

College of Computing

Academic Year 2023/24 - Semester 2

Please note: although we will try our best to avoid it, there may be timetable clashes when choosing modules across different levels and different courses (so you might have to choose alternative modules).

Click on the module name to see the module specification.

Module Code	Name	Level Code	BCU Module Credits	ECTS
CMP4265	Applied Operating Systems	4	20	10
CMP4269	Network Fundamentals	4	20	10
CMP4272	Data Structures and Algorithms	4	20	10
CMP4274	3D Game Programming	4	20	10
CMP4275	Computer Forensics Fundamentals	4	20	10
CMP4282	Business Information Modelling	4	20	10
CMP4285	Innovation Project	4	20	10
CMP4286	Computer Networks	4	20	10
CMP4293	Game Asset Pipeline	4	20	10
CMP4294	Introduction to Artificial Intelligence	4	20	10
CMP4298	Cyber Security Fundamentals	4	20	10
CMP5319	System Security Attacks and Defences	5	20	10
CMP5322	Enterprise Practice Project	5	20	10
CMP5323	Human-Computer Interaction	5	20	10
CMP5324	Smart Systems	5	20	10
CMP5328	Computer Forensics Tools and Techniques	5	20	10
CMP5329	Cyber Security	5	20	10
CMP5337	Enterprise Network Systems	5	20	10
CMP5345	Computer Networks and IP Distribution 2	5	20	10
CMP5348	Database Technology	5	20	10
CMP5352	Data Visualisation	5	20	10
CMP5354	Software Design	5	20	10
CMP5357	Cyber Security Operations	5	20	10
CMP5359	Computer Graphics	5	20	10
CMP5361	Computer Mathematics and Declarative Programming	5	20	10
CMP5363	Game Engine Architecture	5	20	10
CMP5368	Applied Programming	5	20	10
CMP5372	Applied Cyber Forensics	5	20	10
CMP6172	Consultancy and IT Management	6	20	10
CMP6176	Ethical Hacking	6	20	10
CMP6183	Network Security	6	20	10
CMP6186	Mobile Device Forensics	6	20	10
CMP6207	Modern Data Stores	6	20	10
CMP6210	Cloud Computing	6	20	10
CMP6213	Mobile and Wearable Application Development	6	20	10
CMP6228	Deep Neural Networks	6	20	10
CMP6229	Console Game Development	6	20	10
CMP6235	Application Solutions Development	6	20	10

Module Specification

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Module Summary Information

1	Module Title	Applied Operating Systems
2	Module Credits	20
3	Module Level	4
4	Module Code	CMP4265
5	Semester Taught	2

6	Module Overview
In this module, you will learn how modern operating systems are the glue that bind computer hardware and networks together and how they manage the user experience for individual computers and wider networks. We will examine the function and purpose of operating systems, with a focus on hands-on practical skills. We will build on learning from your networking, programming and computer systems modules, enhancing and extending skills in all these areas. You will make extensive use of Open Source software, demonstrating what can be achieved with this huge publicly shareable resource on a very limited budget. The module will be delivered via hands-on labs, interactive seminars and an integral coursework project-based assessment. This project is designed to mirror that found in the workplace to ensure you build transferable skills alongside technical excellence. Relationship to course philosophy: This module provides an opportunity for you to develop knowledge and skills, which will contribute to the acquisition of key BCU graduate attributes, creative problem solvers, global outlook, enterprising, professional and work ready. In the context of computing and data communication, this means an ability to respond to a critical brief to find practical solutions to problems; evaluate and respond to the opportunities and challenges of interdisciplinary approaches to the realisation of a task; respond flexibly and imaginatively to a set, brief within a fixed timescale.	

7	Indicative Content
This module will develop the following areas: • Basic operating system theory • Linux command line administration • Problem solving skills applied to troubleshooting technical problems • Oral and written communication assessed via the final project viva presentation	

8	Module Learning Outcomes		
	On successful completion of the module, you will be able to:		
	1	Administer an operating system using appropriate tools and techniques.	
	2	Troubleshoot simple hardware and software issues using appropriate methods.	
	3	Deploy and configure software to meet a defined need.	
	4	Adhere to appropriate professional and academic standards.	

