Syllabus

IT – Data Analytics

Year 1 & Year 2

Kings Cornerstone International College

Unit 1: Programming

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

Introduction

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

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

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

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

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

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

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

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

Learning Outcomes

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

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

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

LO3. Implement basic algorithms in code using an IDE.

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

Essential Content

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

Algorithm definition:

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

The relationship between algorithms and code.

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

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

Characteristics of code:

Definitions of: data types (the role of constants/variables), 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:

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

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

Review and reflection:

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

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

What a coding standard is and its benefits when writing code.

Learning Outcomes and Assessment Criteria

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

Recommended Resources

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

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

Textbooks

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

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

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

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:

LO1. Examine networking principles and their protocols.

LO2. Explain networking devices and operations.

LO3. Design efficient networked systems.

LO4. Implement and diagnose networked systems.

Essential Content

LO1 Examine networking principles and their protocols

Introduction to Networks:

Impact of networks on daily lives, the basic requirements of a reliable network, employment opportunities in the networking field, network common network attacks, network trends e.g. 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.

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.

Networking software:

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

Server type:

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

Server selection:

Cost, purpose, operating system requirement.

Workstation:

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

LO3 **Design efficient networked systems**

Bandwidth:

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

Users:

Quality expectations, concept of system growth.

Networking services and applications:

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

Communications:

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

Scalable:

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

Selection of components:

Supporting infrastructure needs; supporting connectivity requirements.

LO4 **Implement and diagnose networked systems**

Devices:

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

Verification of configuration and connectivity:

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

System monitoring:

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

Maintenance schedule:

Backups, upgrades, security, auditing.

Diagnose and resolve layer 1 problems:

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

Policy review:

Bandwidth, resource availability.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Examine networking principles and their protocols</td><td rowspan="5">LO1 & 2

D1 Critically evaluate the topology protocol selected for a given scenario to demonstrate the efficient utilisation of a networking system.</td></tr>
<tr><td>P1 Discuss the benefits and constraints of different network types and standards.

P2 Explain the impact of network topology, communication and bandwidth requirements.</td><td>M1 Compare common networking principles and how protocols enable the effectiveness of networked systems.</td></tr>
<tr><td colspan="2">LO2 Explain networking devices and operations</td></tr>
<tr><td>P3 Discuss the operating principles of networking devices and server types.

P4 Discuss the inter-dependence of workstation hardware with relevant networking software.</td><td>M2 Explore a range of server types and justify the selection of a server, considering a given scenario regarding cost and performance optimisation.</td></tr>
<tr><td colspan="2">LO3 Design efficient networked systems</td><td rowspan="2">D2 Design a maintenance schedule to support the networked system.</td></tr>
<tr><td>P5 Design a networked system to meet a given specification.

P6 Test and evaluate the design to meet the requirements and analyse user feedback with the aim of improving efficiency.</td><td>M3 Install and configure network services and applications on your choice.</td></tr>
<tr><td colspan="2">LO4 Implement and diagnose networked systems</td><td rowspan="2">D3 Use critical reflection to evaluate own work and justify valid conclusions.</td></tr>
<tr><td>P7 Implement a networked system based on a prepared design.

P8 Document and analyse test results against expected results.</td><td>M4 Recommend potential enhancements for the networked systems.</td></tr>
</table>

Recommended Resources

Textbooks

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

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

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

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

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

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

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

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

Journals

The Institute of Engineering and Technology

Unit 3: Professional Practice

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

Introduction

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

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

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

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

Learning Outcomes

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

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

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

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

LO4 Examine the need for Continuing Professional Development (CPD) and its role within the workplace and for higher level learning.

Essential Content

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.

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.

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.

Teams and team building:

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

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

Pass	Merit	Distinction
LO3 Discuss the importance and dynamics of working within a team and the impact of team working in different environments		
P5 Discuss the importance of team dynamics in the success and/or failure of group work. **P6** Work 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		
P7 Discuss the importance of CPD and its contribution to own learning. **P8** Produce a development plan that outlines responsibilities, performance objectives and required skills, knowledge and learning for own future goals.	**M5** Compare and contrast different motivational theories and the impact they can have on performance within the workplace.	**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)

Unit 4: Database Design & Development

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

Introduction

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

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

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

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

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

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

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

Learning Outcomes

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

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

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

LO3. Test the system against user and system requirements.

LO4. Produce technical and user documentation.

Essential Content

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 etc.

Determining user and system requirements.

Design tools and techniques for a relational database system.

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

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

User interface design.

Output designs for user requirements.

Overview of object-oriented databases and their design tools.

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.

