Determine any areas of risk related to the successful completion of your application.	**M1** Analyse a business-related problem using appropriate methods and produce a well-structured Software Design Document that defines a proposed solution and includes relevant details on requirements, system analysis, system design, coding, testing and implementation.	**LO1 & LO2** **D1** Justify your solution to a business-related problem and your preferred software development methodology, by comparing between the various software development tools and techniques researched.
LO2 Use design and development methodologies with tools and techniques associated with the creation of a business application		
P3 Research the use of software development tools and techniques and identify any that have been selected for the development of this application.	**M2** Compare the differences between the various software development tools and techniques researched and justify your preferred selection as well as your preferred software development methodology.	

Pass	Merit	Distinction
LO3 Work individually and as part of a team to plan and produce a functional business application with support documentation		
P4 Create a formal presentation that effectively reviews your business application, problem definition statement, proposed solution and development strategy. Use this presentation as part of a peer-review and document any feedback given. **P5** Develop a functional business application with support documentation based on a specified business problem.	**M3** Interpret your peer-review feedback and identify opportunities not previously considered. **M4** Develop a functional business application based on a specific Software Design Document with supportive evidence of using the preferred tools, techniques and methodologies.	**D2** Evaluate any new insights, ideas or potential improvements to your system and justify the reasons why you have chosen to include (or not to include) them as part of this business application.

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

Recommended Resources

Textbooks

Carmen, T. et al. (2009) *Introduction to Algorithms*. USA: MIT Press.

Martin, R.C. (2011) *The Clean Coder: A Code of Conduct for Professional Programmers*. USA: Prentice Hall.

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

Links

This unit links to the following related units:

Unit 6: Managing a Successful Computing Project

Unit 7: Software Development Lifecycles

Unit 23:　　　　Risk Analysis & Systems Testing

Unit code　　　　　**F/615/1689**

Unit level　　　　　**5**

Credit value　　　　**15**

Introduction

Risk-based testing prioritises tests during the system testing phase based on the highest impact and probability of system failure.

The aim of this unit is to provide students with knowledge and skills to use risk-based testing (RBT) using a medium-sized application, developing a full and detailed RBT procedure and documenting the results. They will then be able to evaluate the effectiveness of the application and the testing procedures employed. RBT is used widely in industry to organise software testing and use test resources more efficiently.

This unit introduces students to prioritising testing software features according to risk of failure, evaluated as a function of criticality or importance and impact of failure. Risk of software failure determines the priority of tests within a Test Plan, strategically carrying out testing over multiple test cycles.

Among the topics included in this unit are: how to classify and evaluate software risks using the risk formula, risk matrix, RBT testing and test build strategies, priority test cycles, security testing, coverage analysis and risk reduction reports.

As a result, 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:

1   Examine risk-based testing and requirements.

2   Create a customised risk-based test strategy, plans and techniques for a given specification.

3   Demonstrate a risk-based Test Plan, producing associated outcomes.

4   Evaluate a risk-based Test Plan and its associated outcomes.

Essential Content

LO1 **Examine risk-based testing and requirements**

Risk-based testing and requirements:

Understand risk-based testing stage model (ISO/IEC 9126-1).

Define no risk/no test; distinguish risk classifications, business/operational, security, technical, external, apply risk formula $r(f) = P(f)*C(f)$, test risk assessment and criticality, develop risk weighted matrix, develop risk quality matrix, assess risk reduction methods, detail project risks, identify methods of reporting progress.

The principles underpinning the psychology of testing including required mindset and development mindset difference, how this can influence success of software testing activities.

LO2 **Create a customised risk-based test strategy, plans and techniques for a given specification**

Risk-based test strategy planning:

Develop test risk matrix with selection of risk-based tests.

Develop risk test plan and build environment rollout plan including black box or functional testing, white (or glass) box testing, automated testing as part of the systems development lifecycle and regression testing, sub-system integration (use-case, whole system, interface).

Maintenance following changes or reviews, after length of time or stress/overload.

User evaluation including analysis of requirements, actual outcomes, acceptance, alpha, beta.

Ensuring requirements traceability.

Testing plan:

Examine test cycles prioritising security testing.

Example test data including normal, erroneous and extreme.

Define expected outcomes including valid, invalid and information gained, reporting of risk.

Understand the difference between error, defect, and failure including the distinction between the root cause of a defect and its effects.

Analyse test coverage and follow up, fault density analysis.

Choose appropriate testing methods e.g. static testing, change related,

sequential, iterative and suitable metrics for the defect management process.

Prioritisation of further test cycles, changes to specification, changes to analysis, design, amendments to code written, modifications to risk test strategy and plan, create risk reduction reports.

Techniques:

Black box or functional testing e.g. control flow, data flow.

White (or glass) box testing e.g. boundary value, branch condition, validation, verification.

LO3 **Demonstrate a risk-based Test Plan, producing associated outcomes**

Outcomes:

Review code coverage results and analysis, analyse cause defects, check fault density results.

Review actual results against expected results e.g. Valid information or action, invalid information, or action, system-generated messages, program-generated messages.

Modifications:

Prioritisation of further test cycles including changes to specification, changes to analysis, design, amendments to code written, modifications to risk test strategy and plan, create risk reduction reports.

Links between the testing and software development lifecycles (sequential and iterative), the role of testing in continuous development and integration, the importance of regression testing, approaches to defect tracking and version control.

LO4 **Evaluate a risk-based Test Plan and its associated outcomes**

Evaluation:

Develop risk heuristics evaluation criteria (probability, severity, classification), identify risk-based testing benefits and drawbacks, define fit for purpose criteria (functionality, accuracy, security effectiveness), alterations to tests carried out, possible improvements, program specification and design, self-reflection, management aspects.

Maintainability:

Perform risk testing and reporting refinement, usefulness to self, usefulness to others.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Examine risk-based testing and requirements		**LO1 & LO2** **D1** Justify test strategy and selection of test cases based on quantified risk to project.
P1 Investigate the testing stages involved in relation to a risk-based testing model. **P2** Discuss the type of risks involved in systems testing in relation to the given specification.	**M1** Determine three benefits in applying risk-based testing. **M2** Present key information to be communicated post-risk-based testing.	
LO2 Create a customised risk-based test strategy, plans and techniques for a given specification		
P3 Create a risk-based test strategy for the given specification, explaining specifically how security testing will be carried out. **P4** Develop a full and detailed Test Plan relating to the risk-based test strategy.	**M3** Develop a test risk matrix showing how the risks were evaluated. **M4** Design and apply a suitable risk-based test cycle.	

Pass	Merit	Distinction
LO3 Demonstrate a risk-based Test Plan, producing associated outcomes		
P5 Perform the tests identified in the risk-based Test Plan providing a detailed log of all test results.	**M5** Discuss, with the aid of an example, how prioritisation of test cycles can improve testing. **M6** Propose a strategy for designing and building a risk-based test environment.	**D2** Assess the importance of a suitable build environment to support a risk-based test strategy.
LO4 Evaluate a risk-based Test Plan and its associated outcomes		
P7 Explain the reasons for all modifications made at each stage of the risk-based test procedure. **P8** Discuss the effectiveness of the risk based test strategy including an assessment of security testing cycles.	**M7** Compare two risk-based test strategies and explain the benefits/disadvantages.	**D3** Report on how test risk heuristics are identified, evaluated and monitored in a risk based test strategy, providing justification.

Recommended Resources

Textbooks

Demarco, T. and Lister, T. (2003) *Waltzing with Bears: Managing Risk on Software Projects.* Dorset House Publishing.

Nettleton, D. (2006) *Risk-based Software Validation: Ten Easy Steps*. Parenteral Drug Association.

Journals

Mottahir, M. and Khan, A.I. (2013) *Risk-based Testing Techniques: A Perspective Study. International Journal of Computer Applications*. Article.

Websites

istqbexamcertification.com International Software Testing Qualifications Board

"What is Risk Based testing" (Article)

www.cs.tut.fi   Tampere University of Technology
                              Faculty of Computing and Electrical
                              Engineering "Risk based Testing"
                              (Tutorial)

Links

This unit links to the following related units:

Unit 7: Software Development Lifecycles

Unit 24: Advanced Programming for Data Analysis

Unit code	X/XXX/XXXX
Unit level	5
Credit value	15

Introduction

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

This unit is designed to develop the skills required to meet this need. It includes investigation of a range of different programming languages, both aimed at data analytics and for general use, good development guidelines and the design, development and testing of a sizeable tool to analyse and utilise a large data set. These skills are especially relevant to today's data analyst, data scientist, social researcher, market researcher and others who utilise large data sets in their work.

Learning Outcomes

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

1   Explore the tools a programmer can use to manipulate large data sets for data analysis
2   Design a software tool to analyse a large data set for a given scenario
3   Develop a software tool to analyse a large data set for a given scenario
4   Test a software tool used to analyse a large data set for quality of information produced

Essential Content

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

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

General programming languages:
Explore general programming languages: C++, C, C#, Java, F#, Visual Basic, Python.
Identify interaction methods, R.Net, linking at runtime, direct manipulation of objects.

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

Good coding techniques:

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

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

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

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

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

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

Large datasets:

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

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

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

Dataset Operations:

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

Data analysis methods:

Apply an appropriate range of data analysis methods.

Qualitative methods e.g. content analysis

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

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

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

Implementation:

Utilise an appropriate language and development tools.

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

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

Types of testing:

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

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

Assessing effectiveness of the data analysis:

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

Present results:

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

Learning Outcomes and Assessment Criteria

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

Recommended resources

Textbooks

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

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

Clarke, J (2020) Software Developer, BCS

Journals

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

Web

tutorialspoint.com	Software Testing Dictionary
	(General reference)
hgithub.com/niderhoff/nlp-datasets	Alphabetical list of public datasets
https://data.nasa.gov	NASA public domain datasets
	(General reference)
www.smartdatacollective.com	Big data Sources-Public domain datasets
	(General reference)

Links

This unit links to the following related units:

Unit 1: Programming

Unit 8: Data Analytics

Unit 20: Applied Programming and Design Principles

Unit 22: Application Development

Unit 26: Big Data Analytics and Visualisation

Unit 25:   Machine Learning

Unit code   **J/615/1662**

Unit level   **5**

Credit value   **15**

Introduction

Machine learning is the science of getting computers with the ability to learn from data or experience to solve a given problem without being explicitly programmed. It has been around for many years; however it has become one of the hottest fields of study in the computing sector. Machine learning is in use in several areas such as predictive modelling, speech recognition, object recognition, computer vision, anomaly detection, medical diagnosis and prognosis, robot control, time series forecasting and much more.

This unit will introduce the basic theory of machine learning, the most efficient machine learning algorithms and practical implementation of these algorithms. Students will gain hands-on experience in getting these algorithms to solve real-world problems.

Topics included in this unit are: the foundations of machine learning, types of learning problems (classification, regression, clustering etc.), taxonomy of machine learning algorithms (supervised learning, unsupervised learning, reinforcement learning), machine learning algorithms (Decision Tree, Naïve Bayes, k-Nearest Neighbour, Support Vector Machine etc.).

On successful completion of this unit students will be able to understand the concept of machine learning, machine learning algorithms, gain hands-on experience in implementing algorithms using a programming language such as C/C++, C#, Java, Python, R, or a machine learning tool such as Weka, KNIME, MS AzureML etc.

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

Learning Outcomes

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

1   Analyse the theoretical foundation of machine learning to determine how an intelligent machine works.

2   Investigate the most popular and efficient machine learning algorithms used in industry.

3   Develop a machine learning application using an appropriate programming language or machine learning tool for solving a real-world problem.

4   Evaluate the outcome or the result of the application to determine the effectiveness of the learning algorithm used in the application.

Essential Content

LO1 Analyse the theoretical foundation of machine learning to determine how an intelligent machine works

Consideration of what learning is.

Definitions of machine learning.

Core terminologies of machine learning.

Types of learning problems: classification, regression, optimisation, clustering.

How does machine learning work? Supervised learning, unsupervised learning, reinforcement learning, semi-supervised learning, deep learning.

LO2 Investigate the most popular and efficient machine learning algorithms used in industry

Machine learning algorithms and appropriate programming languages or tools:

Introduction to programming languages or tools.

Introduction to the language or tool.

A quick tour of the language or tool.

Investigating the mathematical background of machine learning with the programming language or tool:

Formulas, functions, descriptive statistics and graphs, probability.

Investigate the machine learning algorithm and demonstrate using the programming language or a tool:

K-Nearest Neighbour, Support Vector Machine, Linear Regression, Decision Tree, Naïve Bayes, K-Means Clustering.

LO3 Develop a machine learning application using an appropriate programming language or machine learning tool for solving a real-world problem

Problem definition:

Investigate and characterise the problem in order to better understand the goals of the project.

Data analysis:

Understand the available data (rows, columns, classes data range and so forth).

Data preparation:

Separate the data as training sets and testing set in order to expose better the structure of the prediction to modelling algorithms.

Implement the algorithm:

Implement the algorithm with an appropriate programming language or tool, train the model using training data set, present results.

LO4 Evaluate the outcome or the result of the application to determine the effectiveness of the learning algorithm used in the application

Improving models' accuracy.

The cause of poor performance in machine learning is either overfitting or underfitting the data.

Under-fitting situations: The cause of poor performance in machine learning is either overfitting or underfitting the data.

Over-fitting situations: Overfitting happens when a model learns the detail and noise in the training data to the extent that it negatively impacts the performance of the model on new data.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Analyse the theoretical foundation of machine learning to determine how an intelligent machine works		**LO1 & LO2** **D1** Critically evaluate why machine learning is essential to the design of intelligent machines.
P1 Analyse the types of learning problems. **P2** Demonstrate the taxonomy of machine learning algorithms.	**M1** Evaluate the category of machine learning algorithms with appropriate examples.	
LO2 Investigate the most popular and efficient machine learning algorithms used in industry		
P3 Investigate a range of machine learning algorithms and how these algorithms solve the learning problems. **P4** Demonstrate the efficiency of these algorithms by implementing them using an appropriate programming language or machine learning tool.	**M2** Analyse these algorithms using an appropriate example to determine their power.	

Pass	Merit	Distinction
LO3 Develop a machine learning application using an appropriate programming language or machine learning tool for solving a real-world problem		
P5 Chose an appropriate learning problem and prepare the training and test data sets in order to implement a machine learning solution. **P6** Implement a machine learning solution with a suitable machine learning algorithm and demonstrate the outcome.	**M3** Test the machine learning application using a range of test data and explain each stages of this activity.	**LO3 & LO4** **D2** Critically evaluate the implemented learning solution and it's effectiveness in meeting end user requirements.
LO4 Evaluate the outcome or the result of the application to determine the effectiveness of the learning algorithm used in the application		
P7 Discuss whether the result is balanced, under-fitting or over-fitting. **P8** Analyse the result of the application to determine the effectiveness of the algorithm	**M4** Evaluate the effectiveness of the learning algorithm used in the application.	

Recommended Resources

Textbooks

Bell, J. (2014) *Machine Learning: Hands-On for Developers and Technical Professionals*. 1st Ed. Wiley.

Flach, P. (2012) *Machine Learning: The Art and Science of Algorithms that Make Sense of Data*. 1st Ed. Cambridge: Cambridge University Press.

Kirk, M. (2014) *Thoughtful Machine Learning: A Test-Driven Approach*. O'Reilly Media.

Websites

archive.ics.uci.edu/ml	University of California, Irvine "Machine Learning Repository" (Data sets)
www.lfd.uci.edu	University of California, Irvine – Laboratory for Fluorescence Dynamics "Binaries for Python Extension Packages" (Development Tool)
cran.r-project.org	The R Project for Statistical Computing "R Archive Network" (Development Tool)
www.cs.waikato.ac.nz	University of Waikato – Machine Learning Group "Data Mining Software in Java" (Development Tool)
www.knime.org	Konstanz Information Miner "KNIME" (Development Tool)
www.codechef.com	CodeChef educational initiative "List of Compilers" (Wiki)

julialang.org   Julia   Programming   Language
(Development Tool) pkg.julialang.orgJulia   Programming   Language
(Development Tool) azure.microsoft.comMicrosoft Azure (Development
Tool)

accord-framework.net   Accord.NET Framework (Development Tool)

Links

This unit links to the following related units:

Unit 15: Fundamentals of Artificial Intelligence and Intelligent Systems

Unit 44: Robotics

Unit 26: Big Data Analytics and Visualisation

Unit code	F/618/5664
Unit level	5
Credit value	15

Introduction

Raw data can be complicated, confusing and a challenge to understand. But when raw data is organised and structured properly it can reveal patterns and information that can be very powerful in business decision making. Without the ability to organise and visualise data, key information would otherwise remain hidden in raw data. Once a business can understand historic patterns of data sets this information can help predict future trends and behaviours.

Data and visualisation is an area which has seen rapid advancement and there has been considerable challenges for data specialists to develop the skills, experience and growth required to maintain innovation in the sector. As data continues to be the fuel for the digital economy, this area remains a constant topic of conversation for organisations, governments and the public who share an interest in its growing commercial use, manipulation, and presentation.

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

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

Learning Outcomes

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

1   Examine data visualisation for decision making of complex data sets

2 Discuss statistical and graphical tools and techniques used to present big data for a given use case

3 Demonstrate statistical and graphical techniques used to present big data as a visualisation

4 Investigate the challenges faced by data professionals in carrying out their role

Essential Content

LO1 **Examine data visualisation for decision making of complex data sets**

Big Data:
Explore common fundamental concepts e.g. Bayesian classification, rule-based classification, The 'Vs' of big data (Volume, Velocity, Variety, Variability, Veracity, Visualization, and Value)
Big data lifecycle to include: purpose, capturing data, searching and filtering, retrieving data for processing, validation and cleansing, visualisation, analysis and querying, utilisation and storage, obsolete and deleted data.

Visualisation:
Identify the target audience needs, e.g. context, reporting, dissemination, accessibility, breadth of data, depth of analysis.
Explain the phases of data visualisation design process to include formulating the brief, working with data, establishing editorial thinking and developing design solution.
Apply principles of good design to data visualisation e.g. Dieter Rams' Ten Principles for Good Design, Gestalt principles of visual perception and Pareto Chart.
Evaluate effective visual elements e.g. charts, graphs, plots, tables, points, lines, bars, area, maps, narratives, metaphors, symbols and aesthetics e.g. position, size, shape, colour and transparency.

Data for decision making:
Explore processes of data driven decision making (DDDM) e.g. define objective, establish hypothesis, identify data need, build data process, sampling methods, collect data, analyse data, interpret results and make decision.
The role of the Data Analysis Lifecycle as part of DDDM (e.g. Discovery, Data preparation, Model Planning, Model Building, Operationalise, Communicate results)
Discuss the advantages of data driven decision-making e.g. continuous improvement and planning, collaborative decisions, reduce costs, real-time insights and new opportunities, digital literacy and data-driven cultures.
Challenges e.g. inconsistent and unstandardised data, aligning decision making with business strategy, bias and discrimination, descriptive vs. predictive trends and probabilities.

LO2 **Discuss statistical and graphical tools and techniques used to present big data for a given use case**

Statistical and graphical techniques for big data analysis and visualisation:

Analyse and apply big data analytics techniques e.g. descriptive, prescriptive, diagnostic and predictive analytics.

Apply principles of mathematics and statistics for analysing data sets.

Explore the various kinds of analysis techniques e.g. anomaly detection, cluster, association by rule, classification and regression analysis

Examine how to organise semi-structured and unstructured data variety e.g. word-cloud visuals, data catalog, taxonomies and ontologies.

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

Industry leading tools and software solutions to analyse data:

Apply tools to analyse data e.g. programming or scripting languages such as Python or R and associated libraries, Application Programming Interfaces (APIs)

Industry leading tools and software solutions to visualise data:

Apply leading tools to a solution e.g. Microsoft Excel, PowerBI and Azure, AWS, Oracle Visual Analyzer, Qlikview, Canvas, Tableau, SAS Visual Analytics.

Explore how user experience and domain context influences approaches to data analytics and visualisation

LO3 **Demonstrate statistical and graphical techniques used to present big data as a visualisation**

Manipulating data:

Construct activities using industry software to manipulate data e.g. importing datasets, data cleansing, data frame manipulation, testing and training a model, summarising analysis process and steps taken.

Apply query basics e.g. reports, calculate aggregate statistics, use built-in functions summarising and grouping data.

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

Prepare visual presentations:

Visual presentations to include using insight analysis to understand data in context, selecting visual elements and aesthetic design e.g. find and filter content in dashboards, view and export data from dashboards to create report, presentation or infographic.

Data set requirements:

Understanding the data and its context including summary of data collection, sampling procedures and data type; stakeholder requirements, interests and needs.

LO4 **Investigate the challenges faced by data professionals in carrying out their role**

Roles and responsibilities:

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

Explore the responsibilities of a data specialist e.g. preparing, analysing, modelling, managing and visualising data, and storage and access rights.

Strategies to ensure data compliance:

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

Assess data protection, informed consent and privacy issues for compliance e.g. personally identifiable information, protected health information, General Data Protection Regulation (GDPR) rights obligations, enforcement and regulatory legal penalties.

Explore and select the most appropriate industry compliance management software tools e.g. Microsoft Compliance Manager, AWS Compliance, IBM DataOps.

Challenges for data specialists:

Understand challenges such as applying data governance framework to ensure value of outcomes, accountability, trust, collaboration, transparency, risks and security, and role of the data steward.

Explain how to guard from poor practice e.g. cherry picking, disclosure of assumptions, conflict of interest, bias from single view and/or choice of technique.

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

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Examine data visualisation for decision making of complex data sets		**D1** Predict the potential impact of using complex data sets on both users and organisations for decision making.
P1 Explain the fundamental concepts of big data and its value in decision making for end users and organisations. **P2** Examine the processes of data driven decision making (DDDM) when using complex data sets.	**M1** Discuss the advantages and challenges to an organisation of using complex data sets for decision making.	
LO2 Discuss statistical and graphical tools and techniques used to present big data for a given use case		**D2** Evaluate how well the chosen data preparation and manipulation methods, the tools selected, and the data derived will impact on business decision making for the given use case.
P3 Discuss statistical and graphical tools and techniques used in industry for big data manipulation and visualisation.	**M2** Assess the suitability of industry leading tools and software solutions for analysing and visualising data for the given use case.	
LO3 Demonstrate statistical and graphical techniques used to present big data as a visualisation.		
P4 Demonstrate the use of data manipulation and automation to present a visualisation for a given user case.	**M3** Interpret the findings derived from the data manipulation to support conclusions made.	
LO4 Investigate the challenges faced by data professionals in carrying out their role.		**D3** Evaluate the impact of the key issues faced by data specialists when working in a data-driven culture.
P7 Investigate the different roles, responsibilities and key issues faced by data specialists in their day-to-day role	**M4** Review the different strategies used by data specialists to ensure data compliance.	