9	Module Assessment		
Learning Outcome Number (from table 8)	Coursework	Exam	In-Person
1-4	100%		

10	Breakdown Learning and Teaching Activities		
Learning Activities		Hours	Details of Duration, Frequency and other comments
Scheduled Learning (SL) includes lectures, practical classes and workshops as specified in timetable		48	(2 x 2 hours Labs) x 12.
Directed Learning (DL) includes placements, work-based learning, peer group learning external visits, on-line activity, Graduate+, peer learning, as directed on VLE		48	Online learning, peer learning, and as directed on VLE.
Private Study (PS) includes preparation for exams		109	Labs and tutorials
Total Study Hours:		200	

11	Key Texts and Online Learning Resources
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Essential:

- Shotts Jr, W. E. (2016) The Linux Command Line: A Complete Introduction (Third Internet Edition, No Starch Press. (free download from <http://sourceforge.net/projects/linuxcommand/files/>)
- Smith, R. W. (2012) Linux Essentials, Wiley. (available from eLibrary)

Recommended:

- Apache Project (2016) Apache HTTP Server Documentation, <http://httpd.apache.org/docs/>, (viewed 01/08/2016)
- Goldman, R and Gabriel, R, (2005), Innovation Happens Elsewhere: Open Source as Business Strategy, Morgan Kaufmann (available free from: <http://www.dreamsongs.com/IHE>)
- Hernández, J M, Jiménez, D M, González Barahona, J M, Pascual, J S, Robles, G, (2009) Introduction to Free Software, Universitat Oberta de Catalunya (available free from: http://ftacademy.org/sites/ftacademy.org/files/materials/fta-m1-intro_to_FS-v1.pdf)

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Module Summary Information

1	Module Title	Network Fundamentals
2	Module Credits	20
3	Module Level	4
4	Module Code	CMP4269
5	Semester Taught	2

6	Module Overview
In this module you will develop your understanding of communication over networks and how devices send and receive data over their connected networks. We will use two of the standard referencing models, OSI and TCP/IP, that will help break down all the steps involved in data transmission and devices' communication over networks using their layered approach. We will discuss the function of each layer in details and some of the protocols at each of these layers and how they help get data delivered from sender to receiver over the network. During the lab sessions, you will also learn how to build simple local area networks and how to perform basic networking device configurations using real networking devices. You will also use networking simulation programs to help you further practice your skills while working from home. This module covers the first part of CCNA curriculum (CCNA1: Introduction to Networks) which will also give you good chance to start working towards your CCNA certification which is highly regarded in networking-related careers.	

7	Indicative Content
During the module students will explore the following areas: - OSI and TCP/IP reference models - Physical layer and Data link layer protocols - Network layer protocols including IPv4 and IPv6 addressing schemes - Upper layer protocols and how they support different network applications - Configuration of networking devices to enable end-to-end connectivity across network	

8	Module Learning Outcomes
On successful completion of the module, students will be able to:	
1	Use standardised layered models in the analysis and design of structured communication networks.
2	Design appropriate network system (using devices, addressing schemes, protocols, etc.) to a meet a given network specification.
3	Deploy, manage and secure network devices.

9	Module Assessment		
Learning Outcome Number <i>(from table 8)</i>	Coursework (100%)	Exam	In-Person
1,2,3	100%		

10 Breakdown Learning and Teaching Activities		
Learning Activities	Hours	Details of Duration, Frequency and other comments
Scheduled Learning (SL) includes lectures, practical classes and workshops as specified in timetable	48	2 hours weekly lectures 2 hours weekly lab sessions x 12
Directed Learning (DL) includes placements, work-based learning, peer group learning external visits, on-line activity, Graduate+, peer learning, as directed on VLE	50	Directed reading of lecture slides + online chapters+ online quizzes Practical work
Private Study (PS) includes preparation for exams	102	General reading to broaden understanding of the theory and practice introduced in the module.
Total Study Hours:	200	

11 Key Texts and Online Learning Resources	
www.netacad.com- on-line course material Introduction to Networks Companion Guide (CCNAV7) Published Jul 14, 2020 by Cisco Press. Part of the Companion Guide series. Alani, M.M., 2014. Guide to OSI and TCP/IP models. Edwards, J. and Bramante, R., 2015. Networking self-teaching guide: OSI, TCP/IP, LANs, MANs, WANs, implementation, management, and maintenance. John Wiley & Sons.	