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

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

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

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

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

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

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Use an appropriate design tool to design a relational database system for a substantial problem</td><td rowspan="2">D1 Evaluate the effectiveness of the design in relation to user and system requirements.</td></tr>
<tr><td>P1 Design a relational database system using appropriate design tools and techniques, containing at least four interrelated tables, with clear statements of user and system requirements.</td><td>M1 Produce a comprehensive design for a fully functional system which includes interface and output designs, data validations and data normalisation.</td></tr>
<tr><td colspan="2">LO2 Develop a fully functional relational database system, based on an existing system design</td><td rowspan="4">LO2 & 3
D2 Evaluate the effectiveness of the database solution in relation to user and system requirements, and suggest improvements.</td></tr>
<tr><td>P2 Develop the database system with evidence of user interface, output and data validations, and querying across multiple tables.
P3 Implement a query language into the relational database system.</td><td>M2 Implement a fully functional database system which includes system security and database maintenance.
M3 Assess whether meaningful data has been extracted through the use of query tools to produce appropriate management information.</td></tr>
<tr><td colspan="2">LO3 Test the system against user and system requirements</td></tr>
<tr><td>P4 Test the system against user and system requirements.</td><td>M4 Assess the effectiveness of the testing, including an explanation of the choice of test data used.</td></tr>
<tr><td colspan="2">LO4 Produce technical and user documentation</td><td rowspan="2">D3 Evaluate the database in terms of improvements needed to ensure the continued effectiveness of the system.</td></tr>
<tr><td>P5 Produce technical and user documentation.</td><td>M5 Produce technical and user documentation for a fully functional system, including diagrams showing movement of data through the system, and flowcharts describing how the system works.</td></tr>
</table>

Recommended Resources

Textbooks

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

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

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

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

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

Journals

International Journal of Database Management Systems

Journal of Database Management

The Computer Journal

Journal of Systems Analysis and Software Engineering

Journal of Emerging Trends in Computing and Information Sciences

Websites

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

Unit 5: Security

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

Introduction

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

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

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

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

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

Learning Outcomes

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

LO1 Assess risks to IT security.

LO2 Describe IT security solutions.

LO3 Review mechanisms to control organisational IT security.

LO4 Manage organisational security.

Essential Content

LO1 Assess risks to IT security

IT security risks:

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

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

LO2 Describe IT security solutions

IT security solution evaluation:

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

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

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

Data centre: replica data centres, virtualisation, secure transport protocol, secure MPLS routing, 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.

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

Recommended Resources

Textbooks

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

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

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

Websites

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

Unit 6: Managing a Successful Computing Project

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

Introduction

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

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

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

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

Learning Outcomes

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

LO1 Establish project aims, objectives and timeframes based on the chosen theme.

LO2 Conduct small-scale research, information gathering and data collection to generate knowledge to support the project.

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

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

Essential Content

LO1 Establish project aims, objectives and timeframes based on the chosen theme

Project management:

What is project management and what does it involve?

The key stages of project management.

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

Initiation of the project and project planning phase:

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

Steps and documentation required in the initiation phase.

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

The work breakdown structure.

Use of Bar and Gantt Charts for effective planning.

LO2 Conduct small-scale research, information gathering and data collection to generate knowledge to support the project

Project execution phase:

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

The distinct phases which support a coherent and logical argument.

Use of secondary research to inform a primary empirical study.

Qualitative and quantitative research methods.

Field work:

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

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

Ethics, reliability and validity:

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

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

Analysing information and data:

Using data collection tools such as interviews and questionnaires.

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

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

Communicating outcomes:

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

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

Convincing arguments:

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

Developing evaluative conclusions.

Critical and objective analysis and evaluation:

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

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

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

Reflection for learning and practice:

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

The cycle of reflection:

To include reflection in action and reflection on action.

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

Reflective writing:

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

Generalisation:

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

Outcomes should be specific and actionable.

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Establish project aims, objectives and timeframes based on the chosen theme</td><td rowspan="5">LO1 & 2

D1 Critically evaluate the project management process and appropriate research methodologies applied.</td></tr>
<tr><td>P1 Devise project aims and objectives for a chosen scenario.

P2 Produce a project management plan that covers aspects of cost, scope, time, quality, communication, risk and resources.