Recommended resources

Textbooks

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

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

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

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

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

LOUKIDES, M., MASON, H. and PATIL, D.J. (2018) *Ethics and Data Science.* USA: O'Reilly Media.

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

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

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

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

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

Journals

Big Data & Society, Online

Journal of Data Science, Statistics and Visualisation, Online

Journal of Big Data, Online

International Journal of Computer Applications, Online

Web

ukdataservice.ac.uk   UK Data Service
(General reference)

gov.uk   UK Government
(Data Ethics Framework)

Links

This unit links to the following related units:

Unit 4: Database Design and Development

Unit 8: Data Analytics

Unit 24: Advanced Programming for Data Analysis

Unit 33: Applied Analytical Models

Unit 27: Transport Network Design

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

Introduction

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

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

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

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

As a result, 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:

1   Explore LAN design principles and their application in the network design process.

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

3   Produce an appropriate WAN solution to a set of organisational requirements.

4   Solve a range of network related problems using appropriate troubleshooting techniques and methods.

Essential Content

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

Discuss and evaluate LAN design principles based on business needs:

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

Network features: bandwidth, delay, load.

Evaluate LAN design models:

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

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

Analyse LAN redundancy:

Issues related to redundancy, spanning tree concepts, Spanning Tree Protocols.

Solving bandwidth and load related issues:

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

Evaluate the need for redundancy at router level:

Default Gateway related issues, router redundancy protocols.

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

Application of LAN design principles in network design and configuration:

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

Configuring LAN devices:

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

Describe the concepts related to VLAN.

Implementing Layer 2 LAN redundancy:

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

Implementing Layer 3 LAN redundancy for IPv4:

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

Implementing Layer 3 LAN redundancy for IPv6:

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

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

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

WAN networks and protocols:

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

WAN Technologies:

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

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

WAN serial connections:

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

Configuring Frame Relay:

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

VPN over a public infrastructure connection:

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

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

Network Security considerations:

Network Security issues, their impacts and solutions.

Network monitoring and troubleshooting methods:

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

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

Troubleshooting LAN and WAN connectivity issues:

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

Network layer issues and troubleshooting:

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

Transport and Application layers networking issues and troubleshooting:

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

Learning Outcomes and Assessment Criteria

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

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

Recommended Resources

Textbooks

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

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

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

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

Websites

www.cisco.com	Cisco – international networking company
	(General Reference)
www.ncsc.gov.uk	National Cyber security centre
	(General Reference)
www.sciencedirect.com	Online science journal
	Computer science section
	(General Reference)

Links

This unit links to the following related units:

Unit 2: Networking

Unit 9: Computer Systems Architecture

Unit 29: Network Security

Unit 39: Network Management

Unit 40: Client/Server Computing Systems

Unit 28:   Cloud Computing

Unit code   **F/615/1644**

Unit level   **5**

Credit value   **15**

Introduction

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

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

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

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

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

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

Learning Outcomes

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

1. Demonstrate an understanding of the fundamentals of Cloud Computing and its architectures.

2. Evaluate the deployment models, service models and technological drivers of Cloud Computing and validate their use.

3. Develop Cloud Computing solutions using service provider's frameworks and open source tools.

4. Analyse the technical challenges for cloud applications and assess their risks.

Essential Content

LO1 Demonstrate an understanding of the fundamentals of Cloud Computing and its architectures

Networking Paradigm:

Peer-to-peer computing, client-server computing, distributed computing, cluster computing, high-performance computing, parallel computing, grid computing.

Cloud Computing Fundamentals:

Definition and history of cloud computing, principles of cloud computing, cloud ecosystem, cloud architecture and infrastructure, virtualisation, network connectivity, managing the cloud, application migration to the cloud.

Explore storage virtualization including storage architecture for virtualisation; physical disk types and related techniques; difference between centralised and distributed storage, visualised and non-virtualised storage features.

LO2 Evaluate the deployment models, service models and technological drivers of Cloud Computing and validate their use

Deployment models:

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

Service models:

Infrastructure as a service (IaaS) a form of cloud computing providing virtualized computing resources over the internet.

Platform as a service (PaaS) providing a complete development and deployment environment.

Software as a service (SaaS) offering users access to a vendor's cloud-based software.

Analytics as a service (AaaS) offering provision of analytics software and operations through web-delivered technologies.

Describe uses cases of cloud computing.

Technological drivers:

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

Explore architecture and components used for virtualisation, and traffic flows between VMs.

LO3 Develop Cloud Computing solutions using service provider's frameworks and open source tools

Cloud Service Providers:

Explore the features of different cloud service providers and virtualization software e.g. EMC, Google, Amazon Web Services, Microsoft, IBM, VMware., KVM, fusionCompute.

Open Source:

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

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

Security aspects:

Data Security, Virtualisation, Network Security.

Platform related security:

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

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Demonstrate an understanding of the fundamentals of Cloud Computing and its architectures		**LO1 & LO2** **D1** Justify the tools chosen to realise a Cloud Computing solution.
P1 Analyse the evolution and fundamental concepts of Cloud Computing. **P2** Design an appropriate architectural Cloud Computing framework for a given scenario.	**M1** Discuss why an organisation should migrate to a Cloud Computing solution.	
LO2 Evaluate the deployment models, service models and technological drivers of Cloud Computing and validate their use		
P3 Define an appropriate deployment model for a given scenario. **P4** Compare the service models for choosing an adequate model for a given scenario.	**M2** Demonstrate these deployment models with real world examples.	

Pass	Merit	Distinction
LO3 Develop Cloud Computing solutions using service provider's frameworks and open source tools		**LO3**
P5 Configure a Cloud Computing platform with a cloud service provider's framework. **P6** Implement a cloud platform using open source tools.	**M3** Discuss the issues and constraints one can face during the development process.	**D2** Critically discuss how one can overcome these issues and constraints.
LO4 Analyse the technical challenges for cloud applications and assess their risks		**LO4**
P7 Analyse the most common problems which arise in a Cloud Computing platform and discuss appropriate solutions to these problems. **P8** Assess the most common security issues in cloud environments.	**M4** Discuss how to overcome these security issues when building a secure cloud platform.	**D3** Critically discuss how an organisation should protect their data when they migrate to a cloud solution.

Recommended Resources

Textbooks

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

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

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

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

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

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

Links

This unit links to the following related units:

Unit 49: Systems Integration

Unit 29:   Network Security

Unit code	**L/615/1646**
Unit level	**5**
Credit value	**15**

Introduction

"Who is accessing my network?" A bank was hacked last week? Did you hear about that? Last night l blocked my neighbours from accessing their internet because they did not have a Wireless Equivalent Protection (WEP) or WPA (Wi-Fi Protected Access) key on their wireless."

It is estimated that Network Security (NS) breaches occur every second worldwide from small home networks to massive corporate networks. The cost to businesses is in billions, if not trillions. There are several methods, techniques and procedures that need to be implemented on a network in order for it to be 'secure'. Sometimes basic procedures such as locking your network room, changing your password regularly, as well as putting a password on all your network devices, is all that is needed to achieve some basic network security.

This unit introduces students to the fundamental principles of Network Security practices. As Systems Administration and Management are important tasks in the day-to-day functioning and security of Information Systems, poor or improper practices can lead to loss of data, its integrity, performance reductions, security breaches or total system failure. Special planning and provisions need to be made for ongoing support of systems and networks, which account for a significant proportion of the IT budget. With the widespread use of computers and the internet for business customers and home consumers, the topic of security continues to be a source for considerable concern.

Among the topics included in this unit are: historical Network Security (NS) principles and associated aspects such as Firewalls, Routers, Switches, MD5, SSL, VPN, AES, SHA-1/2, RSA, DES, 3DES; different types of public and private key cryptography such as Caesar Cipher, IPSec; types of attacks that can be done on a network and methods of preventing such attacks such as Man-In-the-Middle (eavesdropping), Denial of Service (DoS), Distributed Denial of Service (DDoS) (ping); Certificate Authority (CA); 'The Cloud' Security aspects and associated counter-measures such Public Cloud, Private Cloud, Hybrid Cloud, Community Cloud, Platform-as-a-Service (PaaS), Infrastructure-as-a-Service (IaaS), phishing, spoofing, DNS attack, SQL Injection, MAC Address spoofing/control. Firewalls and other Gateways can be used as a tool for Intrusion Detection and Prevention as they can be situated on the perimeter of the Network to provide security.

On successful completion of this unit students will be able to discuss with confidence several types of Network Security measures as well as associated protocols, cryptographic types and configuration settings of Network Security environments. Finally, students will be able to test the security of a given network to identify and fix vulnerabilities.

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:

1   Examine Network Security principles, protocols and standards.

2   Design a secure network for a corporate environment.

3   Configure Network Security measures for the corporate environment.

4   Undertake the testing of a network using a Test Plan.

Essential Content

LO1 **Examine Network Security principles, protocols and standards**

The history of Network Security.

Formation and role of Computer security Response Team (CERT), common and advanced cyber security threats and techniques e.g. malware, DoS etc, network vulnerabilities, threat actors, threat actor tools, threat actor motivations and opportunities.

Network Security devices:

Security frameworks, Authentication, Authorisation, Accounting (AAA), The historical Network Security (NS) principles and associated physical and virtual aspects such as Firewalls, Routers, Switches.

Network Security protocols:

MD5, SSL, VPN, AES, SHA-1/2, RSA, DES, 3DES, IPSec, DNS, DHCP, HTTP, HTTPs, FTP, FTPs, POP3, SMTP, IMAP.

Network Security cryptographic types:

Different types of public and private key cryptography such as Caesar Cipher, Vigenere, Hash.

LO2 **Design a secure network for a corporate environment**

Planning a network:

Considerations must be thought through on what the network will be used for (purpose) according to the scenario.

Backup, recovery and business continuity requirements.

Compliance with legislative and regulatory requirements.

Hardware and software considerations:

What hardware and software will be used on the network?

LO3 Configure Network Security measures for the corporate environment

Configure Network Security:

Configure Network Security measures such as Firewalls, Routers, Switches, Gateways, SSL, IPSec, HTTPs, FTPs, passwords and backup devices.
Select the appropriate tools and comply with organisation policies and processes when configuring and upgrading systems.

Cybersecurity:

Explain the different threats posed to networks, e.g. malware and phishing.

Identify different types of attacks on computer systems, Illustrate the potential impact of different attacks.

Discuss ways in which system users affect system vulnerability and potential physical vulnerabilities to systems, data and information.

LO4 Undertake the testing of a network using a Test Plan

Testing methods:

Different testing methods e.g. network scanning, penetration testing, vulnerability scanning, ethical hacking.

Testing in terms of checks on network connection speed, ethernet cards, testing for network vulnerabilities.

Collection and interpretation of relevant data to identify potential issues e.g. latency, traffic, packet data, system logs.

Create a Test Plan:

Development of a test plan to including testing data, expected results, actual results.

Application of key behaviours to develop an effective test plan and correct defects including consideration of cause and effect to design appropriate tests and test data,

Critical thinking and application root cause analysis to interpret results and identify and correct defects e.g. critical thinking, effective questioning and deconstruction.

Comprehensively Test all devices and the whole environment:

Tests should be carried out on all devices including Firewall, Servers, Domain Controllers, Email Servers, Routers, Switches, gateways, passwords.

Make recommendations:

Recommendations for improving the Network Security for your environment (scenario).

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Examine Network Security principles, protocols and standards		**LO1 & LO2**
P1 Discuss the different types of Network Security devices. **P2** Examine Network Security protocols.	**M1** Compare and contrast at least two major Network Security protocols.	**D1** Evaluate the importance of network security to an organisation.
LO2 Design a secure network for a corporate environment		
P3 Investigate the purpose and requirements of a secure network according to a given scenario. **P4** Determine which network hardware and software to use in this network.	**M2** Create a design of a secure network according to a given scenario.	
LO3 Configure Network Security measures for the corporate environment		**LO3 & LO4**
P5 Configure Network Security for your network. **P6** Discuss different cryptographic types of Network Security.	**M3** Provide Network Security configuration scripts/files/screenshots with comments.	**D3** Critically evaluate the design, planning, configuration and testing of your network.
LO4 Undertake the testing of a network using a Test Plan		
P7 Create a Test Plan for your network. **P8** Comprehensively test your network using the devised Test Plan.	**M4** Provide scripts/files/ screenshots of the testing of the network. **M5** analyse the results of testing to recommend improvements to the network.	

Recommended Resources

Textbooks

Burns, B., Granick, J.S, Manzuik, S., Guersch P., Killion, D., Beauchesne, N., Moret, E., Dhanjani, N., Rios, B. and Hardin, B. (2009) *Hacking: The Next Generation.* O'Reilly.

Cole, E., Krutz, R.L., Conley, J.W., Reisman, B., Ruebush, M., Gollman, D. and Reese, R. (2008) *Network Security Fundamentals*. John Wiley & Sons, Inc.

Cole, E., Krutz, R.L., Conley, J.W., Reisman, B., Ruebush, M., Gollman, D. and Reese, R. (2008) *Network Security Fundamentals: Project Manual*. John Wiley & Sons, Inc.

Forouzan, B.A. (2008) *Cryptography and Network Security*. New York: McGraw-Hill.

Forouzan, B.A. (2008) *Introduction to Network Security and Cryptography*. London: McGraw-Hill.

Gollmann, D. (2006) *Computer Security*. Chichester: John Wiley.

Harris, S., Harper, A., Eagle, C., Ness, J. and Lester, M. (2004) *Gray Hat Hacking: The Ethical Hacker's Handbook*. McGraw-Hill.

Lammle, T. and Graves, K. (2007) CEH: *Official Certified Ethical Hacker Review Guide*. Sybex.

Lockhart, A. (2007) *Network Security Hacks: Tips & Tools for Protecting your Privacy*, 2nd Ed. O'Reilly.

Manzuik, S., Gold, A. and Gatford, C. (2007) *Network security Assessment: from vulnerability to patch*. Rockland, Ma: Syngress Publishing.

Mather, T., Kumaraswamy, S. and Latif, S. (2009) *Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance*. O'Reilly.

Scambray, J. and McClure, S. (2008) *Hacking Exposed Windows: Windows Security, Secrets and Solutions*. London: McGraw-Hill.

Schneier, B. (2000) *Secrets and Lies: Digital Secrets in a Networked World*. Chichester: John Wiley.

Sobrier, J., Lynn, M., Markham, E., Iezzoni, C. and Biondi, P. (2007) *Security Power Tools*, O'Reilly.

Stallings, W. (2005) *Cryptography and Network Security*. Rockland, Ma: Syngress Publishing.

Journals

British Computer Society

ISC²

The Register

Links

This unit links to the following related units:

Unit 2: Networking

Unit 5: Security

Unit 12: Computer Systems Architecture

Unit 27: Transport Network Design

Unit 39: Network Management

Unit 40: Client/Server Computing Systems

Unit 30: Cryptography

Unit code   **T/615/1656**

Unit level   **5**

Credit value   **15**

Introduction

Although confidentiality in the communication between two parties is very often linked with electronic data transfer, methods for ensuring confidentiality have been used for centuries. That is how cryptography started as a methodology, practice and discipline, ensuring confidential communication in the presence of third parties called 'adversaries'. However, encrypting the message for confidentiality purposes is only one aspect of cryptography. It also provides means of ensuring that the parties involved in communication are 'who they say they are'. Cryptography underpins many aspects of security and is a crucial component in protecting the confidentiality and integrity of information. It is now a prevalent part of our day-to-day lives despite many people being unaware of its usage or importance. Almost every interaction we make with an electronic device will involve cryptography in some form. Cryptography is an indispensable tool for protecting information in computer systems.

This unit introduces students to the theoretical principles of cryptography and looks at some practical applications, many of which we use on a daily basis. Students are expected to investigate the inner workings of cryptographic systems and how to correctly use them in real-world applications. Students are expected to explore the mathematical algorithms in relation to cryptography and their applications. Students are also expected to analyse the symmetric and asymmetric encryption methods and ciphers, public key cryptography and the security issues related to their implementation. In addition, students are expected to investigate advanced encryption protocols and their applications.

Among the topics included in this unit are: the mathematical algorithms used in cryptography, the mechanisms by which symmetric and asymmetric cryptography work, 3DES and AES block ciphers, the operations of public key cryptography, Public Key Infrastructure (PKI), primality testing and factoring, discreet logarithms, El Gamal encryption, security issues with cryptography, common attacks on cryptographic schemes, and some practical applications of cryptography.

On successful completion of this unit students will be able to examine the symmetric encryption algorithms and ciphers, assess public key encryption protocols and signatures and their uses in the message and key exchanges, analyse the security issues related to symmetric and asymmetric encryption methods and evaluate advanced encryption protocols and their applications in secure message exchanges.

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

Learning Outcomes

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

1   Examine the symmetric encryption algorithms and ciphers.

2   Assess public key encryption protocols and signatures and their uses in the message and key exchanges.

3   Analyse the security issues related to symmetric and asymmetric encryption methods.

4   Evaluate advanced encryption protocols and their applications in secure message exchanges.

Essential Content

LO1 **Examine the symmetric encryption algorithms and ciphers**

Exploring mathematical algorithms:

Examining modular arithmetic, groups, finite fields and probability; random number generation, exploring elliptic curves and projective coordinates.

Examining symmetric encryption and ciphers:

Exploring historical ciphers, Cezar cipher, Enigma machine and information theoretic security (probability and ciphers, entropy and spurious keys); explaining one time pad.

Investigating stream ciphers, the historical Lorenz cipher, modern stream ciphers (linear feedback shift registers and their combinations, RC4).

Examining block ciphers, Feistel cipher and Data Encryption Standard (DES), operation of 3DES, Rijndael cipher and its mode of operation, explaining Advanced Encryption System (AES).

Analysing symmetric key distributions, hash functions and message authentication codes – key management, secret key distribution, designing hash functions, investigating message authentication codes.

LO2 **Assess public key encryption protocols and signatures and their uses in the message and key exchanges**

Analysing public key cryptography:

Examining public key encryption algorithms, one-way functions, Rivest Shamir Adleman (RSA) algorithm; explaining El Gamal encryption.

Explaining primality testing and factoring and discrete logarithms, prime numbers, factoring algorithms, modern factoring methods; examining Pohlig-Hellman logarithm, logarithmic methods for finite fields, methods for elliptic curves.

Examining key exchange and signature schemes, Diffie-Hellman key exchange, explore digital signatures, using hash functions in signature schemes, digital signature algorithm (DSA), and authenticated key agreement.

Analysing implementation issues and, exponentiation in RSA and DSA, finite field arithmetic.

Obtaining authentic public keys, confidentiality and integrity, digital certificates and Public Key Infrastructure (PKI), analysing examples of PKI.

LO3 **Analyse the security issues related to symmetric and asymmetric encryption methods**

Analysing attacks on public key schemes:

Exploring most common attacks on public key encryption schemes, Wiener's attack on RSA, Lattice-based attacks on RSA, partial key exposure attacks, Meet-in-the-Middle attack, brute force attack and fault analysis.

Analysing different definitions of security:

Examining security of encryption, security of actual encryption algorithms, semantically secure systems, security of signatures.

Analysing provable security, explaining random oracles, security of encryption algorithms and encryption algorithms with random oracles.

Explaining provable security without random oracles, using examples such as strong RSA assumption, signature schemes and encryption schemes.

Analysing hybrid encryption, security of symmetric ciphers, security of hybrid ciphers, explaining the construction of Key Encapsulation Mechanisms (KEMs)

LO4 **Evaluate advanced encryption protocols and their applications in secure message exchanges**

Assessing advanced encryption protocols and their applications:

Evaluating access structures for secret sharing schemes, general secret sharing, Reed-Solomon codes, Shamir sharing scheme.

Applying shared RSA signature generation; explaining commitment schemes and oblivious transfers.

Analysing Zero-Knowledge proofs, demonstrating a Graph Isomorphism in Zero-Knowledge, Sigma protocols, electronic voting systems.

Examining secure multi-party computation, the two-party case, multi-party cases: honest-but-curious adversaries, malicious adversaries.

Evaluating different applications of cryptography, quantum cryptography, digital cash, Bitcoin, Transport Layer Security and IPSec.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Examine the symmetric encryption algorithms and ciphers		
P1 Examine mathematic algorithms and their use in cryptography. **P2** Explain, with the use of examples, the operation of stream cipher and block cipher.	**M1** Compare the operational differences between stream cipher and block cipher. **M2** Analyse issues with symmetric key distribution and how they are solved by hash functions and message authentication codes.	**LO1 & LO2** **D1** Evaluate the improvement introduced by AES compared to DES and 3DES encryption standards and public key and private key encryption.
LO2 Assess public key encryption protocols and signatures and their uses in the message and key exchanges		
P3 Discuss common public key cryptographic methods and their uses. **P4** Explain by the use of examples public key exchange and digital signatures, and their implementation issues.	**M3** Analyse, with examples, the Public Key Infrastructure (PKI).	

Pass	Merit	Distinction
LO3 Analyse the security issues related to symmetric and asymmetric encryption methods		
P5 Discuss the common attacks on public key encryption schemes. **P6** Explain, with examples, provable security in signature schemes and encryption schemes.	**M4** Critically analyse the security of hybrid ciphers and the construction of Key Encapsulation Mechanisms (KEMs).	**D2** Evaluate different definitions of provable security.
LO4 Evaluate advanced encryption protocols and their applications in secure message exchanges		
P7 Examine, by the use of examples, secret sharing schemes. **P8** Evaluate secure multi-party computation using the two-party and multi-party cases.	**M5** Analyse the implementation of public key cryptography in electronic voting systems.	**D3** Critically evaluate the access structures for secret sharing schemes.

Recommended Resources

Textbooks

Martin, K. (2012) *Everyday Cryptography: Fundamental Principles and Applications*. UK: Oxford.

Stallings, W. (2013) *Cryptography and Network Security: Principles and Practice*. UK: Pearson.

Journals

International Association for Cryptologic Research, Online

International Journal of Applied Cryptography, Online

Websites

www.gov.uk/government/publications	Department of Business Innovations and Skills "Guidelines for managing projects – How to organise, plan and control projects." (Report)

Links

This unit links to the following related units:

Unit 5: Security

Unit 19: Data Structures & Algorithms

Unit 31: Forensics

Unit 32: Information Security Management

Unit 31: Forensics

Unit code	**F/615/1658**
Unit level	**5**
Credit value	**15**

Introduction

This unit introduces students to digital forensics involving the use of specialised techniques to investigate the recovery, authentication, and analysis of data on electronic data storage devices as well as Network Security breaches and cyberattacks using different tools and techniques.

With the current widespread use of digital devices, digital forensics has become an important part of the detection of crime by being able to identify details of what has been stored on a digital device(s) in the past. Students will have the opportunity to learn about some of the lower level structures of data storage devices, and techniques used to investigate them.