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Module Summary Information

1	Module Title	Data Structures and Algorithms
2	Module Credits	20
3	Module Level	4
4	Module Code	CMP4272

5	Module Overview
Data structures and algorithms are essential in computer science, software engineering, and computer games and graphics programming. Data structures are structured representations of data; the design of a data structure determines how operations (such as reading to, writing from, modifying, or computing with the data) can be achieved. An algorithm is a set of instructions which can be followed in order to solve a computational problem. This module will equip you with the necessary background knowledge about common data structures and algorithms. It will develop your skills for writing them, and analysing their efficiency and correctness. You will cover topics such as how computers represent and operate on arrays, lists, sets, queues, stacks, graphs and networks, as well as how to write and analyse algorithms. This module will also prepare you for future programming modules and projects, and develops knowledge and skills necessary for employment in software development, game development, computer graphics, and related fields. Standard data structures and algorithms are also common topics for job interview questions.	

6	Indicative Content
• Memory representations of data types • Abstract data types • List data structures • Trees, graphs and networks • Recursion • Simple plans for writing algorithms • Searching and sorting algorithms • Geometric data structures and algorithms • Algorithm design and strategies • Algorithm efficiency analysis • Algorithm correctness analysis	

7	Module Learning Outcomes		
	On successful completion of the module, students will be able to:		
	1	Demonstrate knowledge of fundamental concepts of data structures and algorithms.	
	2	Explain the purpose, design and properties of standard data structures.	
	3	Write simple algorithms using appropriate discrete data structures to solve computational problems.	
	4	Use appropriate methods to analyse the efficiency and correctness of algorithms.	

8	Module Assessment		
Learning Outcome			
	Coursework	Exam	In-Person
1-4	X		

9	Breakdown Learning and Teaching Activities	
Learning Activities	Hours	
Scheduled Learning (SL) includes lectures, practical classes and workshops, peer group learning, Graduate+, as specified in timetable	48	
Directed Learning (DL) includes placements, work-based learning, external visits, on-line activity, Graduate+, peer learning, as directed on VLE	104	
Private Study (PS) includes preparation for exams	48	
Total Study Hours:	200	

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Module Summary Information

1	Module Title	3D Game Programming
2	Module Credits	20
3	Module Level	4
4	Module Code	CMP4274

5	Module Overview
This module will complement and build upon the programming skills that you learnt in CMP4264 2D Game Programming. This time you will focus on learning the principles behind programming and developing a simple 3D computer game using a professional game engine. You will explore working with 3D scenes and cameras; implementing a range of media assets for example 3D models, meshes, 3D animations as well as sound and audio. Other topics will include using simple game based physics, collision detection, ray casting and special effects for example shaders and lighting effects. You will be taught in a workshop based setting with tutors providing support, guidance and formative advice as you develop your skills in 3D game development.	

6	Indicative Content
• Working with cameras. • Models, meshes and animations. • Terrains and skyboxes. • User interfaces for 3D games. • Game effects including shaders and lighting. • Basics of artificial intelligence. • Augmented and virtual reality.	

7	Module Learning Outcomes
On successful completion of the module, students will be able to:	
1	Present and discuss the development of a 3D game.
2	Create a 3D game based upon a set of requirements.