P3 Produce a work breakdown structure and a Gantt Chart to provide timeframes and stages for completion.</td><td>M1 Produce a comprehensive project management plan, milestone schedule and project schedule for monitoring and completing the aims and objectives of the project.</td></tr>
<tr><td colspan="2">LO2 Conduct small-scale research, information gathering and data collection to generate knowledge to support the project</td></tr>
<tr><td>P4 Carry out small-scale research by applying qualitative and quantitative research methods appropriate for meeting project aims and objectives.</td><td>M2 Evaluate the accuracy and reliability of different research methods applied.</td></tr>
</table>

Pass	Merit	Distinction
LO3 Present the project and communicate appropriate recommendations based on meaningful conclusions drawn from the evidence findings and/or analysis		
P5 Analyse research and data using appropriate tools and techniques. **P6** Communicate appropriate recommendations as a result of research and data analysis to draw valid and meaningful conclusions.	**M3** Evaluate the selection of appropriate tools and techniques for accuracy and authenticity to support and justify recommendations.	**LO3** **D2** Critically evaluate the research and data analysis tools used in the project development stages..
LO4 Reflect on the value gained from conducting the project and its usefulness to support sustainable organisational performance		
P7 Reflect on the value of undertaking the research to meet stated objectives and own learning and performance.	**M4** Evaluate the value of the project management process and use of quality research to meet stated objectives and support own learning and performance.	**LO4** **D3** Critically evaluate how the project supports sustainable organisational performance.

Additional Evidence Requirements

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

Recommended Resources

Textbooks

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

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

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

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

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

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

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

Journals

International Journal of Quantitative and Qualitative Research
Qualitative Research Journal

Websites

www.gov.uk/government/publications	Department of Business Innovations and Skills "Guidelines for managing projects – How to organise, plan and control projects." (Report)

Unit 13: Computing Research Project

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

Introduction

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

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

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

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

Learning Outcomes

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

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

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

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

LO4 Reflect on the application of research methodologies and concepts.

Essential Content

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:

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.

Selecting a sample:

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

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

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

Ethics, reliability and validity:

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

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

Analysing data:

Using data collection tools such as interviews and questionnaires.

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

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

Stakeholders:

Who are they?

Why would they be interested in the research outcomes?

What communication method do they expect?

Communicating research outcomes:

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

Convincing arguments:

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

The importance of developing evaluative conclusions.

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

Reflection for learning and practice:

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

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

The cycle of reflection:

To include reflection in action and reflection on action.

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

Reflective writing:

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

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Examine appropriate research methodologies and approaches as part of the research process</td><td rowspan="5">LO1 & LO2

D1 Critically evaluate research methodologies and processes in application to a computing research project to justify chosen research methods and analysis.</td></tr>
<tr><td>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.</td><td>M1 Evaluate different research approaches and methodology and make justifications for the choice of methods selected based on philosophical/theoretical frameworks.</td></tr>
<tr><td colspan="2">LO2 Conduct and analyse research relevant for a business research project</td></tr>
<tr><td>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.</td><td>M2 Discuss merits, limitations and pitfalls of approaches to data collection and analysis.</td></tr>
</table>

Pass	Merit	Distinction
LO3 Communicate the outcomes of a research project to identified stakeholders		
P5 Communicate research outcomes in an appropriate manner for the intended audience.	**M3** Communicate outcomes to the intended audience demonstrating how outcomes meet set research objectives.	**D2** Communicate critical analysis of the outcomes and make valid, justified recommendations.
LO4 Reflect on the application of research methodologies and concepts		
P6 Reflect on the effectiveness of research methods applied for meeting objectives of the computing research project. **P7** Consider 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

Unit 14: Business Intelligence

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

Introduction

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

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

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

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

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

Learning Outcomes

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

LO1 Discuss business processes and the mechanisms used to support business decision-making.

LO2 Compare the tools and technologies associated with business intelligence functionality.

LO3 Demonstrate the use of business intelligence tools and technologies.

LO4 Discuss the impact of business intelligence tools and technologies for effective decision-making purposes and the legal/regulatory context in which they are used.

Essential Content

LO1 Discuss business processes and the mechanisms used to support business decision-making

Business process model:

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

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

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

Mechanisms:

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

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

Business processes:

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

LO2 Compare the tools and technologies associated with business intelligence functionality

Support for business decisions:

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

Business intelligence functionality:

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

Systems and technologies:

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

LO3 **Demonstrate the use of business intelligence tools and technologies**

Tools and techniques:

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

Solutions:

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

Uses:

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

Design considerations:

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

LO4 **Discuss the impact of business intelligence tools and technologies for effective decision-making purposes and the legal/regulatory context in which they are used**

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

Cybersecurity management:

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

Evaluation criteria:

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

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Discuss business processes and the mechanisms used to support business decision-making		
P1 Examine, using examples, the terms 'Business Process' and 'Supporting Processes'.	**M1** Differentiate between unstructured and semi-structured data within an organisation.	**D1** Evaluate the benefits and drawbacks of using application software as a mechanism for business processing.
LO2 Compare the tools and technologies associated with business intelligence functionality		
P2 Compare the types of support available for business decision-making at varying levels within an organisation.	**M2** Justify, with specific examples, the key features of business intelligence functionality.	**D2** Compare and contrast a range of information systems and technologies that can be used to support organisations at operational, tactical and strategic levels.