Among the topics included in this unit are: describing the process of carrying out digital forensics; Forensic Investigation legal guidelines and procedures; understanding low level file structures of several Operating Systems (OS); creating a book disk to enable forensic examination of devices; and undertaking a forensic examination of a device(s) and/or Network Security breaches and cyberattacks.

On successful completion of this unit students will be able to carry out digital forensics in accordance with industry and legal guidelines and procedures using different tools as well as understand low-level file structures of several Operating Systems and undertake digital Forensic Investigation of devices.

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:

1 Examine the processes and procedures for carrying out digital Forensic Investigation.

2 Discuss the legal and professional guidelines and procedures for carrying out digital Forensic Investigation.

3 Use a tool or tools to conduct digital Forensic Investigation on devices or networks or cyberattacks.

4 Develop a Test Plan and make some recommendations for use in digital Forensic Investigation.

Essential Content

LO1 Examine the processes and procedures for carrying out digital Forensic Investigation

The process of carrying out digital Forensic Investigation:

Discuss what is meant by Digital Forensics.

Identity the processes and procedures for carrying out digital Forensic Investigation including: Policy and Procedure development; Evidence Assessment, Evidence Acquisition; Evidence examination (including extraction and analysis).

LO2 Discuss the legal and professional guidelines and procedures for carrying out digital Forensic Investigation

Law enforcement:

Give a summary of the APCO guidelines in relation to evidence collection, evidence preservation in a Forensic Investigation case. Discuss the activities of authorities (e.g. MI5/MI6, GCHQ and NSA) in relation to Forensic Investigations.

Legal and ethical considerations:

Discuss the following legal and ethical considerations when conducting a Forensic Investigation; Data Protection Act; Computer Misuse Act and the Freedom of Information Act.

Other stakeholders:

Forensic Science's Society guidelines

British Computer Society

LO3 Use a tool or tools to conduct digital Forensic Investigation on devices or networks or cyberattacks

Tools required to conduct digital Forensic Investigation:

Hardware and software tools (e.g. Automated Security Information and Event Management (SIEM) tools, System logs, Penetration Testing tools, Network Performance tools).

Conduct digital Forensic Investigation:

Conduct digital Forensic Investigation of devices, networks or cyberattacks to identify anomalies in observed digital system data structures e.g. network packet data and digital system behaviours including protocol behaviours, traffic levels and latency.

LO4 Develop a Test Plan and make some recommendations for use in digital Forensic Investigation

Develop a Test Plan for digital devices or networks or cyberattacks:

Apply risk assessment and audit methodologies to identify potential vulnerabilities to inform a Digital Forensics Test Plan.

Recommendations for improving system security based on identified vulnerabilities and potential emerging threats.

Explore current 'best practice' recommendations from professional and legal bodies for conducting digital forensic investigations and developing test plans.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Examine the processes and procedures for carrying out digital Forensic Investigation		
P1 Discuss what is meant by Digital Forensics with the aid of diagrams/pictures. **P2** Examine the processes and procedures for conducting digital Forensic investigation.	**M1** Assess the importance of following a process or procedure when conducting digital Forensic Investigation.	**D1** Evaluate the advantages and disadvantages of conducting digital Forensic Investigation to improve system security.
LO2 Discuss the legal and professional guidelines and procedures for carrying out digital Forensic Investigation		
P3 Examine several law enforcement guidelines for conducting digital Forensic Investigations. **P4** Discuss several legal and ethical requirements for conducting digital Forensic Investigations.	**M2** Assess how ethical it is to conduct digital Forensic Investigations on a suspected individual with reference to their legal rights.	**D2** Evaluate the impact both following and not following guidelines on a legal case with regards to digital Forensic evidence.

Pass	Merit	Distinction
LO3 Use a tool or tools to conduct digital Forensic Investigation on devices or networks or cyberattacks		
P5 Determine hardware and software tools that can be used to conduct digital Forensic Investigation. **P6** Examine the file system structure of several Operating Systems e.g. MS-DOS, Windows, UNIX, Linux, MacOS, Android, etc.	**M3** Compare two tools that can be used to conduct digital Forensic Investigation. **M4** Conduct a digital Forensic Investigation on a device or network or cyberattack.	**LO3 & 4** **D3** Critically evaluate your work and suggest improvements to the current digital forensic investigation guidelines, processes and procedures.
LO4 Develop a Test Plan and make some recommendations for use in digital Forensic Investigation		
P7 Develop a Test Plan for conducting a test on digital devices or networks or cyberattacks. **P8** Suggest recommendations to security based on test results	**M5** Compare the recommendations for best practices for conducting digital Forensics.	

Recommended Resources

Textbooks

Carrier. B. (2005) *File System Forensic Analysis*. Harlow: Addison-Wesley.

Farmer, D. and Venema, W. (2005) *Forensic Discovery*. Harlow: Addison-Wesley.

Hayes D (2020) *Practical Guide to Digital Forensics Investigations, A* Pearson

Jones, R. (2005) *Internet Forensics*. Sebastopol, O'Reilly.

Parasram, S. (2020) *Digital Forensics with Kali Linux* 2nd Edition Packt Publishing

Sammes, A. and Jenkinson, B. (2007) *Forensic Computing: A Practitioner's Guide*. 2nd Ed. London, Springer.

Journals

British Computer Society Forensics Specialist Group

GCHQ

NSA

Links

This unit links to the following related units:

Unit 5: Security

Unit 30: Cryptography

Unit 32: Information Security Management

Unit 32: Information Security Management

Unit code	**F/615/1661**
Unit level	**5**
Credit value	**15**

Introduction

Organisations of all sizes need to protect their sensitive information from potential attackers, and simply having up-to-date firewalls, anti-virus, and other infrastructure components is not enough to prevent breaches. All physical security devices, the teams who manage them, and the processes surrounding their management need to be constantly monitored and evaluated to ensure the organisation as a whole is protected. This is the concept behind an Information Security Management System (ISMS). An ongoing process to continually assess what the organisation deems its biggest threats, and what its most important assets are.

This unit introduces students to the basic principles of an ISMS and how businesses use them to effectively manage the ongoing protection of sensitive information they hold. There are many reasons for establishing an ISMS for an organisation, but one of the main goals is to enable the organisation to manage information security as a single entity which can be monitored and continually improved upon.

This unit considers information security management in a business context and will allow students to understand how modern organisations manage the ongoing threats to their sensitive assets.

On successful completion of this unit students will be able to describe what an ISMS is, how one is established, maintained, and improved, and describe the role international standards play in developing an ISMS. 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:

1   Explore the basic principles of information security management.

2   Critically assess how an organisation can implement and maintain an Information Security Management System (ISMS).

3   Appraise an ISMS and describe any weaknesses it may contain.

4   Examine the strengths and weaknesses of implementing ISMS standards.

Essential Content

LO1 Explore the basic principles of information security management

What is an ISMS? Why is an ISMS important? Policies (privacy, acceptable use, information security, separation of duties, least privilege); internal and external risks (impact, likelihood, quantitative, qualitative, vulnerabilities, threats); risk treatment (avoid, transfer, accept, mitigate); compliance; stakeholders.

The role a company's internal policies, and service level agreements with providers, have in defining the scope and approach of security management within an organisation.

Use of recognised sources of threat intelligence and vulnerabilities to predict possible, current, and future threats (horizon scanning).

LO2 Critically assess how an organisation can implement and maintain an Information Security Management System (ISMS)

Asset identification; stakeholder requirements; risk assessment; risk treatment planning; policy development; procedure development; senior management buy-in; audit (internal, external); performance monitoring; continual improvement.

LO3 Appraise an ISMS and describe any weaknesses it may contain

Business requirements and impact on business; strategic, functional and non- functional requirements of digital systems, impacts on the business (e.g. interruption costs, cost of failure analyses, worst-case scenario, possibility of new impacts or vulnerabilities)

Review ISMS documentation for potential weaknesses; examine audit and performance monitoring output; business impact analysis, review of current 'security culture' within the organisation; suggest improvements to an ISMS.

LO4 Examine the strengths and weaknesses of implementing ISMS standards

ISO 27001:2013; the organisation and its context; expectations of interested parties; determining ISMS scope; leadership commitment; policy; organisational roles and responsibilities; actions to address risks; information security objectives; resources; competence; awareness; communications; documented information; operational planning; risk assessment; risk treatment; monitoring, measuring, analysis and evaluation; management review; nonconformity and corrective action; continual improvement; external ISMS audit; advantages and disadvantages of ISO 27001:2013 certification; annex A (ISO 27002:2013) controls.

Examination of principles and good practice recommended by computing professional bodies, and their impact on organisational compliance

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Explore the basic principles of information security management		**LO1 & LO2** **D1** Demonstrate through critical analysis the steps required to establish and maintain an ISMS in the context of an example organisation, with reference to the requirements of the ISO 27001:2013 standard.
P1 Examine the key principles of an ISMS and its relevance to the successful operation of an organisation.	**M1** Analyse the benefits an effective ISMS can have on an organisation.	
LO2 Critically assess how an organisation can implement and maintain an Information Security Management System (ISMS)		
P2 Explore the elements of, and processes behind, establishing and maintaining an ISMS.	**M2** Examine the process of implementing an ISMS in a real-world scenario.	

Pass	Merit	Distinction
LO3 Appraise an ISMS and describe any weaknesses it may contain		
P3 Recognise strengths and weaknesses in a given ISMS, based on documentation review and audit output.	**M3** Examine the strengths and weaknesses of an ISMS in the context of an organisation, prioritising issues.	**LO3 & LO4** **D2** Critically examine the strengths and weaknesses in the context of an example ISMS and provide potential remedial actions to improve its effectiveness.
LO4 Examine the strengths and weaknesses of implementing ISMS standards		
P4 Recognise the purpose of the ISO 27000 series and the key clauses of ISO 27001:2013.	**M4** Analyse the relationship between ISO 27001:2013 and establishing an effective ISMS within an organisation. **M5** Critically assess the advantages and disadvantages of certification against the standard.	

Recommended Resources

Textbooks

Alexander, D., Finch, A., Sutton, D. and Taylor, A. (2013) *Information Security Management Principles* BCS. 2nd Revised Ed. The Chartered Institute for IT.

Calder, A. and Watkins, S. (2015) *IT Governance: An International Guide to Data Security and ISO27001/ISO27002.* 6th Ed. Kogan Page.

Journals

Information Management & Computer Security

Websites

www.iso.org   International Organisation for Standardisation "ISO/IEC 27001 – Information Security Management" (General Reference)

Links

This unit links to the following related units:

Unit 5: Security

Unit 30: Cryptography

Unit 31: Forensics

Unit 33: Applied Analytical Models

Unit code	**K/615/1654**
Unit level	**5**
Credit value	**15**

Introduction

Applied analytical modelling has become prevalent in many industries and has developed in the mathematical techniques used and the diversity of modelling tools and techniques. Applied analytical modelling is carried out by a data scientist utilising modelling data, model building and model reporting skills. The aim of this unit is to provide students with knowledge and analytical modelling skills using computers to discover and interpret meaningful patterns in data by creating computer models.

This unit introduces students to applied analytical models used in business to discover, interpret and communicate meaningful patterns of data held in silos or data warehouses, and to derive knowledge to gain competitive advantage. Organisations may apply analytical methods and models to predict/prescribe business outcomes and improve performance in diverse areas such as stock control, financial risk and fraud analysis. Analytical models use mathematical algorithms and require extensive computation to process large amounts of data.

Among the topics included in this unit are: data preparation, fundamentals of applied analytical models and development of predictive or prescriptive models using a suitable algorithm, operating on a large data set.

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:

1   Examine applied analytical modelling methods.

2   Prepare a large data set for use in an applied analytical model.

3   Demonstrate the use of an analytical model with a large data set. 4Investigate improvements to an applied analytical model.

Essential Content

LO1 **Examine applied analytical modelling methods**

Decision/descriptive analytics.

Prescriptive analytics:
Confirmatory data analysis (CDA).

Predictive analytics:
Forecasting or classification algorithms, machine learning, scoring, correlation, causation, regression analysis.

Algorithms:
Filtering, sorting clustering; Data visualisation.

Business Domains:
Behavioural analytics; cohort analytics; collections analytics; cyber analytics; enterprise optimisation; financial analytics; fraud analytics; marketing analytics; pricing analytics; retail analytics; risk analytics; supply chain analytics; talent analytics; telecoms analytic; transportation analytics.

LO2 **Prepare a large data set for use in an applied analytical model**

Identify and evaluate applied analytical model data requirements:

Data requirements; data collection, data processing; semi-structured/unstructured metadata processing, cleaning; aggregation; exploratory data analysis (EDA); data product; data visualisation; information displays; dashboards.

LO3 **Demonstrate the use of an analytical model with a large data set**

Define analytic model requirements:

Data set selection; carry out cleaning, aggregation and EDA; identification of algorithm, selection and configuration of data mining software; model implementation; communication of results; data visualisation; graphical reports/dashboards.

LO4 **Investigate improvements to an applied analytical model**

Data quality; data assumptions; sampling; segmentation; uplift data modelling; algorithm selection; pattern and relationship discovery; qualitative/quantitative use; validating results; output communication methods; tailoring data visualisation.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Examine applied analytical modelling methods		
P1 Discuss the prescriptive and predictive analytical models, using examples. **P2** Illustrate three analytical methods, describing how they function.	**M1** Compare prescriptive and predictive analytical models, stating their advantages and disadvantages.	**D1** Using a case study example, critically evaluate the derived benefits from the use of an applied analytic model.
LO2 Prepare a large data set for use in an applied analytical model		
P3 Describe the process of analytical model data preparation, describing data cleaning, discretisation, aggregation and data reduction stages. **P4** Suggest two methods to visualise the output from an applied analytical model, using illustrations to describe your answer.	**M2** Analyse three potential issues in preparation of data for use in an applied analytical model.	**D2** Review the primary reasons for carrying out data transformation before input to an applied analytical model.

Pass	Merit	Distinction
LO3 Demonstrate the use of an analytical model with a large data set		
P5 Select a suitable algorithm to analyse a large data set to meet a business need. **P6** Use an appropriate analytical modelling tool to carry out an investigation (e.g. R, RapidMiner, Hadoop).	**M3** Propose how the data set will be prepared for the analytical model used in the investigation.	**D3** Review the results of the investigation, assessing the quality of the obtained knowledge.
LO4 Investigate improvements to an applied analytical model		
P7 Investigate improvements to an applied analytical model.	**M4** Propose three improvements to the approach used in the investigation. **M5** Discuss two ways to increase the performance and limits of the analytical model used in the investigation.	**D4** Present the results of your investigation promoting the benefits of using applied analytical models in a business.

Recommended Resources

Textbooks

Carlberg, C. (2012) *Predictive Analytics: Microsoft Excel*. QUE.

Marr, B. (2015) *Big Data: Using SMART Big Data, Analytics and Metrics To Make Better Decisions and Improve Performance*. Wiley.

Runkler, T. (2012) *Data Analytics: Models and Algorithms for Intelligent Data Analysis*. Springer Vieweg.

Websites

www.ericsson.com	Ericsson White paper "Big Data Analytics – Actionable Insights for the Communication Service Provider" (Research)
www.thearling.com	Kurt Thearling "Information about analytics and data science" (General Reference)
aisel.aisnet.org	Association of Information Systems "Big Data Analytics: Concepts, Technologies, and Applications" (Tutorial)
www.fujitsu.com	Fujitsu "The White Book of Big Data" (E-Book)

Links

This unit links to the following related units:

Unit 14: Maths for Computing

Unit 8: Data Analytics

Unit 14: Business Process Support

Unit 18: Discrete Maths

Unit 34: Analytical Methods

Unit code	**F/615/1675**
Unit level	**5**
Credit value	**15**

Introduction

John von Neumann, a Hungarian mathematician, outlined the architecture for a stored-program computer in a paper he wrote in 1945. In order to fully develop new software and hardware technologies within this architecture, analytical skills and techniques needed to be applied to any proposed design. In the modern era, analytical methods still underpin theoretical computer science fundamentals, and developing this mathematical knowledge will support development in many aspects of computing.

This unit introduces students to more advanced analytical techniques that are relevant to them as they progress within their studies in computing, and advances knowledge of mathematical modelling and application of theory.

Among the topics included in this unit are: complex numbers, numerical methods, matrices, formal logic and Z specification.

On successful completion of this unit students will be able to use applications of complex number theory, approximate solutions of contextualised examples with numerical methods, apply matrix theory to a variety of different scenarios and use formal methods of logic. 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:

1   Examine complex number theory within practical situations.

2   Approximate solutions using numerical methods.

3   Employ matrix methods to contextualised examples relevant to computing.

4   Investigate the concepts of formal methods within computer science.

Essential Content

LO1 **Examine complex number theory within practical situations**

Complex number theory:

Introduction to imaginary numbers and complex numbers.

The modulus, argument and conjugate of complex numbers.

The polar form of complex numbers.

The use of de Moivre's Theorem.

Using quaternions for spatial rotation in computer graphics.

LO2 **Approximate solutions using numerical methods**

Numerical methods:

Using sketches to approximate solutions of equations.

Numerical analysis using the bisection method and the Newton–Raphson method.

Numerical integration, the trapezium rule and Simpson's rule.

Analysis:

Error analysis to determine the accuracy of approximations.

Explanation of numerical method failure and comparison of methodology.

LO3 **Employ matrix methods to contextualised examples relevant to computing**

Matrix methods:

Introduction to matrices and matrix notation.

Using matrices to represent ordered data and the relationship with program variable arrays.

The process for addition, subtraction and multiplication of matrices.

Calculating the determinant and inverse of a matrix.

Application of matrices to vector transformations and rotation, maps and graphs.

LO4 Investigate the concepts of formal methods within computer science

Formal reasoning:

Logic and proof.

Introduction to Hoare logic.

Hoare logic to assess the correctness of computer programs.

Automated proof checking.

Z specification language:

Model-based specification.

The modelling of software systems using Z specification.

Proving properties using Z specification.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Examine complex number theory within practical situations		
P1 Solve applicable problems using complex number theory. **P2** Perform arithmetic operations using the polar and exponential form of complex numbers.	**M1** Critique the use of quaternions for application in spatial rotation.	**D1** Formulate solutions of problems using de Moivre's Theorem.
LO2 Approximate solutions using numerical methods		
P3 Examine the roots of an equation using two different iterative techniques. **P4** Determine the numerical integral of functions using two different methods.	**M2** Select two different examples that show the failure of numerical techniques.	**D2** Appraise the different methodology that is used for numerical integration.
LO3 Employ matrix methods to contextualised examples relevant to computing		
P5 Utilise matrices to represent ordered data in array form. **P6** Perform addition, subtraction and multiplication of matrices.	**M3** Ascertain the determinant of two different scale matrices.	**D3** Determine solutions to a set of linear equations using the inverse matrix method.
LO4 Investigate the concepts of formal methods within computer science		
P7 Interpret the meaning of given logical statements into plain English. **P8** Examine the modelling of software systems using Z specification.	**M4** Use Hoare's notation to model the correctness of a given computer program.	**D4** Judge the correctness of a given computer program using Hoare logic.

Recommended Resources

Textbooks

Garnier, R. and Taylor, J. (1992) *Discrete Mathematics: For New Technology*. Oxfordshire: Taylor & Francis.

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

Journals

Communications on Pure and Applied Mathematics. Wiley.

Links

This unit links to the following related units:

Unit 14: Business Process Support

Unit 35: Systems Analysis & Design

Unit code   **L/615/1677**

Unit level   **5**

Credit value   **15**

Introduction

The world is constantly changing, with new and emerging digital technologies bringing many challenges to the commercial world. Organisations have to respond to these changes in addition to responding to new markets and different ways of doing their business. The systems they use to run their businesses have to respond quickly to these transformations. Organisations can find themselves in a situation where they have to regularly upgrade old systems or develop new ones in order to continue operating successfully in the evolving competitive business environment.

Before any system can be upgraded or a new system developed, the system requirements have to be analysed and the system designed, whether this is for a database system, or a web, game or mobile application, and failure to do this adequately could lead to a costly systems failure.

This unit explores the processes of systems analysis and design using two methodologies – the traditional systems development lifecycle methodology providing a comprehensive structured framework and the agile methodology with different framework models developed with the emphasis on variations of iterative incremental modelling. To provide perspective, students will examine the models in both these methodologies. They will consider the particular strengths and weaknesses of the two methodologies and examine the suitability of the methodologies using different examples.

Topics included in this unit are: examining the business case for a new system or for upgrading an existing one, looking at traditional and agile systems analysis methodologies and evaluating the merits of each, considering the implications of moving from using the traditional methods of analysis and design to agile methods on analysts, designers and developers in an organisation, and applying systems design tools and techniques.

On successful completion of this unit, students will be able to produce a business case, and analyse a system and its requirements using a suitable methodology. They will be able to design a system suitable for their application. Theoretical understanding will be translated into practical skills through actual systems investigations and students will become confident in the use of particular tools and techniques relevant to the methodology chosen. Although for practical purposes, it is likely that one particular methodology and related tools and techniques will be used, it is important that students understand that others are available.

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 the unit students will be able to:

1   Evaluate the strengths and weaknesses of the traditional and agile systems analysis methodologies.

2   Produce a feasibility study for a system for a business-related problem.

3   Analyse their system using a suitable methodology.

4   Design the system to meet user and system requirements.

Essential Content

LO1 **Evaluate the strengths and weaknesses of the traditional and agile systems analysis methodologies**

Principles of the traditional Systems Development Life Cycle (SDLC) models, including Waterfall, Prototyping, and Spiral.

Principles of agile methodologies models, including Scrum, Extreme, Lean, Scaled Agile Frameworks (SAFe), Disciplined Agile Delivery (DAD), Kanban, Disciplined Agile Delivery (DAD), Agile Modelling (AM) and DevOps, amongst the many variations.

Strengths and weaknesses of traditional and agile methodologies.

Identify transition problems in organisations of moving from traditional to agile methodology.

Factors that need to be considered when selecting the appropriate methodology to use.

LO2 **Produce a feasibility study for a system for a business-related problem**

Elements of a business case to explore both business and technical feasibility options.

Desirability, viability and feasibility of systems.

Investigation techniques to use.

Criteria to consider for a business case: vision and goals cost-benefit analysis, legal, economic, technical, operational, timeframes, organisational culture, security considerations.

LO3 **Analyse their system using a suitable methodology**

Tools used to investigate the system.

Identifying user and system requirements and any constraints, including possible security issues.

Identifying the team members and their roles and responsibilities in a project team.

Identifying documentation that will be produced at the different stages and determining the sign-off conditions.

Criteria to use to determine the suitability of the methodology used to analyse the system.

LO4 **Design the system to meet user and system requirements**

Design elements for the traditional and agile methodologies.