8	Module Assessment		
Learning Outcome			
	Coursework	Exam	In-Person
1-4			x

9 Breakdown Learning and Teaching Activities	
Learning Activities	Hours
Scheduled Learning (SL) includes lectures, practical classes and workshops, peer group learning, Graduate+, as specified in timetable	48
Directed Learning (DL) includes placements, work-based learning, external visits, on-line activity, Graduate+, peer learning, as directed on VLE	62 Moodle has a set of required pre-sessional and post-sessional activities which are required to be completed each week.
Private Study (PS) includes preparation for exams	90 In this module guide there is a reading list which provides you with important supplementary information to class contact. Private study should also be used to complete your game.
Total Study Hours:	200

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Module Summary Information

1	Module Title	Computer Forensics Fundamentals
2	Module Credits	20
3	Module Level	4
4	Module Code	CMP4275

5	Module Overview
This module provides an introduction to the core principles of a typical computer forensic investigation. It aims to develop a firm grounding in the underpinning knowledge and skills required to analyse and evaluate data from a computer and related data storage devices in a forensically sound manner. This module emphasises a “hands-on” approach to learning forensic computing techniques using open-source and commercial forensic tools. The module will teach you the fundamental data structures applicable to computer forensics and how various tools can be exploited to analyse these structures in a variety of case types. The module is delivered through a truly flipped methodology, placing significant emphasis on the development of practical skills supported by blended learning and a variety of learning activities that include lectures, seminars, practice-led, self-directed and experiential learning; in person and online through Virtual Learning Environments (VLE). Each practical session comprises a series of hands-on analytical experiments to progressively unpack the more advanced aspects of the topic being investigated. All practical sessions will be hosted in the specialist Computer Forensics Laboratory, which in turn hosts a variety of the specialist hardware and software computer forensics tools. The post session activities for each week will comprise a short formative Moodle quiz that will provide instant feedback on the theoretical material covered. For each week’s lab session, there will be an accompanying video taking you step-by-step through the solutions of the practical lab exercises. In addition to the lab-based analytical experiments, each lab session will also provide you with a short set of experiments that are to be conducted on your virtual machine in your own time allowing you to explore the broader aspects of the topic being investigated during the scheduled lab session to help reinforce your learning. Where appropriate, additional surgeries may be held to provide additional guidance, support and feedback. The assessment for this module is based on a simulated Assessment Centre exercise used by increasingly by employers, specifically in the digital forensics sector. The assessment scenario is established around a job application for a Junior Digital Forensic Analyst in a (fictitious) digital forensics service provider. The assessment strategy not only develops the core competencies in digital forensics but also enables first-year students to engage directly in a process that provides them with an academic and professional skill set upon which they can build their personal development planning (PDP) and develop their employability in the subsequent years of degree study.	

6	Indicative Content
	Introduction to the Computer Forensics Profession and Investigations. Fundamentals of Cryptography. System Authentication and Passwords Data Storage Devices and Data Acquisition File Signature Analysis and Validation Data Hiding Techniques Formal Guidelines and Regulations

7	Module Learning Outcomes
	On successful completion of the module, students will be able to:
	1 Demonstrate the practical application of key principles that underlie a forensic investigation process.
	2 Identify and assess the authenticity of digitally stored computer data.
	3 Apply appropriate analytical and forensic tools in different situations.
	4 Formulate academic, personal development and career planning in the context of digital forensics.

8	Module Assessment
Learning Outcome	
	Coursework Exam In-Person
1,2,3, 4	X

9	Breakdown Learning and Teaching Activities
Learning Activities	Hours
Scheduled Learning (SL) includes lectures, practical classes and workshops, peer group learning, Graduate+, as specified in timetable	48
Directed Learning (DL) includes placements, work-based learning, external visits, on-line activity, Graduate+, peer learning, as directed on VLE	48
Private Study (PS) includes preparation for exams	104
Total Study Hours:	200

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Module Summary Information

1	Module Title	Business Information Modelling
2	Module Credits	20
3	Module Level	4
4	Module Code	CMP4282
5	Semester Taught	2

6	Module Overview
The module discusses the relationship between data, information and systems that allow organisations to exploit information and IT in a constantly changing context. The module addresses the challenges of planning and designing IT systems to provide organisations with system models. You will explore the specific organisation needs, data and characteristics required for modelling systems. You will use structured approaches to analysing and designing information systems. In addition, you will be introduced to different ways of modelling and communicating the organisation's information needs. In this module, you will develop practice-based skills to design and develop conceptual system models. The main module topics will be delivered via lectures followed by structured workshops based on an organisational case study which will be presented in segments. Typically, a workshop will start with a briefing about the problem or aspect to be discussed. The workshops will require you to apply problem-solving or discuss a particular aspect and report back, role-play, etc. Teams will then engage in a range of tasks using case study materials. During the workshops, class discussions, master classes and 'mini lectures' may be used to introduce or reinforce theoretical theory and principles. Typically, students will lead the plenary talks, which will conclude the workshops, so that you build confidence to engage in critical debate and discuss your contributions and ideas. You will also gain formative feedback from tutors and peers. Independent learning will be supported by: • Directed reading to be completed before workshops • Case study materials • Reading lists • VLE learning resources and website links • Online (VLE) discussion forums	