Pass	Merit	Distinction
LO3 Demonstrate the use of business intelligence tools and technologies		
P3 Determine, with examples, what business intelligence is and the tools and techniques associated with it. **P4** Design a business intelligence tool, application or interface that can perform a specific task to support problem-solving or decision-making at an advanced level.	**M3** Customise the design to ensure that it is user-friendly and has a functional interface.	**D3** Provide a critical review of the design in terms of how it meets a specific user or business requirement and identify what customisation has been integrated into the design.
LO4 Discuss the impact of business intelligence tools and technologies for effective decision-making purposes and the legal/regulatory context in which they are used		
P5 Discuss how business intelligence tools can contribute to effective decision-making. **P6** Explore the legal issues involved in the secure exploitation of business intelligence tools.	**M4** Conduct research to identify specific examples of organisations that have used business intelligence tools to enhance or improve operations.	**D4** Evaluate how organisations could use business intelligence to extend their target audience and make them more competitive within the market, taking security legislation into consideration.

Recommended Resources

Textbooks

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

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

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

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

Journals

International Journal of Business Intelligence and Data Mining

International Journal of Business Intelligence Research (IJBIR)

Websites

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

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:

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

LO2. Analyse mathematical structures of objects using graph theory.

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

LO4. 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, surjective and transitive functions.

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 directed 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 an 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		**D3** Design a complex system using logic gates.
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.	
LO4 Explore applicable concepts within abstract algebra		**D4** Explore with the aide of a prepared presentation the application of group theory relevant to your course of study.
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.	

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

Unit 21: Data Mining

Unit code	**H/615/1653**
Unit level	**5**
Credit value	**15**

Introduction

Data mining is the process of discovering new knowledge in the forms of patterns and relationships in large data sets. It helps find knowledge from a data set that was previously impossible to obtain with traditional methods. Modern data mining is well equipped to discover useful knowledge or patterns from unstructured data such as web traffic, emails and social media content. Data mining uses a range of machine learning algorithms and modern statistical techniques to discover knowledge from data sets.

This unit will introduce the theoretical foundation of data mining and a range of data mining processes and techniques. The unit will also provide hands-on experience in developing data mining applications using an appropriate programming language or data mining tool.

Topics included in this unit are: data mining terminologies, scope of data mining such as classification, regression and clustering methods and techniques, associate pattern mining, mining time series data, and mining text data.

On successful completion of this unit, students will appreciate the theoretical and technical concepts of data mining and its techniques and processes, gain hands-on experience in implementing data mining techniques using a programming language such as Python, R, or a tool such as Weka, KNIME, 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.

It is assumed that students will have some knowledge of data analytics and machine learning, or will have completed Unit 12: Data Analytics and Unit 26: Machine Learning.

Learning Outcomes

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

LO1. Discuss the historical and theoretical foundation of data mining, its scope, techniques, and processes.

LO2. Investigate a range of data mining techniques to discover patterns and relationships in large data sets.

LO3. Illustrate how a data mining algorithm performs text mining to identify relationships within text.

LO4. Evaluate a range of graph data mining techniques that recognise patterns and relationships in graph-based technologies.

Essential Content

LO1 **Discuss the historical and theoretical foundation of data mining, its scope, techniques, and processes**

Data mining terminologies.

Historical background of data mining:

Traditional approach, modern approach.

Theoretical background of data mining.

Ethics of data mining:

Fundamentals of data mining, the major building blocks of data mining.

LO2 **Investigate a range of data mining techniques to discover patterns and relationships in large data sets**

Scope of data mining:

Classification, regression and clustering.

Data mining algorithms:

Classification algorithms, regression algorithms and clustering algorithms.

LO3 **Illustrate how a data mining algorithm performs text mining to identify relationships within text**

Introduction to text mining.

A brief overview to natural language processing.

Document preparation and similarities.

Clustering methods.

Topic Modelling.

Presentation methods of text (final outcome of the mining): charts, graphs, word cloud and so forth.

LO4 **Evaluate a range of graph data mining techniques that recognise patterns and relationships in graph-based technologies**

Unstructured data and graph-based technologies.

Networks and network analysis.

Graph algorithms: graph pattern mining, graph classification, graph clustering, and so forth.

Content mining, structure mining and usage mining.