Determining the design features for traditional and agile methodologies.

Data flow diagrams and flow charts.

Determining the tools and techniques relevant for the design of systems for database applications, web applications, games, mobile applications and other software applications.

Identifying the design documentation contents for different application types e.g. for databases, web design, games, mobile and other software applications.

Link to other units relevant for students where systems are being designed and developed.

Design sign-off.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Evaluate the strengths and weaknesses of the traditional and agile systems analysis methodologies		**LO1 & LO2**
P1 Discuss the strengths and weaknesses of the traditional and agile systems analysis methodologies.	**M1** Compare and contrast the strengths and weaknesses of the traditional and agile systems analysis methodologies.	**D1** Critically evaluate the strengths and weaknesses of the traditional and agile methodologies and feasibility study.
LO2 Produce a feasibility study for a system for a business-related problem		
P2 Produce a system feasibility study for a business related problem.	**M2** Evaluate the relevance of the feasibility criteria on the systems investigation for the business related problem.	
LO3 Analyse their system using a suitable methodology		**LO3 & LO4**
P3 Review a system using a suitable methodology for a business-related problem.	**M3** Analyse the effectiveness of the methodology used in providing a solution for a given business context.	**D2** Justify the choice of the methodology used in the context of the business problem.
LO4 Design the system to meet user and system requirements		
P4 Design a fully functional system to meet user and system requirements for the business related problem.	**M4** Assess the effectiveness of the system design with particular reference to the methodology used and how the design meets user and system requirements	

Recommended Resources

Textbooks

Ambler, S. and Lines, M. (2012) *Disciplined Agile Delivery (DAD): A Practitioner's Guide to Agile Software Delivery in the Enterprise*. IBM Press.

Dennis, A. and Wixom, B. (2009) *Systems Analysis and Design*. 4th Ed. International Student Version. John Wiley & Sons.

Dingsøyr, T., Tore Dybå, T. and Moe, N.B. (eds) (2010) *Agile Software Development: Current Research and Future Directions*. Springer.

Hoffer, J., George, J. and Valacich, J. (2015) *Essentials of Systems Analysis and Design*. Global Edition. Pearson.

Hoffer, J., George, J. and Valacich, J. (2013) *Modern Systems Analysis and Design*. Global Edition. Pearson Higher Ed.

Kenneth, K. and Kendall, J. (2013) *Systems Analysis and Design*. 9th Ed. Pearson.

Larman, C. (2004) *Agile and Iterative development: A Managers Guide*. Addison-Wesley Professional.

Martin, R. (2013) *Agile Software Development, Principles, Patterns, and Practice*. New International Edition. Pearson.

Journals

The Computer Journal

Journal of Systems Analysis and Software Engineering

Journal of Emerging Trends in Computing and Information Sciences

Websites

agilemodeling.com	Agile Modelling "Agile Analysis" (Article)
www.batimes.com	Resources for Business Analysts "Applying Agile Principles To Requirement Analysis" (Article)
www.sparcedge.com	SPARC "What an Agile Design Process Looks Like" (Article)
forty.co	Forty "Agile design: what we've learned" (Article)

Links

This unit links to the following related units:

Unit 6: Managing a Successful Computing Project

Unit 7: Software Development Lifecycles

Unit 36: User Experience and Interface Design

Unit code	**H/615/1684**
Unit level	**5**
Credit value	**15**

Introduction

User Experience (UX) and User Interface (UI) Design is the process by which software applications and user interactions can be designed to be simple, accessible, effective and attractive for the end user. The objective of UX and UI Design is to create user interactions and software application experiences that are appropriate for specific platforms or devices and provide desirable end user outcomes utilising insight and understanding about the practical, emotional and experiential motivations and values of the end user. UX and UI Design explores the motivations and desires of the end user and seeks to design user's interactions that best satisfy those motivations and desires in a concise manner.

This unit introduces students to the role, basic concepts and benefits of UX and UI Design in the development process of software applications. The aim of the unit is to enhance the student's understanding of the methodology, terminology and benefits of UX and UI Design in the development of software applications.

Among the topics included in this unit are: classification and terminology of UX and UI Design techniques, the relationship between UX and UI Design, how UX and UI Design relates to the rest of the software development lifecycle, understand a user's emotions, desires and attitudes about using a particular feature, product, system, platform or software application, modes of interaction, human-computer interaction models, usability, accessibility, aesthetics, design thinking, value proposition design, user journey mapping and gathering meaningful insights from users feedback and research.

On successful completion of this unit students will be able to explain the basic concepts of UX and UI Design. Plan, build and measure the success of an appropriate UI Design. Design an interface and experience with a specific end user in mind. Conduct testing to gather meaningful feedback to evaluate the success or failure of a user interface. As a result they will develop skills such as communication literacy, design thinking, team working, critical thinking, analysis, reasoning and interpretation, computer software literacy which are crucial for gaining employment and developing academic competence.

Learning Outcomes

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

1   Research what aspects of User Experience and Interface Design are necessary and appropriate to satisfy end user emotions, desires and attitudes when using a user interface concept.

2.   Plan an appropriate User Experience map and Interface Design for a User Interface concept with a specific target end user in mind and also outline the tests you mean to conduct.

3   Build a User Interface concept and test it with users to see if it satisfies their emotions, desires and attitudes as planned.

4   Evaluate user feedback, test results and insights gained from end users interacting with your User Interface concept to determine success or failure and steps to improve in future versions.

Essential Content

LO1 **Research what aspects of user experience and interface design are necessary and appropriate to satisfy end user emotions, desires and attitudes when using a user interface concept**

Identify formats, characteristics and appropriateness of UX and UI Design

Present an overview of UX and UI Design, how they are produced and their appropriate use in software development.

Identify what UX and UI Design is by researching the role, purpose, terminology and methodology of UX and UI Design.

Recognise the various forms of UX and UI Design by researching the history of, current trends and use in the product development lifecycle.

Recognise the use of appropriate UX and UI Design patterns.

Define the characteristics of UX and UI Designs by investigating how they can be used to satisfy end user emotions, desires and attitudes.

Recognise specific forms, patterns and trends of UX and UI Design:

Research, debate and agree current functionality, patterns and trends in UX and UI Design.

Identify various forms of UX and UI Design.

Define the advantages and disadvantages of using UX and UI Design.

Define standard tools available for use in UX and UI Design:

Identify standard tools available to create UX and UI Designs.

The advantages and disadvantages of UX and UI Design tools.

How UX and UI Design tools can be used to capture end user feedback.

Appropriateness of various tools for different end user testing outcomes.

LO2 Plan an appropriate user experience map and interface design for a user interface concept with a specific target end user in mind and also outline the tests you mean to conduct

Identify a specific end user and an appropriate UX and UI Design to test with this user type:

Choose a specific end user to conduct tests against.

Evaluate the benefits, features, advantages and disadvantages of different UX and UI Design methodologies for various end user testing outcomes.

Review different end user categorisations, classifications and behaviour modelling techniques.

Select the most appropriate form of UX and UI Design to achieve desired end user testing and outcomes.

Describe a plan to use appropriate UX and UI Design methodology and tools to conduct end user testing:

Apply end user classification and behaviour modelling to select an appropriate UX and UI Design methodology.

Outline the end user characteristics, desired testing criteria and results your UX and UI Design addresses.

Select an appropriate form of UX and UI Design necessary to achieve desired results.

Use your selected end user, appropriate UX and UI Design methodology and desired testing criteria to create a plan for a UI concept.

LO3 Build a user interface concept and test it with users to see if it satisfies their emotions, desires and attitudes as planned

Utilise appropriate tools to develop a UX and UI Design:

Employ an appropriate set of tools to develop your plan into a UI.

Run end user experiments and examine feedback.

Reconcile and evaluate end user feedback and build a new iteration of your user interface modified with the most important feedback and enhancements.

Make multiple iterations of your user interface and modify each iteration with enhancements gathered from user feedback and experimentation.

LO4 Evaluate user feedback, test results and insights gained from end users interacting with your user interface concept to determine success or failure and steps to improve in future versions

Asses the success of your UX and UI Design:

Assemble and appraise end use feedback from multiple iterations of your user interface.

Undertake a critical review and compare your final user interface and your test results with the original plan.

Evaluate the advantages, disadvantages, strengths and weaknesses of your UX and UI Design methodology.

Critique the overall success of your UI and discuss your UX insights.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Research what aspects of User Experience and Interface Design are necessary and appropriate to satisfy end user emotions, desires and attitudes when using a user interface concept		**LO1**
P1 Recognise specific forms of User Experience and Interface Design and end user testing requirements. **P2** Assess standard tools available for use in User Experience and Interface Design.	**M1** Analyse the impact of common User Experience and Interface Design methodology in the software development life cycle. **M2** Review specific forms of User Experience and Interface Design and advantages and disadvantages of end user testing requirements for appropriateness to different testing outcomes.	**D1** Evaluate specific forms of User Experience and Interface Design and justify their use in a User Interface concept.

Pass	Merit	Distinction
LO2 Plan an appropriate User Experience map and Interface Design for a User Interface concept with a specific target end user in mind and also outline the tests you mean to conduct		**LO2 & LO3**
P3 Review different end user categorisations, classifications and behaviour modelling techniques. **P4** Appraise a specific end user and an appropriate User Experience and Interface Design methodology to test with this user type.	**M3** Apply end user classification and behaviour modelling to select an appropriate Interface Design methodology. **M4** Devise a plan to use appropriate User Interface Design methodology and tools to conduct end user testing.	**D2** Make multiple iterations of your User Interface concept and modify each iteration with enhancements gathered from user feedback and experimentation.
LO3 Build a User Interface concept and test it with users to see if it satisfies their emotions, desires and attitudes as planned		
P5 Examine appropriate tools to develop a user interface. **P6** Run end user experiments and examine feedback.	**M5** Employ an appropriate set of tools to develop your plan into a user interface. **M6** Reconcile and evaluate end user feedback and build a new iteration of your user interface modified with the most important feedback and enhancements.	
LO4 Evaluate user feedback, test results and insights gained from end users interacting with your User Interface concept to determine success or failure and steps to improve in future versions		**LO4**
P7 Evaluate end use feedback from multiple iterations of your user interface. **P8** Suggest steps to improve in future versions of your UI.	**M7** Undertake a critical review and compare your final user interface and your test results with the original plan.	**D3** Critically evaluate the overall success of your User Interface concept and discusses your insight using prototyping.

Recommended Resources

Textbooks

Hanington, B. (2013) *Universal Methods of Design: 100 Ways to Research Complex Problems, Develop Innovative Ideas, and Design Effective Solutions*. Rockport Publishers.

Kalbach, J. (2015) *Mapping Experiences: A Complete Guide to Creating Value through Journeys, Blueprints, and Diagrams*. 1st Ed. O'Reilly Media.

Lidwell, W. (2010) *Universal Principles of Design, Revised and Updated: 125 Ways to Enhance Usability, Influence Perception, Increase Appeal, Make Better Design Decisions, and Teach through Design*. 2nd Ed. Rockport Publishers.

Tidwell, J. (2011) *Designing Interfaces.* 2nd Ed. O'Reilly Media.

Links

This unit links to the following related units:

Unit 13: Website Design & Development

Unit 54: Prototyping

Unit 37:Architecture

Unit code	**R/615/1681**
Unit level	**5**
Credit value	**15**

Introduction

The aim of this unit is to provide students with knowledge about computer systems, functionality and organisation. Systems architecture and elements of computing machines will be examined and the principles and fundamentals of how computer systems work. Computer architecture engineers work in industries such as telecoms, automotive and aerospace.

This unit introduces students to the hardware and software architecture of computer systems and low-level language program development using CPU registers to manipulate data. Students will explore how program instructions and data types can be represented, stored in a computer system and used to carry out a computing task.

Among the topics included in this unit are: computer architecture elements, CPU instruction sets, fetch-execute cycle, CPU registers, binary calculations, use of PC and stack, reading/writing to peripherals, architectural security aspects including protected memory segmentation and synchronous/asynchronous channel I/O operations, parallel machines, emerging computer architectures and security considerations.

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 the unit students will be able to:

1   Examine the functions of computer system components.

2   Discuss how data and programs can be represented within computer systems.

3   Demonstrate the principles of processor operations.

4   Investigate advanced computer architectures and performance.

Essential Content

LO1 Examine the functions of computer system components

Component functions:

Logical/physical component functions; Clock Synchronisation; Processor (CPU), buses, memory maps and IRQ; Boolean logic gates; adder circuits; analysis of how components interact to carry out the fetch-execute cycle and modify data; definition and use of CPU registers. I/O device memory.

LO2 Discuss how data and programs can be represented within computer systems

Data/program representation:

Program/data representation and storage; description, use and storage of data types integer, decimal and character; absolute/relative program location; firmware/software.

LO3 Demonstrate the principles of processor operations

Principles of processor operations:

Low-level program instruction sets; RISC; development of assembler programs (including at least 1 JMP instruction) to manipulate stored data using CPU registers; I/O memory and IRQ locations.

LO4 Investigate advanced computer architectures and performance

Advanced Architectures:

Advanced Architectures; MIMD parallelism (Flynns Taxonomy), Cache, instruction/graphics pipelining; unconventional architectures; benchmarking; functional unit mix, IRQ latency.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Examine the functions of computer system components		**LO1**
P1 Investigate the key computer system components and how they interact. **P2** Show how the different types of memory can be attached to a processor.	**M1** Compare the roles played by different types of memory.	**D1** Evaluate through illustration how the processor is physically connected to memory and input/output (I/O) devices using the system buses.
LO2 Discuss how data and programs can be represented within computer systems		**LO2**
P3 Investigate, using examples, how different types of data can be converted and stored in computer systems. **P4** Carry out Boolean logic operations.	**M2** Show how, using examples, floating point numbers can be represented in binary form. **M3** Illustrate how adder circuits are used to add binary numbers.	**D2** Evaluate how locating a program absolutely in memory can aid ICE target system debugging.

Pass	Merit	Distinction
LO3 Demonstrate the principles of processor operations		**LO3**
P5 Illustrate the use of the different processor registers in the fetch execute cycle. **P6** Illustrate, with an example, how polling and interrupts are used to allow communication between processor and peripherals.	**M4** Create a low-level program which includes decision making, branching and I/O operations. **M5** Investigate the function of an interrupt handler.	**D3** Examine how the width of the data bus and address bus affect processor performance and complexity.
LO4 Investigate advanced computer architectures and performance		**LO4**
P7 State the function of DirectX API, describing its advantages and disadvantages.	**M6** Assess how instruction pipelining modifies the performance of a computer system. **M7** Evaluate how the DirectX API is used by application programmers to control graphics functions.	**D4** Critically evaluate, with illustrations, computer performance improvements with MIMD architectures.

Recommended Resources

Textbooks

Adamatzky, A. (2013) *Collision Based Computing*. Springer.

Blum, R. (2005) *Professional Assembly Language Programming*. John Wiley & Sons.

Gaura, E., Hibbs, D. and Newman, R. (2008) *Computer Systems Architecture*. Lexden.

Links

This unit links to the following related units:

Unit 9: Computer Systems Architecture

Unit 40: Client/Server Computing Systems

Unit 38:Analytic Architecture Design

Unit code	**T/615/1687**
Unit level	**5**
Credit value	**15**

Introduction

Aircraft, trains and other high-tech machines improve our quality of life – none of these could function without automatic systems. The ability to analyse and design an automatic system is a vital subject. Architecture Analysis & Design Language (AADL) is designed for the specification, analysis, automated integration and code generation of real-time performance-critical (timing, safety, scheduling ability, fault tolerant, security, etc.) distributed computer systems.

This unit introduces students to the AADL. It introduces the language and AADL specifications, which is defined in the Society of Automotive Engineers (SAE) standard. The SAE AADL standard provides formal modelling concepts for the description and analysis of application systems architecture in terms of distinct components and their interactions. Within the AADL, a component is characterised by its identity, possible interfaces with other components, distinguishing properties, subcomponents and their interactions. The AADL is a useful tool to model and analyse the existing systems, but also design and integrate new systems.

Among the topics included in this unit are: AADL overview, system models and specification, security, components (software components, execution platform components), structure and instantiation, mode and flow, and properties.

On successful completion of this unit students will be able to describe the abstractions that support the specification of component interactions; present the specification of alternative operational states of a system; describe the use of the AADL flows concept and present examples of the specification of abstract flows throughout a system; describe the constructs for organising an AADL specification. It includes examples of AADL architectural pattern sets.

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:

1. Explore detailed and problem-oriented material and gain a conceptual overview of the AADL abstractions.

2. Illustrate the software component and execution platform component abstractions and provide example declarations for these components.

3. Analyse the specification of composite systems and their instances and describe the abstractions that support the specification of component interactions.

4. Show the specification of alternative operational states of a system by AADL flow concepts, and describe modes mode transitions, and examples of specification.

Essential Content

LO1 Explore detailed and problem-oriented material and gain a conceptual overview of the AADL abstractions

AADL overview (concept, history, applications).

Abstractions:

Basic component of AADL, utilisation of AADL.

System models and specification:

Introduction to architectural analysis and AADL architecture.

LO2 Illustrate the software component and execution platform component abstractions, and provide example declarations for these components

Software components:

Introduction to the AADL software component, the way to describe data, subprogram and thread, different representations of software component.

Execution platform component:

Introduction to the AADL hardware component, the way to describe Processor, Memory, Bus and Device, different representations of software component.

LO3 Analyse the specification of composite systems and their instances, and describe the abstractions that support the specification of component interactions

System abstraction:

Textual and graphical representations of system.

System instance:

The way to create system instance and implementation.

Component interactions:

Introduction to the connection between interface elements, implement the port and the access in the system design.

Subcomponent:

Introduction to implementation of the subcomponents in system, and the access of data in difference subcomponents.

Software components:

Implementation of software components in system design.

Execution platform components:

Implementation of execution platform components in system design.

LO4 Show the specification of alternative operational states of a system by AADL flow concepts, and describe modes mode transitions, and examples of specification

Modes and Flow; Properties; Structure and Instantiation.

Model specifications:

Basic introduction to the modes and the representations of modes.

Model configurations:

Thread with control system, modes in calls sequences.

Flow declarations:

Introduction basic flow concept and element.

Flow paths:

Flow paths of different components in flow design, including secure features.

Property declarations:

Idea of property and declarations about the property.

System abstraction.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Explore detailed and problem-oriented material and gain a conceptual overview of the AADL abstractions		**LO1 & LO2**
P1 Interpret the basic concept of elements and the methods of AADL, and analyse an example using AADL. **P2** List the advantages and disadvantages of using AADL.	**M1** Design and build a system using AADL to realise a specific function. **M2** Distinguish the different AADL representations.	**D1** Critically analyse components, physical design and logical elements.
LO2 Illustrate the software component and execution platform component abstractions, and provide example declarations for these components		
P3 Present a software component using different representations. **P4** Distinguish the software components and execution platform components in a system.	**M3** Declare components under AADL specification. **M4** Implement different components in a system.	

Pass	Merit	Distinction
LO3 Analyse the specification of composite systems and their instances, and describe the abstractions that support the specification of component interactions		**LO3 & LO4**
P5 Design a system that consists of various types of elements. **P6** Discuss the advantages and weak points of the system designed in P5.	**M5** Present the design logic and the relationships between components in the design process. **M6** Illustrate data interaction processes between components and analyse the data communication in the whole system.	**D2** Evaluate the system designed, critiquing the flow methods and selection of elements used.
LO4 Show the specification of alternative operational states of a system by AADL flow concepts, and describe modes mode transitions, and examples of specification		
P7 Design system in flow and modes format. **P8** Recognise different flows and identify the operating process.	**M7** Provide relevant information in design process of flow, such as basic ideas, selection of elements. **M8** Present the contracture of organising an AADL specification.	

Recommended Resources

Textbooks

Feiler, P., Lewis, B., Vestal, S. and Colbert, E. (2005) *An Overview of the SAE Architecture Analysis & Design Language (AADL) Standard: A Basis for Model-Based Architecture-Driven Embedded Systems Engineering.* 1st Ed. Springer.

Gluch, D. and Feiler, P. (2012) *Model-Based Engineering with AADL: An Introduction to the SAE Architecture Analysis & Design Language.* 1st Ed. Addison-Wesley Professional.

Kordon, F., Hugues, J., Canals, A. and Dohet, A. (2013) *Embedded Systems: Analysis and Modeling with SysML, UML and AADL.* 1st Ed. Wiley-ISTE.

Links

This unit links to the following related units:
Unit 20: Applied Programming and Design Principle

Unit 39: Network Management

Unit code	**Y/615/1679**
Unit level	**5**
Credit value	**15**

Introduction

Network Management has become one of the most sought-after skills for government institutions, commercial organisations, financial institutions as well as academic institutions as they try to run their IT networks in a more cost effective, efficient, and secure way. The art of Network Management needs to be perfected by those in charge of networks for today and the future. This includes multimedia applications such as VoIP, IPTV and mobile network as well as virtualised environments.

This unit introduces students to simple network Planning, Configurations, Setup, and Management, including LAN, WAN, NAT, PAN, MAN, using a variety of tools and methods for managing Networks, including Network Monitoring, Network Security such as Snort, Firewalls & IPS, Network Protocols and standards such as SNMP, NETCONF, IEEE, MIBII, RMON, MDIB & ANS.1, as well as industry's best practices. Students will also be introduced to Virtual Networks, Network Operating Systems, Risk Management and Cloud Network Management.

Among the topics included in this unit are: Network Planning, Network Configurations, Network Setup and Network Management of LANs, PAN, MAN, WAN, NAT using several tools and methods; Network Monitoring, Network Security, Network Load Balancing, Network Protocols and Standards, Best Practices, Virtualisation, Network Operating Systems, Network Risk Management and Cloud Network Management.

On successful completion of this unit students will be able to plan a network, configure a network, setup a network, manage a network such as a LAN, PAN, MAN, WAN as well as conduct network monitoring, Network Security, network protocols and standards. Students will also be able to apply industry best practices, manage virtualised networks, work with several operating systems vendors and well as plan and manage network risks and cloud computing.

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

Learning Outcomes

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

1   Explore the concepts and principles of Network Management.

2   Plan, Design, Setup and Configure a network.

3   Justify the Protocols and Standards concerned with Networking and Network Management.

4   Use tools and methods to manage a network, including Network Security and Risk Management.

Essential Content

LO1 **Explore the concepts and principles of Network Management**

Effective network management activities:

Security, networking technologies, networking topologies, networking protocols, self-learning networks and Service Level Agreements (SLAs).

Automatic management:

Identify Data formats, e.g. JSON (JavaScript Object Notation), YAML (YAML ain't a markup language), XML (eXtensible Markup Language).

Compare computer to computer communications, e.g. via APIs (Application Programmable Interfaces), via REST (Representational State Transfer).