7	Indicative Content
• Business Processes • Normalisation • Entity Relationships • The requirements workflow • The analysis workflow • Use case modelling • Unified Modelling Language	

8	Module Learning Outcomes	
	On successful completion of the module, students will be able to:	
	1	Analyse the organisation's requirements using appropriate tools.
	2	Develop systems models for an organisation using appropriate modelling tools.
	3	Communicate the systems models to a professional audience.

9	Module Assessment		
Learning Outcome Number <i>(from table 8)</i>	Coursework	Exam	In-Person
1	30%		
2 and 3			70%

10	Breakdown Learning and Teaching Activities		
Learning Activities		Hours	Details of Duration, Frequency and other comments
Scheduled Learning (SL) includes lectures, practical classes and workshops as specified in timetable		48	4hrs project-based workshops (including quizzes, formative feedback and sprint activities) x 12
Directed Learning (DL) includes placements, work-based learning, peer group learning external visits, on-line activity, Graduate+, peer learning, as directed on VLE		50	Directed reading- materials, case studies. Practical work.
Private Study (PS) includes preparation for exams		102	General reading to broaden understanding of the theory and practice introduced in the module. Review practical 'how-to guides' and relevant articles and websites that provide theory examples in practice.
Total Study Hours:		200	

11	Key Texts and Online Learning Resources
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Arlow, J. & Neustadt, I. (2005) UML 2 and the unified process: practical object-oriented analysis and design. 2nd ed. Upper Saddle River, NJ: Addison-Wesley.

Gordon, K., (2017). Business Information: Entity Relationship and Class Modelling for Business Analysts. BCS, The Chartered Institute for IT

Paul, D. et al. (2020) Business analysis. Fourth edition / Debra Paul, James Cadle, Malcolm Eva, Craig Rollason, Jonathan Hunsley. London: BCS.

Teorey, T. J. (2011) Database modelling and design logical design. 5th ed. Amsterdam; Morgan Kaufmann Publishers.

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Module Summary Information

1	Module Title	Innovation Project
2	Module Credits	20
3	Module Level	4
4	Module Code	CMP4285
5	Semester Taught	2

6	Module Overview
Innovation is finding a different or better way of solving problems, it is the engine that drives an idea to deliver real value to customers. This first-year project allows you to develop and cultivate a creative mind-set through collaborative innovative practice, allowing you to bring together knowledge and imagination to construct a viable product. It is an opportunity to express your ideas, skills and talent to the wider community of innovative practice. Learning and Teaching The project provides you with an opportunity to be part of a thriving community of innovators that practices connected learning. This is facilitated by putting you into inter-disciplinary project teams supported by innovation mentors, advisors and academics; culminating in you exhibiting your work to an international panel of experts. Projects such as the XploR smart cane and Smart Ignite are examples of innovation projects that have progressed their innovation journey from inception to prototype, and the teams have received international accolade at the European Business Congress and won the BCU Extra Mile awards in previous years. This semester long project will challenge teams through an iterative process of requirements capture, ideation, concept design, development and rapid prototyping to deliver a functional proof-of-concept. Whilst the module promotes an attitude of 'product making', emphasis is placed on student excellence by encouraging them to demonstrate deep thinking (research, thought and action) of their ideas and constructs through the development of an extensive speculative project plan that will encourage them to innovate further. The module is designed to teach innovation methods, techniques and processes that are required to develop young professionals, enabling them to articulate and strengthen their career aspirations as the innovators of tomorrow. The module is semi structured using Lectures, Workshops and Innovation Labs within their student teams, whilst being supported and encouraged to continuously progress their projects for assessment. This module encourages students to capitalise on their learning and direct this towards their own career goals; this is done by engaging in research and innovative projects that align to their future aspirations. The relationship to programme philosophy this module provides an opportunity for the student to develop knowledge and skills, which will contribute to the acquisition of key BCU graduate attributes; creative problem solvers, global outlook,	

enterprising, professional and work ready. In the context of computing and data communication, this means an ability to respond to a critical brief to find practical solutions to problems; evaluate and respond to the opportunities and challenges of interdisciplinary approaches to the realisation of a task; respond flexibly and imaginatively to a set, or group-determined brief within a fixed timescale.