Graph data mining tools.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Discuss the historical and theoretical foundation of data mining, its scope, techniques, and processes		
P1 Investigate the historical background of data mining. **P2** Analyse the theoretical background of data mining and identify data mining tools used in industry.	**M1** Evaluate traditional and modern approaches to data mining and show the building blocks of both approaches.	**D1** Review how an organisation benefits from data mining.
LO2 Investigate a range of data mining techniques to discover patterns and relationships in large data sets		
P3 Demonstrate various scopes of data mining. **P4** Investigate a range of data mining algorithms and their uses.	**M2** Investigate a tool or programming language that can support data mining. **M3** Apply an appropriate tool or programming language to demonstrate how data mining algorithms work.	**D2** Develop a complete data mining application for a real world issue.

Pass	Merit	Distinction
LO3 Illustrate how a data mining algorithm performs text mining to identify relationships within text		
P5 Discuss what is meant by text mining and explain with appropriate examples. **P6** Analyse how data mining algorithms, techniques, methods and approaches work.	**M4** Show how text mining works using a tool or programming language.	**D3** Develop a complete text mining application for a real world issue.
LO4 Evaluate a range of graph data mining techniques that recognise patterns and relationships in graph based technologies		
P7 Discuss what is meant by graph data mining and explain with appropriate examples. **P8** Assess how graph mining algorithms work and identify appropriate programming languages and tools used by industry for graph data mining.	**M5** Demonstrate how graph data mining works using a tool or programming language.	**D4** Develop a complete graph data mining application for a real world scenario.

Recommended Resources

Textbooks

Aggarwal, C. (2015) *Data Mining: The Textbook*. Springer.

Hofmann, M. and Chisholm, A. (2015) *Text Mining and Visualization: Case Studies Using Open-Source Tools*. Chapman and Hall/CRC.

Russell, M. (2013) *Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Google+, GitHub, and More*. 2nd Ed. O'Reilly Media.

Witten, I., Eibe, F. and Hall, M. (2011) *Data Mining: Practical Machine Learning Tools and Techniques*. 3rd Ed. Morgan Kaufmann.

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)
gephi.org	Open Graph Viz Platform "Gephi" (Development Tool)

Unit 22: 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:

LO1. Examine applied analytical modelling methods.

LO2. Prepare a large data set for use in an applied analytical model.

LO3. Demonstrate the use of an analytical model with a large data set.

LO4. Investigate improvements to an applied analytical model.

Essential Content

LO1 **Examine applied analytical modelling methods**

Decision/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

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Examine applied analytical modelling methods</td><td rowspan="2">D1 Using a case study example, critically evaluate the derived benefits from the use of an applied analytic model.</td></tr>
<tr><td>P1 Discuss the prescriptive and predictive analytical models, using examples.

P2 Illustrate three analytical methods, describing how they function.</td><td>M1 Compare prescriptive and predictive analytical models, stating their advantages and disadvantages.</td></tr>
<tr><td colspan="2">LO2 Prepare a large data set for use in an applied analytical model</td><td rowspan="2">D2 Review the primary reasons for carrying out data transformation before input to an applied analytical model.</td></tr>
<tr><td>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.</td><td>M2 Analyse three potential issues in preparation of data for use in an applied analytical model.</td></tr>
</table>

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)

Unit 26: 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:

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

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

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

LO4. 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: cassification, 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

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Analyse the theoretical foundation of machine learning to determine how an intelligent machine works</td><td rowspan="4">LO1 & LO2

D1 Critically evaluate why machine learning is essential to the design of intelligent machines.</td></tr>
<tr><td>P1 Analyse the types of learning problems.

P2 Demonstrate the taxonomy of machine learning algorithms.</td><td>M1 Evaluate the category of machine learning algorithms with appropriate examples.</td></tr>
<tr><td colspan="2">LO2 Investigate the most popular and efficient machine learning algorithms used in industry</td></tr>
<tr><td>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.</td><td>M2 Analyse these algorithms using an appropriate example to determine their power.</td></tr>
</table>

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.org	Julia Programming Language (Development Tool)
azure.microsoft.com	Microsoft Azure (Development Tool)
accord-framework.net	Accord.NET Framework (Development Tool)

Unit 27: Artificial Intelligence

Unit code	**L/615/1663**
Unit level	**5**
Credit value	**15**

Introduction

One of the dreams of the computing sector is to build an intelligent digital assistant that could serve people according to peoples' nature. Building this type of intelligent machine is a big challenge to computer scientists. An intelligent machine must have at least the following behaviours – vision, speech and voice recognition, smelling sense, learning from experience to solve new problems and coping with the unknown. The science of artificial intelligence (AI) is trying to overcome these challenges by combining the study of nature, understanding from humans' intelligent behaviour and brain function, other animal's acute senses, with mathematics, statistics, logic and traditional computer science. Some of AIs achievements include the NASA's Mars Rover, Google's Self-Driving Cars, IBM's Watson, Microsoft's Xbox 360 (the first gaming device to track human body movement) and much more.