Assess configuration management tools, e.g. Puppet, Chef, Ansible, Saltstack.

LO2 **Plan, Design, Setup and Configure a network**

Planning and Design:

Planning methodology, topological design, protocols, transmission technologies, hardware, network realisation.

Setup and Configuration:

Devices, cabling, protocols, ACLs, security and optimisation.

LO3 **Justify the Protocols and Standards concerned with Networking and Network Management**

Network Protocols and Standards:

Protocols including SNMP, NTP, NETCONF, RMON, TCP/IP, HTTP, DNS, DHCP,

SSL, IPSec. Standards: IEEE, ITU, ISO, OSI, IANA.

LO4 Use tools and methods to Manage a Network including Network Security and Risk Management

Tools and methods:

NETCONF, CISCO, SNMP, RMON.

Network Security:

IPSec, GRE (Genetic Routing Encapsulation), HHTPs, FTPs, DNS, Firewall, Passwords, Cryptography.

Risk Management:

Explore and apply approaches to risk assessment including risk identification, risk mitigation, risk avoidance, risk management and risk grading e.g. severity, likelihood, impact.

Trouble shooting and maintenance:

Troubleshooting methodologies for network and IT infrastructure.
Diagnostic techniques and tools to interrogate and gather information regarding systems performance.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Explore the concepts and principles of Network Management		**LO1 & LO2**
P1 Investigate Network Management concepts and principles. **P2** Explore the implications of automatic network management.	**M1** Evaluate the importance of Network Management.	**D1** Provide a comprehensive network configuration by providing screenshots of your work.
LO2 Plan, Design, Setup and Configure a network		
P3 Produce a comprehensive design of a network according to a given scenario.	**M2** Implement a network design according to a predefined network specification.	
LO3 Justify the Protocols and Standards concerned with Networking and Network Management		**LO3**
P4 Assess the following Network Protocols and Standards: SNMP, NETCONF, RMON, TCP/IP, HTTP, DNS, DHCP, SSL, IPSec, IEEE, ITU, ISO, OSI including IANA and ICANN.	**M3** Analyse the benefits and limitations of two Protocols.	**D2** Evaluate the role and functions of SNMP and RMON.
LO4 Use tools and methods to manage a network, including Network Security and Risk Management		**LO4**
P5 Use tools and methods to manage a network. **P6** Implement Network Security on your network. **P7** Conduct a Risk Assessment on your network.	**M4** Justify the importance of Network Security in a network.	**D3** Critically evaluate the importance of carrying out a Risk Assessment on a network.

Recommended Resources

Textbooks

Anderson, A. and Benedetti, R. (2009) *Head First Networking*. O'Reilly Media.

Comer, D. and Droms, R. (2003) *Computer Networks and Internets*. 4th Ed. Upper Saddle River: Prentice Hall.

Fitzgerald, J. and Dennis, A. (2006) *Business Data Communications and Networking*. 9th Ed. Hoboken. John Wiley.

Hallberg, B. (2013) *Networking: A Beginner's Guide*. 6th Ed. McGraw-Hill Osborne.

Harrington, J.L. (1999) *Ethernet Networking Clearly Explained*. Morgan Kaufman.

Kurose, J.F. and Ross, K.W. (2001) *Computer Networking: A Top-Down Approach Featuring the Internet*. London: Addison-Wesley.

Lowe, D. (2012) *Networking All-in-One For Dummies*. 5th Ed. John Wiley & Sons.

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

Reid, A. (2006) *WAN Technologies CCNA 4 Companion Guide*. Cisco Press.

Spurgeon, C. and Zimmerman, J. (2014) *Ethernet: The Definitive Guide*. 2nd Ed. O'Reilly Media.

Stallings, W. (2003) *Data and Computer Communications*. 7th International Ed. Upper Saddle River: Prentice Hall.

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

Tanenbaum, A. and Wetherall, D. (2013) *Computer Networks*. 5th Ed. Pearson.

Websites

www.ietf.org	Internet Engineering Task Force (General Reference)
www.itu.int	International Telecommunication Union (General Reference)
www.iso.org	International Organisation for Standardisation (General Reference)
www.tmforum.org	TeleManagement Forum (General Reference)
www.dmtf.org	Distributed Management Task Force (General Reference)

Links

This unit links to the following related units:

Unit 2: Networking

Unit 9: Computer Systems Architecture

Unit 27: Transport Network Design

Unit 29: Network Security

Unit 40: Client/Server Computing Systems

Unit 40: Client/Server Computing Systems

Unit code	**L/615/1680**
Unit level	**5**
Credit value	**15**

Introduction

The client/server system is a distributed application structure that partitions tasks or workloads between the providers of a resource or service (called servers) and service requesters (called clients). It is the basis of most internet communication. When surfing the internet, sending/receiving emails, using VoIP software and other applications, these functions work by using client/server systems.

This unit introduces students to the client/server system, an exchange mode for different applications. It consists of communication processes between clients and servers, the operation of applications based on the client/server system, and the socket programming used to code the system.

Among the topics included in this unit are: an introduction to the internet (concept, history, operation), client/server systems, various application protocols based on client/server systems, an introduction to Linux, client/server system programming, security considerations.

On successful completion of this unit students will be able to demonstrate an understanding of the concepts of servers, clients, and processes; illustrate different application protocols based on a client/server model (such as the meaning of http in a website address, POP/IMAP in email); reconstruct a client/server model in Linux 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 competences.

Learning Outcomes

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

1   Explore the concepts of servers, clients, and processes and the differences between PPID and PID.

2   Analyse the communication processes between clients and servers in different application protocols with records captured from the internet.

3   Create a client/server model in a Linux system with User Datagram Protocol (UDP), Transmission Control Protocol (TCP) and Application Layer protocols.

Essential Content

LO1 **Explore the concepts of servers, clients, and processes and the differences between PPID and PID**

Introduction to the structure of Open Systems Interconnection model (OSI model) and the operation of Transmission Control Protocol/Internet Protocol (TCP/IP).

Basic concepts of client, server, process.

Introduction to the concept and function of Sockets Interface.

The communication process between servers and clients (e.g. echo server process).

Measures to ensure server security.

LO2 **Analyse the communication processes between clients and servers in different application protocols with records captured from the internet**

Typical internet applications.

The concept, function, communication process based on the client/server system, and applications of following protocols:

Domain Name System (DNS).

Dynamic Host Configuration Protocol (DHCP).

Remote Interactive Computing: TELNET/ Secure Shell (SSH).

Email: Simple Mail Transfer Protocol (SMTP)/ Post Office Protocol (POP)/Internet Message Access Protocol (IMAP)/ Multipurpose Internet Mail Extensions (MIME).

File Transfer and Access: File Transfer Protocol (FTP)/ Trivial File Transfer Protocol (TFTP)/ Network File System (NFS).

World Wide Web: Hypertext Transfer Protocol (HTTP).

Network Management: Simple Network Management Protocol (SNMP).

Introduction to the Wireshark:

Function, history, install Wireshark, interface, and operation.

LO3 Create a client/server model in a Linux system with User Datagram Protocol (UDP), Transmission Control Protocol (TCP) and Application Layer protocols

Introduction of Linux:

Introduction to the Linux system: concept, history, advantages and disadvantages.

Basics–Linux command, the way to compile, the debugging method.

Programming of client/server program:

Socket Programming in Linux, including socket operation, byte order operation, address formats conversion, socket option, name and address operation, secure coding.

Simple UDP client / server program: UDP-based socket API, UDP-based client, UDP-based server.

Simple TCP client / server program: TCP-based socket API, TCP-based client, TCP-based server.

Application programming, such as a DNS server/client system.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Explore the concepts of servers, clients, and processes and the differences between PPID and PID		**LO1 & LO2**
P1 Illustrate the communication processes between servers and clients. **P2** Compare parent process and child process, PID and PPID.	**M1** Recognise parent process and child process in a communication record (such as the records obtained by Wireshark) between servers and clients. **M2** Design a model composed of parent process and child process to realise a simple function.	**D1** Design a realistic model to realise a function in real life using an Application Layer protocol.
LO2 Analyse the communication processes between clients and servers in different application protocols with records captured from the internet		
P3 Examine the concepts and functions of several Application Layer protocols. **P4** Operate Wireshark software, and recognise the different windows in the Wireshark interface.	**M3** Illustrate the communication processes of Application Layer protocols based on the client/server system. **M4** Analyse communication records captured from the internet based on Application Layer protocols.	**LO1 & LO2**

Pass	Merit	Distinction
LO3 Create a client/server model in a Linux system with User Datagram Protocol (UDP), Transmission Control Protocol (TCP) and Application Layer protocols		**LO3**
P5 Create a UDP system in Linux. **P6** Create a TCP system in Linux.	**M5** Build a system with DNS and illustrate it by a flowchart. **M6** Implement the created DNS system in Linux.	**D2** Implement the system with some advanced functions such as breakpoint resume.

Recommended Resources

Textbooks

Comer, D. (2013) *Internetworking with TCP/IP Volume I Principles, Protocols and Architecture*. 6th Ed. Pearson.

Comer, D. (2000) *Internetworking with TCP/IP, Vol. III: Client-Server Programming and Applications*. Linux/Posix Sockets Version. 1st Ed. Pearson.

Edwards, J. and Bramante, R. (2009) *Networking Self-Teaching Guide: OSI, TCP/IP, LANs, MANs, WANs, Implementation, Management, and Maintenance*. 1st Ed. Wiley.

Johansen, A. (2015) *LINUX: The Ultimate Beginner's Guide!*
CreateSpace Independent Publishing Platform.

Links

This unit links to the following related units:

Unit 2: Networking

Unit 9: Computer Systems Architecture

Unit 27: Transport Network Design

Unit 29: Network Security

Unit 39: Network Management

Unit 50: Operating Systems

Unit 41:   Database Management Systems

Unit code   **Y/615/1682**

Unit level   **5**

Credit value   **15**

Introduction

As globalisation and the 24-hour economy develop and increase, organisations must ensure that their database management systems (DBMS) are reliable, secure, efficient and able to cope with rapid change. Database management systems will continue to service the many operations of our modern world; they are becoming increasingly complex, to develop and manage, due to technological advancements and changes in the way organisations do their business in a global market.

In this unit, students will examine the structure of data, and how an efficient data design follows through into an effectively developed database management system. Students will examine the merits of different DBMS platforms, and investigate system administration and management tools of the platform.

Amongst the topics included in this unit are: examination of different database management systems, database design tools and techniques of relational database management systems, using an open source platform to develop, test and manage a client's system.

On successful completion of this unit students will be able to demonstrate their knowledge of the fundamentals of database management systems, be able to make informed choices between vendor and open source platforms for database management systems, design and develop a relational DBMS for a client using an open source platform, and carry out system administration tasks.

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:

1   Analyse different types of database management systems.

2   Design a database management system using a relational model to meet client requirements.

3   Develop a database management system using a suitable platform.

4   Demonstrate the system administration and management tools available on the chosen platform.

Essential Content

LO1 **Analyse different types of database management systems**

Types of database management systems (DBMS) and their operating system support, e.g. MySQL, Oracle.

Data models: Entity-Relationship, relational, hierarchical, network, object-oriented, object-relational.

Examine details of DBMS based on a relational model.

Relational data structures, including: relations, attributes, domain, tuple, cardinality.

Constraints: key, domain, referential integrity.

Normalisation in developing efficient data structures.

Modelling languages: query language, data definition language (DDL), data, manipulative language (DML), relational languages.

Transaction and concurrency in DBMS.

Investigation of open source and vendor-specific systems.

Multiple platform approaches to database management.

LO2 **Design a database management system using a relational model to meet client requirements**

Determine user and system requirements.

Examine design tools and techniques for a relational database management system.

Physical system design.

Logical design: design for relational databases, tables, data elements, data types, keys and indexes, entity relationship modelling, data flow diagrams, flowcharts.

Mathematical relations e.g. relational algebra, relational calculus.

DBMS selection, e.g. MySQL.

Application design, including: data entry/input (verification, validation, calculated fields, masks, directed input), reports (queries, presentation of data, layouts), task automation (imports, updates, deletions), queries using multiple criteria, form values and wild cards, action queries, calculated queries, queries across multiple tables.

Hardware, software and other resource requirements.

Test plans to check correctness of data, security, functionality, accessibility and usability.

Quality, effectiveness and appropriateness of the solution: correctness of data, relationships between data, data integrity, normalisation.

Working with clients and others to improve the quality, effectiveness, security and appropriateness of solution design

LO3 **Develop a database management system using a suitable platform**

Use of an appropriate database management system and Structured Query Language (SQL) to produce a secure solution to meet client's requirements.

Creating, setting up and maintaining data tables.

Applying data validation rules.

Generating outputs e.g. user-generated queries, automated queries, reports.

Application and user interface e.g. navigation, data entry forms and sub-forms, automated functions.

Populating the database.

SQL statements to extract, manipulate and modify data.

Applying security measures to control access to data, e.g. user access levels.

Testing the database solution using different types of testing: referential integrity, functionality, security, stability.

Selection and use of appropriate test data.

Selecting suitable test users and gathering feedback from users.

Making use of testing outcomes to improve and/or refine the solution.

Reviewing the solution, criteria for use when reviewing the solution against: quality of the database, fitness for purpose, suitability against the original requirements, technology constraints, strengths and improvements, platforms and compatibility.

Optimising the solution: data types, data sizes e.g. size on disk, many tables e.g. overheads for many tables, query optimising.

LO4 **Demonstrate the system administration and management tools available on the chosen platform**

Describe core database administration tasks and tools.

Practical demonstrations of server management to include:

Setting up and managing data storage for servers and users.

Backup and recovery routines for data and applications.

Managing authorisations.

Managing security and encryption.

Importing and exporting data.

Trace database activity.

Monitoring performance and optimising performance.

Audit trails.

Managing alerts and notifications.

Database maintenance including setting up automatic routines.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Analyse different types of database management systems		**LO1** **D1** Critically evaluate different database management systems available in relation to open source and vendor-specific platforms, justifying the criteria used in the evaluation.
P1 Compare and contrast the different types of database models.	**M1** Assess how relational database models and the process of normalisation can provide reliable and efficient data structures.	
LO2 Design a database management system using a relational model to meet client requirements		**LO2 & LO3** **D2** Critically evaluate the effectiveness of the system design and development against client and system requirements.
P2 Produce a design for a relational database management system to meet client requirements.	**M2** Analyse how the design will optimise system performance.	
LO3 Develop a database management system using a suitable platform		
P3 Develop a fully functional system which meets client and system requirements, using an open source language (with an application software e.g. MySQL with front end Microsoft Access). **P4** Test the system for functionality and performance.	**M3** Implement effective features in the solution to handle concurrency, security, user authorisations and data recovery.	

Pass	Merit	Distinction
LO4 Demonstrate the system administration and management tools available on the chosen platform		**LO4**
P5 Demonstrate the tools available in the system to monitor and optimise system performance, and examine the audit logs. **P6** Demonstrate the tools available in the system to manage security and authorisations.	**M4** Assess the effectiveness of the system administration and management tools available on the platform identifying any shortcomings of the tools.	**D3** Analyse any future improvements that may be required to ensure the continued effectiveness of the database system.

Recommended Resources

Textbooks

Connolly, T. and Begg, C. (2014) *Database systems: A practical guide to design, implementation and management*. 3rd Ed. Addison-Wesley.

Elmasri, R. and Navathe, S. (2011) *Fundamentals of Database Systems*. 6th Ed. Addison-Wesley.

Hoffer, J. (2008) *Modern Database Management*. Pearson Education.
Jeffrey A., Ramesh, V. and Topi Heikki, T. (2012) *Modern Database Management*. Pearson Education.

Silberschatz, A., Korth, H.F. and Sudarshan, S. (2011) *Database System Concepts*. 6th Ed. McGraw-Hill Edition.

Plus others linked specifically to the version of the software used for a given platform.

Journals

International Journal of Database Management Systems

Journal of Database Management

The Computer Journal

Journal of Emerging Trends in Computing and Information Sciences

Links

This unit links to the following related units:

Unit 4: Database Design & Development

Unit 11: Strategic Information Systems

Unit 42: Game Design Theory

Unit code	**T/615/1673**
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. However, it is a completely different story 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. Initially this unit establishes an overall history of games and reviews how they have (and are still) evolving. It also takes the opportunity to introduce and assess common game features and help the students identify the roles, responsibilities and challenges of game design. As part of this unit students will become familiar with a range of standard documents associated with games design including the 'Game Design Document'. Before students 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, 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-reviews before finally presenting a 'High Concept' pitch. To help maximise the 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 regards 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:

1 Critically assess the types, practices, principles and skills used in the design of games.
2 Analyse the concepts and elements required for the production of a Games Design Document.
3 Evaluate the game design process with regards to game development and production.
4 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**

Review 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.

Investigate the 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**

Investigate 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.

Analyse the 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 regards to game development and production**

Introduce key terminologies and define a basic roadmap for the game design process (including: 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).

Introduce game development constraints (and possible pitfalls) together with platforms commonly available to support development.
Discuss testing methods and introduce the purpose of Quality Assurance (QA) and business and monetisation models (e.g. Steam, retail, Free-to-Play (F2P) supported by techniques such as: item-purchase, affiliate, advertising, Freemium, restricted access, subscription) with regards to 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.**

Create an original game concept:

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

Peer-review and evaluate feedback on a number of your game ideas to justify the selection of a specific game idea.

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

Create an original Game Design Document and present its 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 a 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.	**LO1 & LO2** **D1** Evaluate each section of a Games Design Document and explain the effect of game loops and Metagame design with regards to game play.
LO2 Analyse the concepts and elements required for the production of a Games 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 regards 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 regards 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, Design Document and High Concept pitch and fully justify opportunities for improvement and further development.

Recommended Resources

Textbooks

Gibson, J. (2014) *Introduction to Game Design, Prototyping, and Development*. New Jersey: Pearson Education.

Gregory, J. (2014) *Game Engine Architecture*. 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

44: Games Engine & Scripting

Unit 43: Games Development

Unit 43: Games Development

Unit code	**D/615/1697**
Unit level	**5**
Credit value	**15**

Introduction

In the field of computing, games development is a multidisciplinary art form that creates worlds that blend player psychology, problem-solving and artificial intelligence with knowledge about dedicated hardware and software platforms. This level of ability can often require significant effort on the part of the student with regards to time and practice. However, as more experience is gained, the skills and abilities quickly improve. In addition, once completed it is important to know that 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 and 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 are expected to discuss and review a number of original game ideas before synthesising them into a single game concept. Once defined they will need to adopt and use appropriate methods and practices to analyse, breakdown and discuss the issues – then, decide, 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. On completion, and in addition to the student reviewing and reflecting on the experience, they will be expected to formally evaluate their completed game against their Games Design Document and original concept.

Among the topics included in this unit are: game design and developer documentation, problem analysis, research, system and user requirements, design methodologies and principles, development methodologies, unified modelling language (UML), software development lifecycles, games engines, hardware platforms, graphic manipulation, physics, maths for games, sound, networking, collision detection, teamwork, peer-reviews, development tools and techniques, integrated development environments, debugging, testing, software versions and quality assurance.

On successful completion of this unit students will be able to develop a Game Design Document by evaluating and 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, 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, which are crucial for gaining employment and developing academic competence.

Learning Outcomes

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

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

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

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

4   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**

Research and compare 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 and predict the overall success of fully developing your game.

Develop a Game Design Document:

Review and discuss the value of Game Design Documents with regards to games development.

Evaluate and synthesise your game ideas into a single document that describes (in detail) your game concept.

Research and use information relating to games testing to create a suitable test plan for your game.

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

Discuss different design and development methodologies:

Present overviews on current design and development methodologies.

Debate various strengths and weaknesses commonly associated with each methodology.

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

Use appropriate tools and techniques:

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

Establish your development plan by debating the advantages and disadvantages of your 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

Work as a small team to plan and prepare your functional video game:

Peer-review and debate your development plan and Games Design Document by effectively communicating and defending your ideas and reasoning.

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

Modify your design document or plans to reflect any new insights or considerations.

Prepare and produce a functional video game:

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

Create and quality check appropriate support documents for your video game.

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

Assess the performance of a video game:

Analyse factors that influence the performance of a video game with regard to its system requirements.

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

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

Plan improvements to a video game:

Evaluate the overall strengths and weaknesses of your video game against its Game Design Document and original concept.

Discuss and plan in detail possible revisions (including implementation) with regard to improving your 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 your video game.	**M1** Analyse and combine common game design elements (such as type, story, characters, environment, levels, gameplay, loops, art, sound, user interface and controls) with your 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.

Pass	Merit	Distinction
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 this video game.	**M2** Compare the differences between the various design and development methodologies, tools and techniques researched and justify your preferred selection.	**LO2 & LO3** **D2** Evaluate any new insights, ideas or potential improvements to your concept, methodology or use of tools and justify the reasons why you have chosen to include (or not to include) them as part of this development.
LO3 Work individually and as part of a team to plan and produce a functional video game, including support documentation		
P4 Create a formal presentation that effectively reviews your video game concept together with your preferred design and development methodologies and selected tools and techniques. Use this presentation as part of a peer-review and document any feedback given. **P5** Develop a functional video game based on a specified game concept.	**M3** Interpret your 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 your video game against your original concept.	**M5** Critically 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 your video game. Conclude your review by reflectively discussing your previously identified risks.	**D3** Critically evaluate the strengths and weaknesses of your video game and fully justify opportunities for improvement and further development.

Recommended Resources

Textbooks

Gibson, J. (2014) *Introduction to Game Design, Prototyping, and Development.*
New Jersey: Pearson Education.

Gregory, J. (2014) *Game Engine Architecture*. 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 44: Games Engine & Scripting

Unit code	**K/615/1671**
Unit level	**5**
Credit value	**15**

Introduction

Professional game development typically represents a significant investment in time, effort, skill and money. These requirements are further complicated due to the generally increasing differences in hardware platforms (such as PCs, Mac, Xbox, PlayStation, tablets and other mobile devices). Prior to the use of a games engine, a developer would need highly detailed and specific knowledge relating to the platform, device drivers and operating system calls. In addition, they would need to be capable of writing efficient low-level maths functions to simulate physics, gravity, calculate trajectories and determine object collisions in 2D and 3D environments, including designing image transition algorithms. Using a games engine, a developer can implement more features, more quickly and more effectively, and deploy them on more platforms than ever before. However, despite using a games engine there are still plenty of unique challenges to be solved.

This unit introduces students to the origin and evolution of games engines and their effect on game design, it also expects students to project this path into the future to draw conclusions and predict a possible future for engines. After being introduced to the core services of most engines and their advantages, students are expected to evaluate a range of different engines and debate their features. In addition, and while students assimilate, reflect and consider the advantages and technical challenges of a games engine they will be issued with an existing Games Design Document (supported with all appropriate assets) and challenged with planning and using a specific engine to develop the design into a functional game. On completion, and in addition to the student reviewing and reflecting on the experience, they will be expected to formally assess their functional game against the Games Design Document and user expectation.