Inclusivity

To deliver an inclusive module, the following concepts will be included to curriculum/assessment design as well as regular teaching and learning of the curriculum:

Fostering a collaborative learning environment and create opportunities for students and staff to engage in community building to encourage all members (staff and students) to contribute their thoughts and ideas and therefore strengthen the learning experience.

Encouraging discussion and coverage of relevant, real-world examples drawn, not only from various industries / sectors, but from a diverse array of life experiences (e.g., cultures, countries, genders, geographies, socio-economic classes, etc). Drawing particular attention to the wider contributions made by people from differing backgrounds and life experiences when solving practical problems and developing the field as a whole

Encourage collaborative learning and create opportunities to get to know the students. Avoid making assumptions about a students' background, ability, point of view or pre-existing knowledge of a subject.

Accessibility

To ensure suitable accessibility to the curriculum for students with diverse array of accessibility requirements/preferences, the course team will provide materials that meet the following criteria:

Face-to-face lectures for the core content that can also be delivered online will be designed and provided to students.

Online lectures will be recorded for future use/reference.

Written materials will be provided while giving specific attention to the official accessibility guidelines for producing [word](#) and [PDF](#) documents.

Appropriate adjustments for students when engaging with day-to-day curriculum content and assessments will be guided by the University's "[Student Disability and Mental Health](#)" policy, the module team will also regularly engage with the [support team](#) during periods where curriculum content is being transformed (created/updated) to help ensure an appropriate approach to holistic curriculum design is adopted.

Sustainability

To build awareness of the problem faced by today's society, students' projects are required to be challenging and attempting to make an impact towards the [United Nations Sustainable Development Goals](#).

Employability

The module will apply the following [employability skills](#) throughout:

Problem solving investigate problems and practical situations and formulate, evaluate and apply evidence-based solutions and arguments.

Communication communicate effectively knowledge, understanding and skills to a variety of audiences in a range of settings and using a variety of media.

Curiosity to learn: students are encouraged to search broadly for insights and information across a wide range of situations (via further reading and researching).

Innovative/Creative examine problems from a fresh perspective and develop innovative solutions.

Collaboration collaborate, work in teams and groups, and lead where appropriate.

Interpersonal/Networking listen actively, negotiate effectively, be empathetic, and develop positive connections with others.

Autonomy think independently, exercise personal judgment, take the initiative and be enterprising.

Self-management plan and organise my time, prioritise important tasks, work under pressure and to tight deadlines.

Resilience respond flexibly and adapt my skills and knowledge when dealing with change, unfamiliar or challenging situations.

Reflective/self-awareness use feedback productively, identify and articulate my skills in a variety of contexts, and set goals for my continuing personal, professional and career development.

7	Indicative Content
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- Ideation
- Design thinking
- Project planning
- Innovation process and techniques
- Development Lifecycle
- Project Principles – Internal & External Factors
- Project Organisation
- Digital Marketing and competitor analysis
- Production and Costing
- Gap analysis
- Presentation and Pitching
- Sustainable Development Goals

8	Module Learning Outcomes	
	On successful completion of the module, students will be able to:	
	1	Collaborate in design-thinking to present a concept in a concise manner.
	2	Position your team contribution to maximise your employability opportunities.
	3	Consolidate team expertise to construct a Minimum Viable Product (MVP).
	4	Develop an opportunistic project plan through reflective practice.