This unit is designed to introduce the philosophy behind artificial intelligence, the most efficient techniques of AI and various intelligent systems that help us to overcome various challenges. This unit guides the student to investigate the emerging AI technologies which could solve various real-world challenges and problems.

Topics included in this unit are the philosophical background to AI, current trends and the future of AI, ethics and issues in AI ,a range of AI applications (computer vision, speech processing and so forth), top-down approach of AI techniques, fuzzy logic, knowledge-based systems, natural language processing), bottom-up approach of AI techniques (neural networks, evolutionary computing, swarm intelligence), and emerging AI technologies (Brain Computer Interfacing, Ambient AI, Smart City, GPU AI etc).

On successful completion of this unit students will be able to understand the fundamental concepts in artificial intelligence from a theoretical, practical and cognitive point of view, and also gain innovative thought processes to build intelligent systems for future needs. Furthermore, the students can gain hands-on experience in developing intelligent systems using a programming language such as C/C++, C#, Java, Prolog, Lisp, Python, R, or a tool such as Weka, KNIME, MS AzureML, Accord.NET, AForge.NET, Neuroph, tools for NLP (NLTK, AIML), tools for swarm robotics (Microsoft robotics developer studio, Orocos, 'Player Stage Gazebo') etc.

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

Learning Outcomes

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

LO1. Analyse the theoretical foundation of artificial intelligence, current trends and issues to determine the effectiveness of AI technology.

LO2. Implement an intelligent system using a technique of the top-down approach of AI.

LO3. Implement an intelligent system using a technique of the bottom-up approach of AI.

LO4. Investigate and discuss a range of emerging AI technologies to determine future changes in industry.

Essential Content

LO1 **Analyse the theoretical foundation of artificial intelligence, current trends and issues to determine the effectiveness of AI technology**

Philosophical background of AI:

What is an intelligence? How does the brain work? What is artificial intelligence? The Turing test, John Searle's 'The Chinese Room' test, Strong AI vs. Weak AI, Top-down approach of AI vs. bottom up approach of AI.

Top-down approach of AI:

Knowledge-based system, natural language processing, fuzzy logic.

Bottom up approach of AI:

Artificial neural networks, evolutionary computing, swarm intelligence.

Applications of AI:

Intelligent Robot, intelligent agent, artificial life, computer vision, speech recognition, artificial nose, data mining and other smart technologies.

Issues of AI:

Practical difficulties in building brain like machine, ethics and social issues of AI, philosophical issues of AI – will computers control the human?

LO2 **Implement an intelligent system using a technique of the top-down approach of AI**

Choose and develop skill on a development tool or programming language which support top-down approach:

Introduction to the language or tool; a quick tour of the language or tool; investigate and develop skill on functions, classes, libraries and/or packages which support the top-down approach.

Choose a technique from the list below, then investigate and demonstrate the technique using the programming language or a tool:

Knowledge based system: data representation, semantic net, rule-based system.

Fuzzy logic: uncertainty, fuzzy sets, fuzzy inferences, fuzzy rules.

Natural language processing: NLP techniques, parsing with generations, compositional and lexical semantics, dialogues.

LO3 **Implement an intelligent system using a technique of the bottom-up approach of AI**

Choose and develop skill on a development tool or programming language which support bottom-up approach:

Introduction to the language or tool; a quick tour of the language or tool; investigate and develop skill on functions, classes, libraries and/or packages which support the bottom-up approach.

Choose a technique from the list below then investigate and demonstrate the technique using the programming language or a tool:

Artificial neural network: supervised learning algorithms, single perceptron, MLP & backpropagation learning algorithms.

Evolutionary computing: problem model, fitness evaluation, selection method, crossover operator, evolution scheme, observation.

Swarm intelligence: swarm intelligent approaches, swarm robotics, team size and composition, team configurability, communication pattern and range.

LO4 **Investigate and discuss a range of emerging AI technologies to determine future changes in industry**

Distributed AI; GPU AI; Ambient AI; Brain Computer Interfacing; Smart Systems, Smart Home and Smart Cities.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Analyse the theoretical foundation of artificial intelligence, current trends and issues to determine the effectiveness of AI technology		
P1 Investigate the top-down approach of AI and its techniques, and show how these techniques have been used to build intelligent systems. **P2** Investigate the bottom-up approach of AI and its techniques, and show how these techniques have been used to build intelligent systems.	**M1** Discuss how AI has changed the world in the last two decades and evaluate the ethical, social and philosophical issues of AI.	**D1** Review the contribution that AI has had on a global basis to individuals and society with the use of examples.
LO2 Implement an intelligent system using a technique of the top-down approach of AI		
P3 Develop an intelligent system using a top-down approach with a suitable programming language or tool. **P4** Test the system and analyse the results against expected results to identify consistencies.	**M2** Critically evaluate the effectiveness of the intelligent system and suggest methods of improvement.	**D2** Develop an outstanding intelligent system based on a top-down approach to overcome a real-world issue.