Among the topics included in this unit are: games engine evolution and purpose, player expectation, types of engine, design documentation, research, system and user requirements, game design, ad management, monetisation, usage analytics, build services, graphics and animation, adding physics, storing world data, artificial and automated intelligence, collision detection, user interface and user control methods, gameplay, assets and asset management, hardware platforms, development tools and techniques, integrated development environments, scripting languages, debugging, testing, software versions and quality assurance.

On successful completion of this unit students will be able to analyse the evolution, impact and possible future of games engines with regard to game development and expectation, evaluate the features and architecture of different games engines, use an existing Game Design Document (with assets) to synthesise key features of a selected games engine into a playable game and assess and plan improvements to a playable game by evaluating its performance against its Game Design Document and user expectation.

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:

1   Analyse the evolution, impact and possible future of games engines with regards to game development and expectation.

2   Evaluate the features and architecture of different games engines.

3   Use an existing Game Design Document (with assets) to synthesise key features of a selected games engine into a playable game.

4   Assess and plan improvements to a playable game by evaluating its performance against its Game Design Document and user expectation.

Essential Content

LO1 Analyse the evolution, impact and possible future of games engines with regards to game development and expectation

Analyse the evolution of games engines:

Identify what a games engine is by researching the purpose and history of games engines.

Assemble and evaluate a timeline illustrating milestones and linking the release of pivotal games with the development and use of games engines.

Investigate the possible future of games engines with regards to games development and expectation:

Research, debate and agree current gaming trends.

Discuss the evolution of player expectation and its influence and effect on games development.

Analyse trends and use the information to predict a possible future for games (short, mid and long term) and relate this to the development and use of games engines.

LO2 Evaluate the features and architecture of different games engines

Features and architecture of a games engine:

Introduce and discuss the core features of games engines, such as: ad management, monetisation, usage analytics, build services, multiplayer support, developer collaboration, debugging, 2D and 3D graphics and animation services, particle and lighting systems, physics and database services, multiple language support, virtual reality, artificial and automated intelligence, collision detection, user interface and user control methods.

Select a specific games engine and discuss game engine architecture, including: game and update loops, assets and memory management, graphics manipulation, scripting, collisions and physics engine, math libraries and user interface.

Evaluate a range of different types of published games to determine and agree the type of features commonly embedded in each.

Use your selected games engine to investigate the implementation and technical challenges associated with each of your previously identified features.

Research different games engines:

Debate the features from a range of games engines and evaluate the strengths and weaknesses of each.

LO3 Use an existing Game Design Document (with assets) to synthesise key features of a selected games engine into a playable game

Synthesise ideas defined in an existing Game Design Document with games engine features:

Evaluate and synthesise an existing Game Design Document with the features of a specific games engine to create a development plan.

Peer-review and discuss your development plan by effectively communicating and defending your ideas and reasoning.

Modify your plan to reflect any new insights or considerations.

Create and test a playable game:

Use the Game Design Document (with assets) with your development plan to create a playable game.

Adopt an appropriate level of testing to identify, debug and fix issues.

LO4 Assess and plan improvements to a playable game by evaluating its performance against its Game Design Document and user expectation

Assess the performance of a playable game:

Analyse factors that influence the performance of a playable game with regard to game genre, style and player expectation.

Undertake a critical review of the performance and development of your playable game against all identified factors, including use of any games engine features.

Critique the overall success of your playable game and identify any new areas of personal insight.

Plan improvements to a playable game:

Evaluate the overall strengths and weaknesses of your playable game against its Game Design Document.

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

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Analyse the evolution, impact and possible future of games engines with regards to game development and expectation		
P1 Compare different games engines and explain how their evolution has impacted on game design and development.	**M1** Discuss the origin, type and chronological evolution of games engines, associating them with influential titles that had a significant impact on video game design and development and explain how this affected player expectation. **M2** Provide evidence of current gaming trends and technology and use it to predict the future of games engines and explain how this could affect designers, developers and gamers.	**LO1 & LO2** **D1** Critically analyse each of the games engines evaluated in M3.
LO2 Evaluate the features and architecture of different games engines		
P2 Compare the features of different games engines and explain the purpose and operation of each. **P3** Review different published games and determine the types of features embedded in each against the features available in a selected games engine.	**M3** Evaluate the features and architecture of different games engines and explain with technical detail the purpose and operation of each. **M4** Use a selected games engine to create simple prototypes that demonstrate features commonly embedded in games.	

Pass	Merit	Distinction
LO3 Use an existing Game Design Document (with assets) to synthesise key features of a selected games engine into a playable game.		**D2** Further expand your playable game by adding support for: animation, sound, end of level detection, player victory and loss conditions and level restarting.
P4 Use an existing Games Design Document to plan the development and testing of a playable demo and conduct formal peer-reviews regarding your development and testing plan, documenting any feedback given. **P5** Use a Games Design Document supported with a development and test plan and a selected games engine to develop a playable demo.	**M5** Interpret your peer-review feedback and identify opportunities not previously considered. **M6** Extend your playable demo into a game that supports: splash screens, credits, scoring and losing player life.	
LO4 Assess and plan improvements to a playable game by evaluating its performance against its Game Design Document and user expectation		
P6 Review the performance of your playable demo or game against the Games Design Document.	**M7** Evaluate the strengths and weaknesses of your playable game against player expectation.	**D3** Critically evaluate the strengths and weaknesses of your playable game against player expectation and explain opportunities for improvement and further development.

Recommended Resources

Textbooks

Gibson, J. (2014) *Introduction to Game Design, Prototyping, and Development.* New Jersey: Pearson Education.

Gregory, J. (2014) *Game Engine Architecture*. 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 42: Game Design Theory

Unit 43: Games Development

Unit 45:   Internet of Things

Unit code   **T/615/1690**

Unit level   **5**

Credit value   **15**

Introduction

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

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

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

On successful completion of this unit students will be able to explain the basic concepts of IoT; design, build and simulate an IoT application using any combination of hardware, software, data, platforms and services; be able to discuss the problem IoT applications solves; the potential impact on society, business and the end user and the problems encountered when integrating into the wider IoT ecosystem.

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

Learning Outcomes

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

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

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

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

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

Essential Content

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

Identify role, formats and characteristics of IoT:

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

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

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

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 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.

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.

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 this problem:

Choose a specific problem to solve using IoT.

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

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

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

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

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

Select an appropriate IoT application to achieve desired results.

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

Use your selected techniques to create an IoT application development plan.

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

Utilise appropriate tools and techniques to develop an IoT application:

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

Run end user experiments and examine feedback.

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

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

Assess the success of your IoT application:

Assemble and appraise end use feedback from your IoT application.

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

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

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

Discusses your insight using IoT.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Analyse what aspects of IoT are necessary and appropriate when designing software applications		**LO1**
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 life cycle. **M2** Review 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		**LO2 & LO3**
P3 Investigate architecture, frameworks, tools, hardware and API techniques available to develop IoT applications. **P4** Determine a specific problem to solve using IoT.	**M3** Select the most appropriate IoT architecture, frameworks, tools, hardware and API techniques to include in an application to solve this problem. **M4** Apply your selected techniques to create an IoT application development plan.	**D2** Make multiple iterations of your 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 your plan into an IoT application. **P6** Run end user experiments and examine feedback.	**M5** Reconcile and evaluate end user feedback and determine advantages and disadvantages of your chosen IoT techniques.	

Pass	Merit	Distinction
LO4 Evaluate your IoT application and the problems it might encounter when integrating into the wider IoT ecosystem		**LO4**
P7 Review your IoT application detailing the problems it solves. **P8** Assess the potential impacts of your IoT application on people, business and society and the end user. **P9** Investigate the potential problems your IoT application might encounter when integrating into the wider system.	**M6** Undertake a critical review and compare your final application with the original plan.	**LO4** **D3** Critically evaluate the overall success of your application.

Recommended Resources

Textbooks

Arshdeep, B. (2014) *Internet of Things: A Hands on Approach*. 1st Ed. VPT.

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

Links

This unit links to the following related units:

Unit 21: Application Program Interfaces

Unit 47: Emerging Technologies

Unit 46:　　　　Robotics

Unit code	**F/615/1692**
Unit level	**5**
Credit value	**15**

Introduction

Robots are becoming much more widely used, with applications ranging from agriculture through to manufacturing, including an increasing interest in autonomous systems. These are mechanical devices produced in various forms, including human form. Robots can move by themselves, and their motion can be modelled, planned, sensed, actuated and controlled by programming.

This unit is designed to explore robotic systems, both historically and as an area of rapid contemporary development. The student will be introduced to the different types and applications of robotic systems and will be encouraged to discuss and reflect on the implications of using robots

Topics included in this unit are an introduction to robotic systems, types of robots, industrial robots, automation system components, developing a solution, sensors, and sensor-based robots, ethical considerations, safety, social and economic impacts.

On successful completion of this unit, students will gain experience in building a robot and be exposed to a wide range of practical applications of robotic systems. 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:

1   Explore different robotic systems commonly used in industry, taking into account different configurations and the advantages and disadvantages of these.

2   Build a robot and appraise this from the perspectives of cost-benefit impact.

3   Evaluate the operation and application of a range of sensors (e.g. vision, tactile) and how they can apply to a mobile or static robotic system.

4   Evaluate the relevance of biologically inspired robotic systems and how these can benefit both the understanding of biological systems and the design of individual or groups of robots.

Essential Content

LO1 **Explore different robotic systems commonly used in industry, taking into account different configurations and the advantages and disadvantages of these**

Introduction to robotics:

Types and applications of robotics, why robots are important.

Industrial robotics:

Applications of robotics to industries, including medical, surgical and rehabilitation robotics.

Advantages and disadvantages, safety, security, social and economic impacts, and ethical issues of robots.

LO2 **Build a robot and appraise this from the perspectives of cost-benefit impact**

Components and instruction to build:

Classification of types of robot; identification of manipulator components and terminology; joints classification, compactor, digital millimeter, robot-line followings, battery, register, LEDs, DC motor, etc.

LO3 **Evaluate the operation and application of a range of sensors (e.g. vision, tactile) and how they can apply to a mobile or static robotic system**

Sensors:

Range of sensors, their components and compatibilities.

Tactile sensors:

Construction of tactile, and touch sensors, interpretation of sensory information, use of sensory data to determine kinematic information.

Vision systems:

Computer vision, perception, optical flow, road car and quad-copter navigation.

LO4 Evaluate the relevance of biologically inspired robotic systems and how these can benefit both the understanding of biological systems and the design of individual or groups of robots

Biologically inspired robotics:

Types of biologically inspired robotics, humanoid robots, bio-inspired morphologies, reactive and deliberative control, learning behaviours; multi-robot and swarm systems.

Reflection:

How does the robot help to understand biological systems? How do biological systems help to design a robot?

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Explore different robotic systems commonly used in industry, taking into account different configurations and the advantages and disadvantages of these		**LO1 & LO2**
P1 Analyse the types of robots and their use in industry. **P2** Discuss the advantages and disadvantages of using these robots.	**M1** Choose an industry and critically evaluate the use of robotics in that industry and the benefits of using them.	**D1** Critically evaluate the social and ethical impact of using these robots.
LO2 Build a robot and appraise this from the perspectives of cost-benefit impact		
P3 Assess all the components which are used to build a simple robot. **P4** Build a fully functional simple robot.	**M2** Discuss the construction process and explain the cost-benefit impact.	

Pass	Merit	Distinction
LO3 Evaluate the operation and application of a range of sensors (e.g. vision, tactile) and how they can apply to a mobile or static robotic system		**LO3 & LO4**
P5 Evaluate a range of sensors and their use. **P6** Embed a sensory system for the robot built in P4, to enhance the robots intelligence.	**M3** Critically analyse the construction process and explain the benefit of this upgrade.	**D2** Evaluate the impact of the chosen biologically inspired techniques used in the robot and detail the behavioural changes of the robot.
LO4 Evaluate the relevance of biologically inspired robotic systems and how these can benefit both the understanding of biological systems and the design of individual or groups of robots		
P7 Evaluate the range of biologically inspired techniques which can be embedded within a robot. **P8** Discuss how a biologically inspired robot can be used to study the understanding of the biological system.	**M4** Choose a biologically inspired technique and analyse how the robot behaves after embedding the technique in the robot.	

Recommended Resources

Textbooks

Backstop Media and Waldron, R. (2015) *JavaScript Robotics: Building NodeBots with Johnny-Five, Raspberry Pi, Arduino, and BeagleBone*. Maker Media.

Band, T., Mihelj, M., Lenarcic, J., Stanovnik, A. and Munih, M. (2010) *Robotics*. Springer, London.

Ceceri, K. (2015) *Making Simple Robots*. Make Publications.

Cook, D. (2015) *Robot Building for Beginners*. 3rd Ed. Apress.

Corke, P. (2011) *Robotics: Vision and control*. Springer. Berlin.

Donat, W. (2014) *Make a Raspberry Pi-Controlled Robot: Building a Rover with Python, Linux, Motors, and Sensors*. Maker Media.

Grimmett, R. (2014) *Arduino Robotic Projects*. Packt Publishing.

Grimmett, R. (2015) *Raspberry Pi Robotics Essentials*. Packt Publishing.

Grimmett, R. (2015) *Raspberry Pi Robotics Projects*. 2nd Ed. Packt Publishing.

Siciliano, B., Sciavicco L., Villani L. and Oriolo G. (2010) *Robotics: Modelling, planning and control*. Springer. London.

Links

This unit links to the following related units:

Unit 15: Fundamentals of Artificial Intelligence and Intelligent Systems

Unit 26: Machine Learning

Unit 47:   Emerging Technologies

Unit code	**R/615/1695**
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 and allows rapid development and sharing of ideas, products and scientific understanding to occur 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 create entirely new scientific fields and novel technologies by converging different systems, technology, thinking or disciplines together. Emerging Technologies explore a variety of changing technologies that display radical novelty, have the potential for significant commercial or social impact, fast growth, scalability and affect the future in uncertain ways.

This unit introduces students to the role, benefits, disadvantages and potential outcomes Emerging Technologies have in the development of software applications. The aim of the unit is to enhance the student's understanding of the current state, terminology, advantages, disadvantages, potential impact and benefits of Emerging Technologies on the development of software applications.

Among the topics included in this unit are: classification and terminology of Emerging Technologies, review the most promising and impactful Emerging Technologies, trends of convergence, the impact of computers in the development of Emerging Technologies, the hardware, software, data, platforms and services used to enable development of Emerging Technologies, understand the scale, scope, advantages and disadvantages Emerging Technologies may have on humankind.

On successful completion of this unit students will be able to explain some of the most promising and impactful Emerging Technologies. Have an awareness of the impact, advantages and disadvantages Emerging Technologies may have on humankind. Understand the impact Emerging Technologies will 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:

1   Assess what Emerging Technologies are necessary and appropriate when designing software applications for the future.

2   Research state-of-the-art Emerging Technologies and choose one you believe will have significant impact in the future.

3   Discuss the current state and future impact of your chosen Emerging Technology.

4   Evaluate the political, economic and social factors which play a role in the competition between Emerging Technologies and their success or failure in the future.

Essential Content

LO1 **Assess what Emerging Technologies are necessary and appropriate when designing software applications for the future**

Evaluate formats, characteristics and trends of Emerging Technologies:

Present an overview of Emerging Technologies and their appropriate use in software development.

Assess what Emerging Technology is by researching its role, purpose and terminology.

Recognise the various forms of Emerging Technology by researching its history and current trends.

Define the characteristics of Emerging Technology by investigating how they can be used and how they differ from and converge with developed technology.

Recognise specific Emerging Technologies:

Research, debate and agree current trends in Emerging Technology.

Assess various forms of Emerging Technology, focusing on their relevance to software development and computing.

Define the advantages and disadvantages of Emerging Technology.

How Emerging Technologies can converge with existing technologies or replace them.

Appropriateness of using of Emerging Technology to disrupt the status quo throughout industries, markets, user adoption and established practices.

LO2 **Research state-of-the-art Emerging Technologies and choose one you believe will have significant impact in the future**

Investigate a specific Emerging Technology and how it will affect the status quo of an industry, end user group and the current state of technology development:

Investigate a specific Emerging Technology for discussion choosing one you believe will have the most impact to software application design and development in the future.

Choose a specific industry and end user group that will be the most influenced by this Emerging Technology.

Evaluate the benefits, features, advantages and disadvantages of this Emerging Technology.

LO3 Discuss the current state and future impact of your chosen Emerging Technology

Develop a report and presentation using research gathered about your chosen Emerging Technology, industry and end user:

Organise your research and findings.

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

Relate how your chosen Emerging Technologies can converge with existing technologies or replace them.

Defend your choice of Emerging Technology in relation to your belief it will have the most impact on software application design and development in the future.

Develop a report of your research and findings.

LO4 Evaluate the political, economic and social factors which play a role in the competition between Emerging Technologies and their success or failure in the future

Assess the success of your research:

Arrange a presentation to demonstrate your findings, gather feedback and answer questions.

Assemble and appraise your report findings and research.

Evaluate the political, economic and social factors which play a role in the competition between Emerging Technologies and their success or failure in the future.

Discuss how your chosen Emerging Technologies can converge with existing technologies or replace them.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Assess what Emerging Technologies are necessary and appropriate when designing software applications for the future		
P1 Assess formats, characteristics and trends of Emerging Technologies. **P2** Explore the advantages and disadvantages of Emerging Technology.	**M1** Evaluate the ability of Emerging Technology to disrupt the status quo throughout industries, markets, user adoption and established practices. **M2** Review various forms of Emerging Technologies, focusing on their relevance to software development and computing.	**D1** Evaluate Emerging Technologies and justify their use when designing software applications for the future.

Pass	Merit	Distinction
LO2 Research state-of-the-art Emerging Technologies and choose one you believe will have significant impact in the future		
P3 Select a specific Emerging Technology. **P4** Review a specific industry and end user group that will be the most influenced by this Emerging Technology.	**M3** Evaluate the benefits, features, advantages and disadvantages of this Emerging Technology. **M4** Show how Emerging Technologies can converge with existing technologies or replace them.	**LO2 & LO3** **D2** Defend your choice of Emerging Technology in relation to your belief it will have the most impact on software application design and development in the future.
LO3 Discuss the current state and future impact of your chosen Emerging Technology		
P5 Organise your research and findings. **P6** Contrast the benefits, features, advantages and disadvantages of your chosen Emerging Technology.	**M5** Relate how your chosen Emerging Technologies can converge with existing technologies or replace them. **M6** Develop a report of your research and findings.	
LO4 Evaluate the political, economic and social factors which play a role in the competition between Emerging Technologies and their success or failure in the future		
P7 Evaluate your report findings and research.	**M7** Arrange a presentation to demonstrate your findings, gather feedback and answer questions.	**D3** Critique the benefits, features, advantages and disadvantages of your chosen Emerging Technology.

Recommended Resources

Textbooks

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

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

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

Links

This unit links to the following related units:

Unit 14: Business Process Support

Unit 48:   Virtual & Augmented Reality Development

Unit code   **Y/615/1696**

Unit level   **5**

Credit value   **15**

Introduction

Virtual (VR) and Augmented (AR) Reality is the process by which you can use computer software and hardware technologies to develop fully immersive, simulated virtual reality environments or augment the real world with virtual reality content. The objective of Virtual and Augmented Reality development is to design virtual environments or real-world augmentations for numerous beneficial, experimental, educational or entertainment purposes. VR and AR explore the potential to work, interact, play, collaborate and communicate in expansive simulated environments or use technology to enhance the real world with some of the benefits and features of simulated virtual environments.

This unit introduces students to the role, basic concepts and benefits of VR and AR technology and how to apply them in the development of VR/AR computer applications. The aim of the unit is to enhance the student's understanding of the methodology, terminology and benefits of VR and AR software applications.

Among the topics included in this unit are: classification and terminology of VR and AR technology, the relationship between VR and AR design, how VR and AR development relates to and differs from other forms of software development, modes of interaction, human-computer interaction models, usability, accessibility, aesthetics, spatial design, 3D vision, motion tracking, understand the hardware, software, data, platforms and services available to develop VR and AR software applications.

On successful completion of this unit students will be able to explain the basic concepts of VR and AR development. Plan, build and measure the success of an appropriate VR or AR software application. Design a VR or AR software application. 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:

1   Examine what aspects of VR and AR technology are necessary and appropriate when designing VR and AR software applications.

2   Plan an appropriate VR or AR software application using common architecture, frameworks, tools, hardware and APIs.

3   Design, build and simulate a VR or AR software application using any combination of hardware, software, data, platforms and services.

4   Evaluate your VR or AR software application and detail the problems and limitations your application encountered and the reaction your VR or AR application generated with end users.

Essential Content

LO1 **Examine what aspects of VR and AR technology are necessary and appropriate when designing VR and AR software applications**

Identify formats, characteristics and aspects of VR/AR technology:

Present an overview of VR/AR technology and its appropriate use in software development.

Identify what AR/VR is by researching the role, purpose, terminology and methodology of this technology.

Recognise the various forms of AR/VR technology by researching its history, current trends and use in the product development lifecycle.

Define the characteristics of AR/VR by investigating how it is similar to and differs from traditional simulated and virtual environments.

Recognise specific forms of AR/VR technology:

Research, debate and agree current functionality and capabilities of AR/VR technology.

Identify various forms of AR/VR technology and end user hardware.

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

Define the advantages and disadvantages of AR/VR technology.

Define standard tools available for use in developing AR/VR applications:

Identify standard tools available to develop AR/VR applications.

The advantages and disadvantages of AR/VR tools and hardware.

Appropriateness of various tools to develop AR and VR applications.

LO2 **Plan an appropriate VR or AR software application using common architecture, frameworks, tools, hardware and APIs**

Identify an application concept to develop in AR/VR:

Evaluate the benefits, features, advantages and disadvantages of AR/VR technology to develop this application.

Review different AR/VR architecture, frameworks, tools, hardware and API techniques you could apply to develop this application.

Select the most appropriate AR/VR architecture, frameworks, tools, hardware and API techniques to include in this application.

Describe a plan to develop your AR/VR application concept:

Use your selected techniques to create an AR/VR application development plan.

LO3 Design, build and simulate a VR or AR software application using any combination of hardware, software, data, platforms and services

Utilise appropriate tools and techniques to develop an AR/VR application:

Employ an appropriate set of tools to develop your plan into an AR/VR application.

Run end user experiments and examine feedback.

Reconcile and evaluate end user feedback and determine advantages and disadvantages of your chosen AR/VR techniques.

LO4 Evaluate your VR or AR software application and detail the problems and limitations your application encountered and the reaction your VR or AR application generated with end users

Assemble and appraise end use feedback from your AR/VR application:

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

Evaluate the advantages, disadvantages, strengths and weaknesses of your AR/VR techniques.