9	Module Assessment		
Learning Outcome Number <i>(from table 8)</i>	Coursework	Exam	In-Person
1 and 4	30 %		
2 and 3			70%

10 Breakdown Learning and Teaching Activities		
Learning Activities	Hours	Details of Duration, Frequency and other comments
Scheduled Learning (SL) includes lectures, practical classes and workshops as specified in timetable	54	<i>1 hr lecture x6, 4hr seminar x12</i>
Directed Learning (DL) includes placements, work-based learning, peer group learning external visits, on-line activity, Graduate+, peer learning, as directed on VLE	70	Includes: peer group learning, Graduate+, on-line activity, as directed on VLE
Private Study (PS) includes preparation for exams	76	<i>General reading to broaden understanding of the theory and practise introduced in the module</i> <i>Review relevant articles and websites that provide theory examples in practice.</i>
Total Study Hours:	<i>200 notional learning hours</i>	

11 Key Texts and Online Learning Resources
Brenner, W. and Uebernickel, F. (eds.) (2016) Design thinking for innovation: Research and practice: 2016. Cham, Switzerland, Switzerland: Springer International Publishing AG Kallet, M. (2014) Think smarter: Critical thinking to improve problem-solving and decision-making skills. United States: John Wiley & Sons. Project Innovation. (2022) Project innovation: Developing an innovation mind set. Available at: http://www.socialinnovationtoolkit.com/innovation-mindset.html (Accessed: 1 May 2022). Bhana R. et al. (June, 2016) Living Labs (LILA): A community driven approach to technology transfer and internationalising entrepreneurship, Networks and Open Innovation in Entrepreneurship, 9th International Conference for Entrepreneurship, Innovation and Regional Development (ICEIRD 2016), dedicated to responsible entrepreneurship; National University of Political Studies and Public Administration and University of Sheffield International Faculty; Bucharest, Romania. Majeed A, Bhana R et al. (April, 2016) Living Labs (LILA): An Innovative Paradigm for Community Development: Project of "XploR" Cane for Blinds, Technology, Innovations, and Sustainability, The International Conference on Leadership, Innovation and Entrepreneurship as driving forces of the Global Economy; Canadian University Dubai; Dubai, United Arab Emirates.

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Module Summary Information

1	Module Title	Computer Networks
2	Module Credits	20
3	Module Level	4
4	Module Code	CMP4286

5	Module Overview
This module examines network technology, applications and protocols to enable the student to gain a thorough understanding of the technology in this area. Network models and terminology along with routing and switching will be investigated in theory and in practice. This curriculum provides knowledge in IP networking that is essential for the success in subsequent networking modules.	

6	Indicative Content
Models used to describe network operations. Logical addressing schemes Network operating system commands Fault identification.	

7	Module Learning Outcomes
On successful completion of the module, students will be able to:	
1	Describe the operational models and the protocols used in data networks.
2	Calculate and apply network addressing schemes to a simple network.
3	Apply network device configuration commands.
4	Use basic data network fault finding techniques and tools and communicate fault analysis.

8	Module Assessment		
Learning Outcome			
	Coursework	Exam	In-Person
1,2,3,4		x	

9 Breakdown Learning and Teaching Activities	
Learning Activities	Hours
Scheduled Learning (SL) includes lectures, practical classes and workshops, peer group learning, Graduate+, as specified in timetable	48
Directed Learning (DL) includes placements, work-based learning, external visits, on-line activity, Graduate+, peer learning, as directed on VLE	36
Private Study (PS) includes preparation for exams	116
Total Study Hours:	200

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Module Summary Information

1	Module Title	Game Asset Pipeline
2	Module Credits	20
3	Module Level	4
4	Module Code	CMP4293

6	Module Overview
In this module, you will implement asset management processes in the context of the development of a 3D interactive environment using industry-standard game middleware. You will use a game engine to develop your own 3D game, managing assets for the game accordingly. This unit covers the set of techniques and concepts related to the creation of a modern computer game using industry-standard middleware products. The unit also aims to introduce you to game programming skills related to asset management (pre-production, production and integration) and illustrate game middleware components and their utilisation with plugin tools designed to facilitate export from art creation tools and their import into the middleware. This unit covers the game asset pipeline and the issues faced when using industry-standard middleware.	