Pass	Merit	Distinction
LO3 Implement an intelligent system using a technique of the bottom-up approach of AI		
P5 Develop an intelligent system using a bottom-up approach with a suitable programming language or tool. **P6** Test the system and analyse the test results against expected results to identify consistencies.	**M3** Critically evaluate the effectiveness of the intelligent system and suggest methods of improvement.	**D3** Develop an outstanding, intelligent system based on a bottom-up approach to overcome a real-world issue.
LO4 Investigate and discuss a range of emerging AI technologies to determine future changes in industry		
P7 Investigate and chose an emerging AI technology and demonstrate how it works. **P8** Illustrate how three emerging technologies are expected to determine future changes in industry.	**M4** Critically evaluate the industrial and social implications of an emerging AI technology.	**D4** Discuss how emerging AI technology might change our future.

Recommended Resources

Textbooks

Engelbrecht, A. (2007) *Computational Intelligence: An Introduction*. Wiley-Blackwell.

Jain, A. (2011) *Introduction to Biometrics*. Springer.

Fankhauser, W. (2015) *Artificial Intelligence Applications: Natural Language Processing*. CreateSpace Independent Publishing Platform.

Frankish, K. and Ramsey, W. (2014) *The Cambridge Handbook of Artificial Intelligence*. Cambridge: Cambridge University Press.

Klette, R. (2014) *Concise Computer Vision: An Introduction into Theory and Algorithms*. Springer.

Picon, A. (2015) Smart *Cities: A Spatialised Intelligence*. AD Primer. John Wiley & Sons.

Vaden, L. (2015) *Advanced Topics in Brain-Computer Interfacing*. CreateSpace Independent Publishing Platform.

Warwick, K. (2011) *Artificial Intelligence: The Basics*. Routledge.

Websites

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www.codechef.com	CodeChef educational initiative "List of Compilers" (Wiki)
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)
julialang.org	Julia Programming Language (Development Tool)
pkg.julialang.org	Julia Programming Language (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)
azure.microsoft.com	Microsoft Azure (Development Tool)
accord-framework.net	Accord.NET Framework (Development Tool)

www.swi-prolog.org	SWI-Prolog (Development Tool)
common-lisp.net	The Common Lisp Foundation "Common-Lisp.NET" (Development Tool)
www.aforgenet.com	Open source C# framework "AForge.NET" (Development Tool)
www.nltk.org	Natural Language Toolkit "NLTK" (Development Tool)
www.alicebot.org	ALICE A.I. Foundation "AIML: Artificial Intelligence Markup Language" (Development Tool)
www.orocos.org	The Orocos Project "Open Robot Control Software" (Development Tool)
www.microsoft.com	Microsoft "Robotics Developer Studio" (Development Tool)

Electives

Unit 7: Strategic Information Systems

Unit code	**A/615/1626**
Unit type	**Optional**
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:

LO1 Analyse the information requirements of organisations.

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

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

LO4 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.

Uses:

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

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		
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.	**D1** Evaluate the inputs, outputs and processing activities of a selected organisation.
LO2 Discuss the types of information systems that are used within all levels of 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.	**D2** Differentiate between the function and purpose of information systems at different levels within an organisation.

Pass	Merit	Distinction
LO3 Demonstrate the use of an information system to produce management information		
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		
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

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

Robson, W. (1997) *Strategic Management and Information Systems: An Integrated Approach*. 2nd Ed. Financial Times / Prentice Hall.

Ward, J. (2002) *Strategic Planning for Information Systems*. 3rd Ed. John Wiley & Sons.

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)

Unit 10: Website Design & Development

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

Introduction

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

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

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

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

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

Learning Outcomes

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

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

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

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

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

Essential Content

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

Hosting and website management:

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

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

Different server technologies:

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

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

Common web development technologies and frameworks.

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

Website technologies:

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

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

Tools, techniques and software used to develop websites:

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

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

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

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

Establish the client and user requirements:

Differentiate client and user requirements from behaviours.

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

Review accessibility standards and guidelines and their possible impact on design and aesthetics.

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

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

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

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

Consider factors that influence website performance:

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

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

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

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

Assess the impact of poorly optimised website graphics.

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

Learning Outcomes and Assessment Criteria

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Explain server technologies and management services associated with hosting and managing websites</td><td rowspan="5">LO1 & LO2
D1 Justify the technologies, management services, tools and software chosen to realise a custom built website.</td></tr>
<tr><td>P1 Identify the purpose and types of DNS, including explanations on how domain names are organised and managed.