Critique the overall success of your application. Was it successful? How did users react to it?

Discusses your insight using AR/VR Technology.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Examine what aspects of VR and AR technology are necessary and appropriate when designing VR and AR software applications		**LO1 & LO2**
P1 Explore the necessary aspects of AR/VR technology **P2** Review the appropriateness of the standard architecture, frameworks, tools, hardware and APIs available for use in AR/VR development.	**M1** Justify the impact of common AR/VR architecture, frameworks, tools, hardware and APIs in the software development lifecycle.	**D1** Evaluate the benefits, features, advantages and disadvantages of AR/VR technology to develop this application. In addition, critique the architecture and techniques that have been used.
LO2 Plan an appropriate VR or AR software application using common architecture, frameworks, tools, hardware and APIs		
P3 Investigate architecture, frameworks, tools, hardware and API techniques you could apply to develop this application.	**M2** Select the most appropriate AR/VR architecture, frameworks, tools, hardware and API techniques to include in an application to solve this problem. **M3** Use your selected techniques to create an AR/VR application development plan.	

Pass	Merit	Distinction
LO3 Design, build and simulate a VR or AR software application using any combination of hardware, software, data, platforms and services		**LO3**
P4 Employ an appropriate set of tools to develop your plan into an application. **P5** Run end user experiments and examine feedback.	**M4** Reconcile and evaluate end user feedback. **M5** Determine the advantages and disadvantages of your chosen techniques.	**D2** Make multiple iterations of your application and modify each iteration with enhancements gathered from user feedback and experimentation.
LO4 Evaluate your VR or AR software application and detail the problems and limitations your application encountered and the reaction your VR or AR application generated with end users		**LO4**
P6 Assemble and appraise end use feedback from your AR/VR application.	**M6** Undertake a critical review and compare your final application with the original plan.	**D3** Critically evaluate the overall success of your software application, detailing any problems or limitations encountered.

Recommended Resources

Textbooks

Parisi, T. (2015) *Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web and Mobile*. O'Reilly Media.

Schmalstieg, D. (2016) *Augmented Reality: Principles and Practice (Usability)*. Addison-Wesley Professional.

Links

This unit links to the following related units:

Unit 21: Application Program Interfaces

Unit 45: Internet of Things

Unit 49:   Systems Integration

Unit code	**H/615/1698**
Unit level	**5**
Credit value	**15**

Introduction

Large organisations and businesses are composed of different functional areas, such as finance, HR, customer management, engineering services, product manufacturing, storage and warehousing. These functional areas carry out different operations in order to fulfil the goals of the business and often use a variety of different IT systems (e.g. stock control, accounts, HR, etc.) from a range of different suppliers and vendors to service their needs. The success of any large business or enterprise in achieving its goals depends on the ability of IT systems to effectively communicate with each other. However, IT systems from different vendors or suppliers often use different hardware and/or software platforms and services, thus creating the need for systems integration.

This unit introduces students to enterprise business requirements, and the need and purpose of systems integration to support organisational goals. Students are expected to gather and review business objectives with the aim of developing a systems specification document. As part of a feasibility analysis, students are expected to evaluate factors and issues affecting the successful completion of integration, including describing and documenting the functional architecture and design of a system. Students are also expected to explore hardware and software technologies used to connect systems and subsystems and establish an integration methodology to design and implement an integrated solution. In addition, students will investigate and compare different cloud service models and evaluate different deployment methods and consider their effect on systems integration.

Among the topics included in this unit are: enterprise business objectives, purpose and operation of systems integration, systems specification documents, feasibility analysis, risk assessments, architectural development, hardware and software technologies for systems integration, operational configuration, systems integration design framework, design, development and deployment of a systems integration solution, quality assurance, cloud services as a systems integration provision, cloud service models and different deployment models, such as private and public cloud services.

On successful completion of this unit students will be able to analyse systems integration requirements with regard to business objectives, investigate different hardware and software systems with regard to connectivity, communication and data transfer, prepare a suitable integrated solution based on a set of business requirements and compare a range of cloud computing providers and evaluate their services.

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:

1   Analyse systems integration requirements with regards to business objectives.

2   Investigate different hardware and software systems with regards to connectivity, communication and data transfer.

3   Prepare a suitable integrated solution based on a set of business requirements.

4   Compare a range of cloud computing providers and evaluate their services.

Essential Content

LO1 **Analyse systems integration requirements with regards to business objectives**

Identifying business objectives:

Introduce and outline the purpose and operation of 'systems integration'.

Gathering and reviewing business objectives, including interpreting business needs from different functional areas and departments.

Developing a systems specification document, including establishing and ensuring requirements can be met.

Feasibility analysis:

Using risk assessments to evaluate issues threatening the successful completion of integrating systems, including identifying any reasonable steps necessary to prevent or mitigate issues.

Architectural development; describe and document the functional architecture and design of the system and specify all technical requirements and capabilities.

LO2 **Investigate different hardware and software systems with regards to connectivity, communication and data transfer**

Exploring hardware and software technologies:

Research and evaluate hardware and software servers, technologies, platforms and services.

Connecting systems and subsystems, including custom software services and development.

Establish a systems integration methodology:

Operational configuration: exploring requirements, information needs and facilitating data transfer and communication.

Identifying and tracking issues for problem resolution and fault detection, including diagnosing type and location.

Implementing a design framework: using top-down and bottom-up methodologies.

LO3 **Prepare a suitable integrated solution based on a set of business requirements**

Establishing a strategic approach:

Analyse functional architecture and technical capabilities against a specification document to determine the probability of successfully developing (and deploying) an effective integrated solution.

Establishing a management strategy.

System design, development and deployment:

Designing, developing and monitoring an integrated system.

Quality Assurance, including deploying and testing an integrated system.

Evaluating system functionality: documentation, maintenance and upgrades.

LO4 **Compare a range of cloud computing providers and evaluate their services**

Investigating and comparing cloud service models:

Introduce and discuss IaaS (Infrastructure as a Service).

Review and debate PaaS (Platform as a Service).

Research and discuss: SaaS (Software as a Service).

Investigating and comparing deployment models:

Research and discuss private, public and hybrid clouds.

Evaluating issues: security, privacy and constraints.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Analyse systems integration requirements with regards to business objectives		
P1 Discuss the objectives and effect of 'Systems Integration' with regards to business operations and management. **P2** Prepare a suitable 'Systems Specification' and 'Risk Assessment' document for a set of specific business objectives.	**M1** Evaluate the processes involved in 'System Integration' and review the purpose and impact of assessing risk. **M2** Provide a detailed 'Systems Specification' and 'Risk Assessment' document.	**LO1 & LO2** **D1** Critically evaluate your detailed 'System Specification' and 'Risk Assessment' document, including justification on how each of the specified business objectives has been met.
LO2 Investigate different hardware and software systems with regards to connectivity, communication and data transfer		
P3 Discuss a range of hardware and software systems, technologies, platforms and services that would be suitable for use with a given 'Systems Specification' document. **P4** Determine the purpose of top-down and bottom-up methodologies and how they relate to 'Systems Integration'.	**M3** Provide a detailed and evaluated review of your selected systems, platforms, technologies and services and include details on system and service connectivity.	

Pass	Merit	Distinction
LO3 Prepare a suitable integrated solution based on a set of business requirements		
P5 Create an 'Integrated Systems' solution to a set of specific business objectives using existing 'Systems Specification and Risk Assessment' documents, including illustrated design diagrams and details on information flow. **P6** Create a systems deployment and test plan suitable for use with your 'Integrated Systems' solution.	**M4** Provide a detailed and evaluated 'Integrated Systems' solution, including fully annotated diagrams, details on information flow, risk, redundant systems, backups, security, connectivity, deployment, testing and a full review of the solution's functionality compared to the 'Systems Specification' document.	**LO3 & LO4** **D2** Critically evaluate the impact of cloud services on 'Systems Integration' and discuss the implications of 'IaaS', 'PaaS' and 'SaaS' and how they could be used to help organisations improve their performance.
LO4 Compare a range of cloud computing providers and evaluate their services.		
P7 Discuss the differences between 'IaaS, 'PaaS' and 'SaaS' services and compare the 'private', 'public' and 'hybrid' deployment models offered by cloud computing providers.	**M5** Review a range of cloud computing providers and compare the services offered.	

Recommended Resources

Textbooks

Erl, T., Mahmood, Z. and Puttini, R. (2014) *Cloud Computing: Concepts, Technology & Architecture*. USA: Prentice Hall

Paul, D., Yeates, D. and Cadle, J. (2010) *Business Analysis*. UK: BCS.

Poulton, N. (2016) *CompTIA Server+ Study Guide: Exam SK0-004*. USA: John Wiley & Sons Inc.

Links

This unit links to the following related units:

Unit 28: Cloud Computing

Unit 50:   Operating Systems

Unit code   **R/615/1700**

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 foundations 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 competently operate any given Operating System and undertake routine maintenance of Operating System as well as their optimisation. 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:

1 Investigate different Operating Systems, their functions and user interfaces.

2 Explore the processes managed by an Operating System.

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

4 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 of Operating Systems:

Discuss the history of Operating Systems from Legacy Operating Systems to current Operating Systems, tracking its development from Batch files to the modern Operating Systems.

History and evolution of operating systems:

Discuss what is meant by an Operating System, why Operating Systems are needed, how Operating Systems started and developed throughout the ages, what constitutes an Operating System, similarities and differences between Operating systems and firmware.

LO2 Explore the processes managed by an Operating System

Operating Systems Management:

Understanding of how Memory Management is conducted in an Operating System, job scheduling is handled by an Operating System, how Process Scheduling happens in in Operating Systems, how concurrent processing happens in an Operating System, device management is accomplished by an Operating System, File Management is performed by an Operating System.

Explain the functions of IoT OS, overview of IoT operating systems and firmware.

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

Operating system knowledge:
Commands for manipulating a range of different Operating Systems e.g. MS-DOS, Windows, UNIX and Linux commands.

Security and Communications:

Consider 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, AWS, Google Cloud Platform, IBM Watson IoT, Microsoft Azure.

Common IoT communication protocols, CIG Functions and Architecture,

Features of IoT platforms.

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

Critical evaluation of an Operating System environment:

Operating Systems can be used for a number of domains. Your task is to evaluate different Operating Systems' environments, including Distributed Operating Systems as well as Concurrent Operating Systems, etc.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Investigate different Operating Systems, their functions and user interfaces		**LO1, LO2 & LO3**
P1 Explore what an Operating System is. **P2** Research the evolution of Operating Systems.	**M1** Discuss the importance of Operating Systems.	**D1** Critically 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** Analyse, with the aid of a diagram, the importance of Resource Management in an Operating System to aid its efficiency.	
LO3 Demonstrate the use of DOS, Windows, UNIX and Linux		
P5 With an aid of screenshots, prove the use of MS-DOS and Windows. **P6** With an aid of screenshots, prove the use of UNIX and Linux and MacOS.	**M3** Justify the security of each operating system discussed in P5 and P6.	
LO4 Analyse appropriate techniques and technologies used in distributed and concurrent systems		**LO4**
P7 Discuss distributed Operating Systems. **P8** Discuss Concurrent Operating Systems.	**M4** Justify which techniques and technologies you would use in a Distributed Operating system.	**D2** Critically evaluate your work and make some recommendations about current Operating Systems and future advancements.

Recommended Resources

Textbooks

Davis, W.S. and Rajkumar, T.M. (2004) *Operating Systems: A Systematic View*. 3rd Ed. Harlow, Addison-Wesley.

McHoes, A.M. and Flynn, I.M. (2007) *Understanding Operating Systems*. 5th Ed. Course Technology.

Nutt, G.J. and Clegg, N. (2003) *Operating Systems*. International Edition. Harlow, Addison-Wesley.

O'Gorman, J. (2000) *Operating Systems (Grassroots)*. Basingstoke. Palgrave Macmillan.

Ritchie, C. (2002) *Operating Systems*, 4th Ed. London, Thomson Learning.

Silberschatz, A. and Galvin, P. (1998) *Operating System Concepts*. Harlow. Addison-Wesley.

Stallings, W. (2001) *Operating Systems: Internals and Design Principles*. London. Prentice Hall.

Tanenbaum, A.S. (2001) *Modern Operating Systems*. Upper Saddle River. Prentice Hall.

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 units:

Unit 40: Client/Server Computing Systems

Unit 51:   E-Commerce & Strategy

Unit code	**D/615/1683**
Unit level	**5**
Credit value	**15**

Introduction

Electronic Commerce, or E-Commerce, refers to any type of commercial/business transaction where information, data, products and services are exchanged across the internet. These transactions can cover a wide diversity of business types to include: consumer-based retail sites (e.g. Amazon), sites that provide facilities such as auctions (e.g. eBay) and business exchanges between different organisations. E-Commerce allows consumers to electronically exchange goods and services 24/7 with no barriers in terms of time or geography.

Within this unit students will gain an understanding of how and why businesses and organisations develop E-Commerce strategies: to remain competitive in the global market. Students will also appreciate the elements and resources required to set up an E-Commerce site and be engaged in the design and implementation of their own strategies that would in reality form part of a secure E-Commerce site.

Students will examine the impact that E-Commerce has on society and the global market for consumers, buyers and sellers in terms of the benefits and drawbacks of online purchasing. Through investigation, students will also research the technologies involved in setting up a secure E-Commerce site in preparation for their own E-Commerce strategy.

There is an expectation that students will devise a strategy based on an element of E-Commerce such as designing a shopping cart, an ordering system, payment system or an online marketing system, for example. This design should be fully implemented and evaluated accordingly in terms of its success or failure.

Standards and levels of support, marketing, CRM, promotion and supply chain management will all be explored within the context of developing the implementation strategy.

On successful completion of this unit a student will have gained both a technical and practical insight into E-Commerce strategy, design and development. 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:

1   Examine the strategies employed and the impact of E-Commerce on business organisations.

2   Analyse the hardware, software, web-based and database technologies involved in setting up a secure E-Commerce site.

3   Design an E-Commerce strategy based on a given end user requirement or specification.

4   Implement an E-Commerce strategy based on a given end user requirement or specification.

Essential Content

LO1 Examine the strategies employed and the impact of E-Commerce on business organisations

Customer expectations:

Raised expectations for a quick and efficient service e.g. timely responses to customer communications, quick delivery of the product or service, accurate information, reduced pricing for the product/service, greater choice.

Benefits:

Wider market, niche target marketing, lower overheads and costs, greater flexibility and access to goods/services 27/7.

Drawbacks:

Visibility, security issues and threats, down-time, high set up and maintenance costs, need to employ a technician or web-based administrator to manage the provision.

LO2 Analyse the hardware, software, web-based and database technologies involved in setting up a secure E-Commerce site

Web architecture:

Components e.g. server-side scripting, client/server/script interaction, operation of server-side web applications, accessing data on the web server, dynamic web pages, consistent navigational menu on all pages, browser cookies, embedding animation and video content in web pages, adding interactivity with plug-ins.

Hardware and software:

Web servers, browsers, server software, web authoring tools, database system, shopping cart software, scripting software, browser and platform compatibility. Networking technology e.g. TCP/IP addresses, ports and protocols; domain names, multiple registration of domains (.com as well as .co.uk); setting up the server directory structure, deploying access configuration/security.

Database technology:

Uses and processes e.g. database-driven web pages, opening a connection to a database, storing data captured from forms, performing dynamic queries on the database, generating a web page response displaying the results of a query.

Communication technology:

Uses e.g. email support, forum; search engine optimisation; additional hardware and software components required to support communications.

Data transmission:

Features e.g. download speeds, transfer rates, bandwidth required for given applications including text, graphics, video, speech.

LO3 **Design an E-Commerce strategy based on a given end user requirement or specification**

Considerations:

Hardware and software, design and development, costs and resources, security, maintenance, customer online support and logistics.

Internet strategy:

Hosting e.g. internal, sub-contracted; design of the website; maintaining 24/7 access.

Marketing strategy:

Methods e.g. targeting market segments and interest groups, developing electronic 'web-communities', CRM, promotion strategies to target specific market segments, search engine optimisation, e-marketing software.

Supply chain strategy:

Methods e.g. satisfying customer demand, responsive supply chain, managed in house or sub-contracted, developing 'partnership' relationships with suppliers.

Electronic payment:

Methods e.g. online transaction processing, Commercial Off the Shelf Software (COTS), other payment systems e.g. PayPal, WorldPay.

LO4 Implement an E-Commerce strategy based on a given end user requirement or specification

Implementation:

Demonstrate that the E-Commerce strategy devised has been implemented using suitable tools and applications. The strategy could be marketing, supply chain or payment based, for example designing an online ordering system or an online payment system.

Evaluation:

Evaluate the success of the design and implementation of the E-Commerce strategy.

Technique:

SWOT analysis to evaluate the overall strengths, weaknesses, opportunities and threats of the implemented E-Commerce strategy.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Examine the strategies employed and the impact of E-Commerce on business organisations		**LO1**
P1 Discuss the importance of addressing and meeting customer expectations when employing an E-Commerce strategy.	**M1** Analyse organisation case studies and examine how E-Commerce has been used to improve an element of business operations.	**D1** Critically review the benefits and drawbacks of an organisation utilising E-Commerce.
LO2 Analyse the hardware, software, web-based and database technologies involved in setting up a secure E-commerce site		**LO2**
P2 Discuss the technologies involved in setting up a secure E-Commerce site.	**M2** Justify the importance of communications technology in E-Commerce design.	**D2** Evaluate the role that database technology plays in the development and sustainability of E-Commerce.
LO3 Design an E-Commerce strategy based on a given end user requirement or specification		**LO3**
P3 Discuss the types of strategies that could be used to drive an E-Commerce solution. **P4** Design an E-Commerce solution based on a specified requirement or strategy.	**M3** Analyse the factors and resources that should be considered when designing an E-Commerce strategy. **M4** Differentiate between the types of payment systems that are integral to E-Commerce success.	**D3** Appraise the design and functionality of the E-Commerce solution.

Pass	Merit	Distinction
LO4 Implement an E-Commerce strategy based on a given end user requirement or specification		**LO4**
P5 Implement an E-Commerce solution based on a specified requirement or strategy.	**M5** Produce a detailed SWOT analysis to support the implemented E-Commerce design.	**D4** Evaluate the success of the E-Commerce implementation and identify how it fulfils a specified requirement or strategy.

Recommended Resources

Textbooks

Bones, C. and Hammersley, J. (2015) *Leading Digital Strategy: Driving Business Growth Through Effective E-commerce.* 1st Ed. Kogan Page.

Chaffey, D. (2009) *E-Business and E-Commerce Management: Strategy, Implementation and Practice*. 4th Ed. Financial Times: Prentice Hall.

Laudon, K. and Traver, C. (2015) *E-Commerce*. 11th Ed. Pearson.

Philips, J. (2016) *Ecommerce Analytics: Analyse and Improve the Impact of Your Digital Strategy*. 1st Ed. Pearson FT Press.

Journals

Journal of Electronic Commerce Research

Journal of Electronic Commerce in Organisations (JECO)

Websites

www.networksolutions.com	Network Solutions
	Education Centre
	"Developing an E-Commerce Strategy" (Articles)
www.ecommercefuel.com	E-Commerce Fuel (Discussion Forum)

Links

This unit links to the following related units:

Unit 4: Database Design & Development

Unit 14: Business Process Support

Unit 41: Database Management Systems

Unit 52: Digital Sustainability

Unit code	A/618/5694
Unit level	5
Credit value	15

Introduction

Living and working in the 21st century within the Digital Technologies sector, presents a range of unforeseen sustainability challenges, based around mineral resource, ethical working and employment practices, economic impact, supply chain challenges and climate impact amongst many other potential issues.

The Brundtland Commission of the United Nations in March 1987 defined sustainability as: "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Digital Technologies is a sector in the frontline of the battle to overcome the challenges of creating a sustainable economy, but no single discipline will have the capability to tackle the problems alone. Sustainability is a multidisciplinary challenge, and technologists of the future will have to work collaboratively with a whole range of other stakeholders, such as engineers, scientists, governmental bodies and financiers, if they are to be able to produce the practical and technological solutions required within the necessarily urgent time scales.

For reducing carbon footprints to be effective, sustainable technologies from across every relevant discipline will need to be built in to all new developments and retro fitted to current systems to extend their lifetimes. Novel and innovative uses of energy will contribute to this.

On successful completion of this unit the student with possess a wide range of knowledge and understanding of the issues and topics associated with sustainability, low impact digital technology solutions and will explore the interdisciplinary context of sustainability and how the development of a low carbon economy is essential within the digital technology sector. They will have the opportunity to explore a current digital technology solution and evaluate its impact and potential sustainability, evaluating a range of solutions and data sources.

Learning Outcomes

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

1. Determine the nature and scope of the technical challenges, ensuring sustainability, within the digital technologies sector.
2. Explore the importance of collaborating with other disciplines in developing digital technical solutions to sustainability problems.
3. Explore the use of sustainable techniques in relation to their contribution to a low carbon economy.
4. Analyse a variety of data sources to estimate the carbon footprint of a digital technologies solution.

Essential Content

LO1 **Determine the nature and scope of the technical challenges, ensuring sustainability, within the digital technologies sector.**

The scope and social context of sustainability:

Current sustainable development and digital technology challenges, evaluating the Brundtland definition of sustainability within a digital technologies context, evaluating the impact of global demographics, trends and predictions population growth and how this affects demand, economics, employment ethics and resource availability

Environmental issues:

Climate change, planetary energy balance, carbon cycle science, carbon foot print of digital technologies including: power consumption, mineral and material use, shipping, heat/energy output, packaging, recycling and safe disposal, potential pollution issues, contaminants in older equipment, low carbon power sources, sustainable use of technologies – extending lifetime utilisation

LO2 **Explore the importance of collaborating with other disciplines in developing digital technical solutions to sustainability problems.**

Systems thinking and socio-technical systems:

The politics and economics of sustainability, following the principles of the Kyoto Protocol, UN Climate Change Conference (COP) and European Union Emissions Trading Scheme

Maintaining sustainable infrastructures:

Low carbon transport systems, engaging with sustainable cities and societies, using green building and built infrastructure principles, ensuring the use of low impact power generation, power storage and power distribution. Assuring low impact, sustainable logistics and maintaining a low waste based system.

Ethical standards:

Assuring 3rd party supplier, manufacturer and supply chain contractors all conform to current ethical sustainable and fair employment standards, along with associated legislation, e.g. ethical sourcing and disposal of end-of-life electrical equipment – Waste Electrical and Electronic Equipment (WEEE) Regulations 2013. Use of environmentally neutral, beneficial 3rd party cloud solutions, reviewing ecological credentials of cloud provisioning organisation.

LO3 **Explore the use of sustainable techniques in relation to their contribution to a low carbon economy.**

Sustainable techniques:

Evaluating how digital technologies can be maintained via nuclear, solar, wind, tidal and wave, geothermal, biomass and bioenergy. Ensuring Whole life cycle costing and using the precautionary principle.

Exploring the cost, power consumption and impact of data centres within a sustainability context. Evaluate the KWH (kilowatt hour) power consumption of cloud solutions, data transmission and device use (routers, switches, servers, desktop systems, mobile computing, smart devices, wireless, wired etc). Powering down devices when unused, reducing standby time, power consumption on 'spin up' to full utilisation.

Inclusion of green technology e.g. LED lights, solar / wind generation, heat pump cooling, in data centre developments

LO4 **Utilise a variety of data sources to estimate the carbon footprint of a digital technologies solution.**

Data sources:

Evaluating power consumption, manufacturers ecological/green rating of device(s), data sheets, regional waste management metrics, energy efficiency ratings,

Carbon footprint:

Investigating the digital technology carbon footprint perspective, including organisational, value and supply chain, product based challenges, current carbon footprint science, calculation of footprint based on system boundaries (limits of sphere of influence and control)

Long term sustainability:

Projecting long term utilisation of selected digital technologies.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Determine the nature and scope of the technical challenges, ensuring sustainability, within the digital technologies sector.		
P1 Investigate the nature and scope of the technical challenges of ensuring sustainability for the digital technologies sector	**M1** Determine the impact of sustainability on the deployment of digital technologies	**D1** Critically evaluate the interrelationship between sustainability, digital technology demand and resource availability
LO2 Explore the importance of collaborating with other disciplines in developing digital technical solutions to sustainability problems.		
P2 Explain the interdisciplinary issues associated with the construction of sustainable infrastructures, with attention to the competing pressures within these infrastructures	**M2** Explore how political, economic and ethical standards can impact digital technical solutions	**D2** Critically analyse how a systemic approach can be used to support interdisciplinary collaboration in developing sustainable digital technologies in compliance with standards
LO3 Explore the use of sustainable techniques in relation to their contribution to a low carbon economy.		
P4 Discuss the sustainable techniques that need to be considered when selecting alternative low carbon energy sources	**M3** Analyse the challenges present, when selecting low carbon sustainable techniques, for a digital technology solution	**D3** Critically analyse how current digital technology solutions could be improved via the application of low carbon sustainable techniques.
LO4 Utilise a variety of data sources to estimate the carbon footprint of a digital technologies solution		
P5 Analyse the relative value of multiple data sources for estimating the impact on of a digital technology solution **P6** Estimate the carbon footprint of a digital technology solution	**M4** Investigate the value of current data sources for making projections regarding the long term sustainability of a digital technologies solution	**D4** Critically evaluate how the carbon footprint of an existing digital technology solution impacts on the environment

Recommended resources

Textbooks

BERNERS-LEE, M. (2019) *There Is No Planet B: A Handbook for the Make or Break Years* Cambridge University Press

BERNERS-LEE, M. (2010) *How Bad Are Bananas?* Profile Books.

BOYLE, G. (2012) *Energy Systems and Sustainability: Power for a Sustainable Future*. Oxford University Press.

FENNER, A. and AINGER, C. (2013) *Sustainable Infrastructures: Principles into Practice*. ICE Publishing.

HAZAS, M. & NATHAN, L (2017) Digital Technology and Sustainability: Engaging the Paradox, Routledge

HELM, D. (2015) *The Carbon Crunch: Why we are Getting Climate Change Wrong and How to Fix It*. Yale University Press.

HONE, D. (2014) *Putting The Genie Back: 2^0c Will Be Harder Than We Think*. Whitefox Publishing.

Journals

IEEE: Xplore

Elsevier: Sustainability journals

Taylor and Francis: Sustainability papers

Web

http://www.carbontrust.com	Carbon Trust Carbon foot printing (General Reference)
http://www.fern.org/	FERN Trading Carbon How it Works and Why it is Controversial (Ebook)
https://www.populationinstitute.org	Population Institute Demographic Vulnerability report (Report)
https://www.gov.uk/guidance/regulations-waste-electrical-and-electronic-equipment	UK Government Technology Waste Disposal

Links

This unit links to the following related units:

Unit 53: Digital Technology as a Catalyst for Change

Unit code	T/618/5662
Unit level	5
Credit value	15

Introduction

Digital technology has transformed how people communicate, learn, and work. This sector is one of the most valuable and fastest growing economic areas in most of the world. Although the first electronic digital computer was created in the 1930s, the digital revolution began between the late 1950's and 1970's, when key developments of technologies from mechanical and analogue to digital took place. It was during this time the use of digital computers and digital record keeping became the norm. The industry has grown rapidly in recent decades and digital technologies are now a part of our daily lives. The digital technologies we are familiar with today are the electronic tools, systems, devices and resources that generate, store or process data. Most popular examples include mobile phones, social media, online games, virtual reality and multimedia. Spanning cultural, creative, educational and many other industries, digital technologies are a vibrant sector with growth that has surpassed the rest of the economy. Digital technology has completely modified the way we live today and in years to come this will be even more incredible.

In this unit, students will explore both the current and emerging digital technologies used across different industries and investigate how organisations and businesses use digital technologies to meet their needs. They will also develop a solution for a specific organisation to use a new or emerging technology to manage a change initiative.

On successful completion of the unit, students will have explored industry sectors that use digital technologies, the history of the industry, current and emerging digital technologies, how organisations are adapting and solving problems using digital technologies and planning for the future.

Learning Outcomes

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

1. Explore how digital technologies impacts organisational change
2. Evaluate how the use of digital technology impacts on an organisation's strategy and operations to meet its needs
3. Investigate how digital technologies influence leadership decision making in relation to a specific industry
4. Present a new or emerging digital technology solution to manage a change initiative within a specific organisation

Essential Content

LO1 **Explore how digital technologies impacts organisational change**
Evolution of current digital systems and technologies:
Development of the digital technologies sector and the impact on organisational change, e.g. evolution of digital technologies, computers, laptops, smartphones, tablets / touchscreen devices, SMART products and experiences, digital manufacturing, Cloud technologies, virtual reality experiences,
Industries using Digital Technologies:
The impact of digital transformation in different industries e.g. Automotive and Manufacturing, Banking and Financial Services, Government / Public Sector, Healthcare, Marketing, Retail & Consumer Packaged Goods, Sport, Agriculture, Telecom and Media / Entertainment, Travel / Transportation
Emerging Digital Technologies:
Impact of emerging digital technologies on organisational change, e.g. robotics, Artificial Intelligence (AI) (including Machine Learning), Cybersecurity, Internet of Things (IoT), Blockchain, Bitcoin, Virtual Reality and Augmented Realty, Edge Computing,
Purposes:
Purpose of digital technologies on organisational change, e.g. social connectivity, global communication / communication speed, wider consumer reach, support remote working (e.g. local, national, and international), versatile working e.g. flexible working practices, increased connectivity options, information storage, reduce costs, improving productivity, increasing promotion and sales, meeting business goals, improving efficiency, recruitment, education, increase business support, enhance customer experience / providing instant customer service, technical support, news and updates, GPS and mapping
Rationale for change management:
Digital transformation and the disruptive effects of emerging technologies on organisational change
The value of digital transformation to improve organisational performance, seize new opportunities, address key issues, optimise the customer experience

Types of organisational change:
Change in a business context, including large scale, e.g. radical, discontinuous, revolutionary and small scale, e.g. incremental, evolutionary.
Different types of change that include planned or emergent, initiated or imposed.
Types of internal organisational change: structural, strategic, people and process change.
Individual, group and organisational levels of change
Change management models:
Different approaches to managing change within organisations, e.g. Kotter's 8 Step model, McKinsey 7-S, ADKAR (Awareness, Desire, Knowledge, Ability and Reinforcement), Kubler-Ross Change Curve, Lewin's change management model.
The benefits and drawbacks of the key change models.

LO2 **Evaluate how the use of digital technology impacts on an organisation's strategy and operations to meet its needs**
Responding to drivers of change:
Using systems theory and continuous improvement models to predict and proactively plan for change
Burke-Litwen mode to make the change process efficient and effective
Change impact assessment:
Organisational strategy, e.g., business plans, annual forecasts, aims and objectives, short/long term goals, financial accounts (including profit and loss), financial projections
Operational aspects, e.g., organisational structure, human resources, physical resources, working hours, staffing (internal and external), sales, advertising, marketing
Business needs, e.g., business type (e.g. large corporate, SME, freelance, self-employed), types of technology that organisations use to provide a product/service, needs and/or benefits of the customers/clients, hardware/software/network requirements, security requirements
Tools to identify needs, e.g., gap analysis process, feasibility study (based on organisation's needs, market research), digital strategy/digital policies of business plan, feedback from stakeholders, customers, employees
Assessing if technology meets an organisation's needs:
Benefits realisation, e.g. improved efficiency, increased profit, increased productivity, reduction in wasted time, reduction in cost
Risks and issues, e.g. customer feedback, complaints, loss of sales, profit loss
Change management, e.g. training, transition from existing to new technology, risk of loss of service / data
Ethical considerations, e.g. consultation with stakeholders, data ownership, impacts on employees
Data management and access, e.g. privacy, security of data
Legal considerations of digital transformation use of data, technology, and software as a means to generate meaningful business insights and conduct

operations more efficiently. Legislation includes, e.g. Intellectual Property (IP), Copyright, Trademarks, trade secrets, compliance, e.g. data protection and security, data mining and control, use of data for advertising, Computer Misuse Act 1990.

Change management processes:

Sequence of steps or activities that move change from inception to delivery, e.g. identify need for change, impact analysis, approve/deny, implement, review/report.

LO3 **Investigate how digital technologies influence leadership decision making in relation to a specific industry**

Driving factors of change:

The external and internal drivers that are driving change.

The implications of current factors for future development of digital technologies and decision making e.g. distributed ledger technology (DLT), and the impact for e-commerce, transformational impact of 5G networks on IT systems for faster and efficient decision making.

Barriers to change:

How barriers to change influence leadership decision-making Initiated or imposed change, e.g. deciding to be pre-emptive and proactive or responsive and reactive will be based on the situation and the nature/scope of the change. Adaptive and constructive change.

The impact that the scope of the change may have on decision making.

Responding to barriers and resistance to change.

Barriers and resistance to change, e.g. force field analysis to understand likely opposition and support for change in a contemporary context.

Schein's organisational culture model, self-efficacy perceptions and situational resistance when determining barriers.

Leadership ethics for effective decision making, e.g. respecting and valuing diversity, values and ethical beliefs.

Speed of change, e.g. pre-emptive and proactive or responsive and reactive.

Resource implications of digital development, e.g. financial, physical, human – requisite skills and experience.

Change factors:

Positive Factors, e.g. increased skillsets, training opportunities, improve people's quality of life, wage increases, increased employment, enhanced career prospects

Negative Factors, e.g. loss of employment, reduced career progression opportunity, necessity to retrain in an alternative sector, impact of local community and wider economy

Evolution of digital technologies and change management:

Current examples of digital technologies driving change

Sustainability and the need for enhanced/refined digital technologies

Agility and leadership in response to change

Change at a time of crisis and long-term benefits, e.g. COVID 19 and rapid

development of technology to provide lifesaving support, post-World War II enhanced vehicle manufacture, climate change
Leadership skills and techniques to support change, e.g. focused, inspirational, flexible, ability to learn from mistakes, defined vision and outcome, clear communication, empowering, address unsatisfied employee issues, encourage team collaboration, challenge.

LO4 **Present a new or emerging digital technology solution to manage a change initiative within a specific organisation**
Initiating a Change:
Influence of position and perception influence a view of change as negative or positive
Types of organisational change as a result of digital technologies, e.g., structural and strategic, people and processes
The impacts of change initiated by leaders, e.g. increased control, time and increased opportunity to select the best approach to apply.

The impacts of change that is imposed, e.g. opportunities are reduced or even negated.

The stages of the change lifecycle.
Managing change:
Different perspectives to dealing with change e.g. individual, open system
Change impact analysis, e.g. Bohner and Arnold, and impact analysis techniques.

The importance of stakeholder analysis and communication in change.
Application of the Burke-Litwin model to make the change process efficient and effective.

Planned and emergent change.
Strategies for managing different types of change e.g. planning, communication, setting out a roadmap.
Developing Solutions:
Project and time management plans
The elements and principles of using digital technology hardware and software
Equipment, techniques, and processes
Suitability of selected equipment, techniques, and processes.
Health, safety, safe working practices
Project reports and project evaluations
Purpose and value of quality assurance techniques
Present a Resolved Solution:
Different types of presentation formats, e.g. Industry-standard presentation software
Hierarchy of text-based and visual information
The key considerations for delivering a presentation e.g. timing, structure, pace.

Selection and editing of content presentation skills
Audience:
The importance of understanding audiences and stakeholder requirements and the implications this has on presentation style etc
Techniques for generating and collating audience feedback

Justifications:
Supporting and justifying the choice of solutions using creative, cultural, social, political, economic trends and contexts
Industry-specific terminology
How to engage, interact and respond to audience feedback
Reflective practice

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Explore how digital technology impacts organisational change		**LO1 and LO2** **D1** Evaluate the use of emerging digital technologies for an organisations strategy and operations to meet its needs, in a specific industry context.
P1 Investigate how digital technologies can support organisational change. **P2** Explain what is meant by digital technologies, in relation to different industries.	**M1** Examine the relationship between current and emerging technologies, their purposes and how these are being used in a specific industry context.	
LO2 Assess how the use of digital technology impacts on an organisation's strategy and operations to meet its needs		
P3 Assess how the use of digital technology impacts an organisation's strategy and operation across a range of sectors or organisations. **P4** Discuss the positive and negative impact of organisational tools to support the use of digital technologies	**M2** Analyse organisational tools used to support the implementation of digital technology to meet organisational strategic goals.	
LO3 Investigate how digital technologies influence leadership decision making in relation to a specific industry		**LO3** **D2** Justify the effective planning and implementation of a change initiative within a specific organisation.
P5 Review the factors that may affect the future development of digital technologies in relation to a given industry context. **P6** Examine barriers to change and determine how they influence leadership decision making in a given industry context.	**M3** Analyse the connection between positive and negative factors of digital technology development and its influence on leadership decision making.	
LO4 Present a new or emerging digital technology solution to manage a change initiative within a specific organisation		**LO4** **D3** Evaluate the success of presenting a new or emerging digital technology solution, making recommendations for improvements
P7 Develop a plan to implement a digital technology change initiative for an organisation. **P8** Reflect on the plan developed for a new or emerging digital technology	**M4** Assess the impact of barriers to change on a new or emerging digital technology solution.	

solution and the impact of feedback on the change lifecycle.		

Recommended Resources

Textbooks

LEWIS, L. K. (2011) Organizational Change: Creating Change Through Strategic Communication. Chichester: Wiley-Blackwell.

STANFORD, N. (2013) Organization Design: Engaging with Change. 2nd Ed. London: Routledge.

VENKATRAMAN, V. (2017) The Digital Matrix: New Rules for Business Transformation Through Technology. Canada: Life Tree Media.

SCHAEFFER, E . (2019) Reinventing the Product: How to Transform your Business and Create Value in the Digital Age. London: Kogan Page.

Journals

International Journal of Digital Enterprise Technology

Journal of Change Management

Journal of Organisational Change Management Leadership

International Journal of Digital Technology & Economy

Links

This unit links to the following related units:

Unit 47: Emerging Technologies

Unit 52: Digital Sustainability

Unit 54: Prototyping

Unit code	**D/615/1666**
Unit level	**5**
Credit value	**15**

Introduction

A prototype is the first or early sample, model or demonstration version of a concept, design or idea used to test functionality and gather feedback. The objective of prototyping is to build a functional and demonstrable version of a concept and use this version to evaluate different aspects of the concept with end users. A prototype may test a single or multiple facet of a concept and can range in functionality from very basic design mock-ups to fully functional features within complex software applications.

This unit introduces students to the role, basic concepts, and benefits of prototyping in the design and development process of software applications. The aim of this unit is to enhance a student's understanding of the methodology, terminology. and benefits of prototyping in the design and development of secure software applications.

Among the topics included in this unit are: classification and terminology of prototyping tools and techniques, the relationship between prototypes and release candidate software applications, how prototypes differ from release candidate software applications, categorising prototypes by their intended target end user, functionality and testing requirements, methods of prototyping, most appropriate forms of prototype for the different categories of testing, gathering meaningful insights and results from prototype testing, software release lifecycle and software prototyping concepts.

On successful completion of this unit students will be able to explain the basic concepts of prototyping; plan, build and measure the success of an appropriate prototype with a specific end user in mind; and conduct testing to gather meaningful feedback and data to improve a prototype or final software application.

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

Learning Outcomes

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

1   Explore forms of prototypes appropriate for various functionality and end user testing requirements.

2   Plan a prototype for specific target end users and planned tests. 3

     Develop multiple iterations of the prototype using appropriate tools.

4   Evaluate user feedback and test results from multiple iterations of the prototype and end user testing.

Essential Content

LO1 Explore forms of prototypes appropriate for various functionality and end user testing requirements

Explore formats, characteristics and appropriateness of prototyping:

Present an overview of prototyping, how prototypes are produced and their appropriate use in software development.

Identify what a prototype is by researching the role, purpose, terminology and methodology of prototyping.

Recognise the various forms of prototyping by researching the history of prototyping, current trends and use in the product development lifecycle.

Define the characteristics of a prototype by investigating how they can be used and how they differ from complete applications.

Recognise the use of appropriate prototyping formats to achieve specific end user testing requirements and outcomes.

Recognise specific forms of prototyping functionality and end user testing requirements:

Research, debate and agree current functionality and end user testing trends and appropriate prototyping methodology.

Identify various forms of functionality and end user testing methodology.

Define the advantages and disadvantages of using prototyping to perform end user testing.

Understand the value of following company, team or client approaches to continuous integration, version and source control.

Define standard tools available for use in prototyping:

Identify standard tools available to develop prototypes. The advantages and disadvantages of prototyping tools. Categories of prototyping tools to support testing.

How prototyping tools can be used to rapidly iterate prototypes and capture end user feedback.

Appropriateness of various tools for different end user and functionality testing requirements.

LO2 **Plan a prototype for specific target end users and planned tests**

Identify a specific end user and an appropriate prototyping methodology to test with this user type:

Choose a specific end user to conduct tests against.

Evaluate the benefits, features, advantages and disadvantages of different prototyping methodologies for various end user testing outcomes.

Review different end user categorisations, classifications and behaviour modelling techniques.

Select the most appropriate form of prototyping to achieve desired end user testing and outcomes to ensure the production of a secure end product.

Choose appropriate testing methods e.g. static testing, change related, sequential, iterative and suitable metrics for the defect management process.

Describe a plan to use appropriate prototyping methodology and tools to conduct end user testing:

Apply end user classification and behaviour modelling to select an appropriate prototyping methodology.

Outline the end user characteristics, desired testing criteria and results your prototype addresses.

Understand the difference between error, defect, and failure including the distinction between the root cause of a defect and its effects.

Select an appropriate form of prototyping necessary to achieve desired results.

Use your selected end user, appropriate prototyping methodology and desired testing criteria to create a prototyping plan.

LO3 **Develop multiple iterations of the prototype using appropriate tools**

Utilise appropriate tools to develop multiple prototypes:

Employ an appropriate set of tools to develop your plan into a prototype.

Run end user experiments and examine feedback.

Reconcile and evaluate end user feedback and build a new iteration of your prototype modified with the most important feedback and enhancements.

Make multiple iterations of your prototype and modify each iteration with enhancements gathered from user feedback and experimentation.

LO4 **Evaluate user feedback and test results from multiple iterations of the prototype and end user testing**

Asses the success of your prototype:

Assemble and appraise end use feedback from multiple iterations of your prototype.

Undertake a critical review and compare your final prototype and your test results with the original plan.

Evaluate the advantages, disadvantages, strengths and weaknesses of your prototyping methodology.

Critique the overall success of your prototype and discusses your insight using prototyping.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Explore forms of prototypes appropriate for various functionality and end user testing requirements		**LO1 & LO2**
P1 Recognise specific forms of prototyping functionality and end user testing requirements. **P2** Evaluate standard tools available for use in prototyping.	**M1** Review specific forms of prototyping and the advantages and disadvantages of end user testing requirements for appropriateness to different testing outcomes.	**D1** Evaluate the impact of common prototyping methodology within the software development lifecycle.
LO2 Plan a prototype for specific target end users and planned tests		
P3 Review different end user categorisations, classifications and behaviour modelling techniques. **P4** Explore a specific end user and an appropriate prototyping methodology to test with this user type.	**M2** Apply end user classification and behaviour modelling to select an appropriate prototyping methodology. **M3** Suggest a plan to use appropriate prototyping methodology and tools to conduct end user testing.	

Pass	Merit	Distinction
LO3 Develop multiple iterations of the prototype using appropriate tools		**LO3**
P5 Explore appropriate tools to develop multiple prototypes. **P6** Perform end user experiments and examine feedback.	**M4** Employ an appropriate set of tools to develop your plan into a prototype. **M5** Using end user feedback build a new iteration of your prototype modified using the most important feedback and enhancements.	**D2** Create multiple iterations of your prototype and modify each iteration with enhancements gathered from user feedback and experimentation.
LO4 Evaluate user feedback and test results from multiple iterations of the prototype and end user testing		**LO4**
P7 Review end use feedback from multiple iterations of your prototype.	**M6** Undertake a critical review and compare your final prototype and your test results with your original plan.	**D3** Critically evaluate the overall success of your prototype and discuss your insight using prototyping.

Recommended Resources

Textbooks

Hanington, B. (2013) *Universal Methods of Design: 100 Ways to Research Complex Problems, Develop Innovative Ideas, and Design Effective Solutions*. Rockport Publishers.

Kalbach, J. (2015) *Mapping Experiences: A Complete Guide to Creating Value through Journeys, Blueprints, and Diagrams*. 1st Ed. O'Reilly Media.

Lidwell, W. (2010) *Universal Principles of Design, Revised and Updated: 125 Ways to Enhance Usability, Influence Perception, Increase Appeal, Make Better Design Decisions, and Teach through Design*. 2nd Ed. Rockport Publishers.

Osterwalder, A. (2015) *Value Proposition Design: How to Create Products and Services Customers Want*. 1st Ed. Wiley.

Warfel, T. Z. (2009) *Prototyping a Practitioner's Guide.* 1st Ed. Rosenfield Media.

Websites

www.usability.gov	Information about product design including prototyping and UX
aws.amazon.com/devops/	DevOps information and tools including CI/CD

Links

This unit links to the following related units:

Unit 1: Programming

Unit 7: Software Development Lifecycles

Unit 20: Applied Programming and Design Principles