P2 Explain the purpose and relationships between communication protocols, server hardware, operating systems and web server software with regards to designing, publishing and accessing a website.</td><td>M1 Evaluate 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.</td></tr>
<tr><td colspan="2">LO2 Categorise website technologies, tools and software used to develop websites</td></tr>
<tr><td>P3 Discuss the capabilities and relationships between front-end and back-end website technologies and explain how 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).</td><td>M3 Evaluate a range of tools and techniques available to design and develop a custom built website.</td></tr>
</table>

Pass	Merit	Distinction
LO3 Utilise website technologies, tools and techniques with good design principles to create a multipage website		
P5 Create a design document for a branded, multipage website supported with medium fidelity wireframes and a full set of client and user requirements. **P6** Use 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		
P7 Create a suitable Test Plan identifying key performance areas and use it to review the functionality and performance of your website.	**M5** Evaluate 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.

Unit 19: Data Structures & Algorithms

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

Introduction

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

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

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

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

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

Learning Outcomes

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

LO1. Examine abstract data types, concrete data structures and algorithms.

LO2. Specify abstract data types and algorithms in a formal notation.

LO3. Implement complex data structures and algorithms.

LO4. Assess the effectiveness of data structures and algorithms.

Essential Content

LO1 Examine abstract data types, concrete data structures and algorithms

Abstract Data Types (ADTs):

Specification of ADTs with formal notation.

Data structures:

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

Algorithm types:

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

Algorithms:

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

LO2 Specify abstract data types and algorithms in a formal notation

Design specification:

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

Creation:

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

LO3 Implement complex data structures and algorithms

Implementation:

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

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

Use of data structure libraries (DSL):

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

Algorithm effectiveness:

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

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
LO1 Examine abstract data types, concrete data structures and algorithms		
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.

Unit 26: 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:

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

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

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

LO4. 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: cassification, 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

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Analyse the theoretical foundation of machine learning to determine how an intelligent machine works</td><td rowspan="4">LO1 & LO2

D1 Critically evaluate why machine learning is essential to the design of intelligent machines.</td></tr>
<tr><td>P1 Analyse the types of learning problems.

P2 Demonstrate the taxonomy of machine learning algorithms.</td><td>M1 Evaluate the category of machine learning algorithms with appropriate examples.</td></tr>
<tr><td colspan="2">LO2 Investigate the most popular and efficient machine learning algorithms used in industry</td></tr>
<tr><td>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.</td><td>M2 Analyse these algorithms using an appropriate example to determine their power.</td></tr>
</table>

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.org	Julia Programming Language (Development Tool)
azure.microsoft.com	Microsoft Azure (Development Tool)
accord-framework.net	Accord.NET Framework (Development Tool)

Unit 30: Application Development

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

Introduction

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

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

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

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

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

Learning Outcomes

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

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

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

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

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

Essential Content

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.

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

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">LO1 Produce a Software Design Document by analysing a business-related problem and deduce an appropriate solution including a set of initial requirements</td><td rowspan="5">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.</td></tr>
<tr><td>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.</td><td>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.</td></tr>
<tr><td colspan="2">LO2 Use design and development methodologies with tools and techniques associated with the creation of a business application</td></tr>
<tr><td>P3 Research the use of software development tools and techniques and identify any that have been selected for the development of this application.</td><td>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.</td></tr>
</table>

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.

Unit 40: 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:

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.

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.

LO3. Build a User Interface concept and test it with users to see if it satisfies their emotions, desires and attitudes as planned.

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.

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		
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.

<table>
<tr><th>Pass</th><th>Merit</th><th>Distinction</th></tr>
<tr><td colspan="2">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</td><td rowspan="5">LO2 & LO3

D2 Make multiple iterations of your User Interface concept and modify each iteration with enhancements gathered from user feedback and experimentation.</td></tr>
<tr><td>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.</td><td>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.</td></tr>
<tr><td colspan="2">LO3 Build a User Interface concept and test it with users to see if it satisfies their emotions, desires and attitudes as planned</td></tr>
<tr><td>P5 Examine appropriate tools to develop a user interface.

P6 Run end user experiments and examine feedback.</td><td>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.</td></tr>
<tr><td colspan="2">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</td><td rowspan="2">D3 Critically evaluate the overall success of your User Interface concept and discusses your insight using prototyping.</td></tr>
<tr><td>P7 Evaluate end use feedback from multiple iterations of your user interface.

P8 Suggest steps to improve in future versions of your UI.</td><td>M7 Undertake a critical review and compare your final user interface and your test results with the original plan.</td></tr>
</table>

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 throughJourneys, 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.