7	Indicative Content
• Assets Importation (3D models, animations, dynamics textures and sounds). • Gameplay evaluation • Project planning • Prototyping-based software methodology • Version control • 3D Actors properties and behaviour (Finite State Machine and Event-based behaviour). • Collision Model and Physics Engine. • Skeletal / Vertex/ Key-framed Animation playing. • User Interface. • Player Data saving and loading. • Level loading. • Games related scripting and programming techniques.	

8	Module Learning Outcomes
On successful completion of the module, you will be able to:	
1	Express knowledge of industry-standard game engine architecture and components.
2	Describe the game production pipeline.
3	Select appropriate methodologies to import assets into a game engine (e.g. geometry models, animation, textures, sounds, music, particle systems).
4	Summarise the process of producing a 3D game using game middleware, employing game logic and object behaviour.

9	Module Assessment		
	Coursework	Exam	In-Person
1-4	x		

10	Breakdown Learning and Teaching Activities	
Learning Activities	Hours	Details of Duration, Frequency and other comments
Scheduled Learning (SL) includes lectures, practical classes and workshops, peer group learning, Graduate+, as specified in timetable	48	4hr workshop x 12
Directed Learning (DL) includes placements, work-based learning, external visits, on-line activity, Graduate+, peer learning, as directed on VLE	62	Work on developing and versioning game assets. Pre- and Post-sessional activities are available on Moodle
Private Study (PS) includes preparation for exams	90	Reading literature, reviewing lecture notes, independent research, practicing problem-solving with code, language learning, development of assignments.
Total Study Hours:	200	

11	Key Texts and Online Learning Resources
Venter, Henk, and Wilhelm Ogterop. Unreal Engine 5 Character Creation, Animation and Cinematics : Create Custom 3D Assets and Bring Them to Life with Unreal Engine 5 Using Nanite, Lumen, and Blender. Birmingham, England: Packt Publishing, Limited, 2022. Print. Marques, Goñalo et al. Elevating Game Experiences with Unreal Engine 5. Second edition. Birmingham, UK: Packt Publishing Ltd., 2022. Print. Menard, Michelle. Game Development with Unity. Boston, Mass: Course Technology Cengage Learning, 2012. Print.	

Munaiah, Nuthan et al. "Curating GitHub for Engineered Software Projects." *Empirical software engineering : an international journal* 22.6 (2017): 3219–3253. Web.

Carter, Ben. *The Game Asset Pipeline*. Australia: Delmar Cengage Learning, 2004. Print.

Dunlop, Renee. *Production Pipeline Fundamentals for Film and Game*. Ed. Renee Dunlop. 1st edition. Burlington, Massachusetts: Focal Press, 2014. Web.

Mori, Haruka. *Game Sector (Industry Edition): Sentiment Likely to Improve Further Given Momentum Rebound for Platforms and Loaded Game Pipelines*. New York: JPMorgan Chase & Company, 2023. Print.

Module Specification

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Module Summary Information

1	Module Title	Introduction to Artificial Intelligence
2	Module Credits	20
3	Module Level	4
4	Module Code	CMP4294
5	Semester Taught	2

6	Module Overview
From tech vendors to governments to small and medium enterprises (SMEs), Artificial Intelligence (AI) is being increasingly used as an enabling technology. Therefore, broad guidelines on how AI systems should be responsibly developed, trained, tested, and deployed are essential. At first glance, this is a positive update, as it reveals an awareness of the fact that AI unleashed on the world with limited consideration could have devastating societal and economic consequences. In an enterprise context, this means evaluating the risks and benefits of AI adoption carefully. Teaching and Learning: This module covers the basic principles of AI systems, techniques and the types of problems that can be solved by such techniques. This module will also evaluate the risks and benefits of AI adoption in different domains. You will learn about the philosophy of AI and how knowledge is represented. The module also offers an introduction to machine learning. This module will utilise a hands-on approach to teaching. Teaching sessions will include individual/team based experiential activities such as critique of example scenarios; these scenarios will include situations tailored to make a point as well as real world case studies. Lectures will be interactive, and you will apply the lessons learnt on problem scenarios by employing suitable software tools. The contact sessions will be a relationship between theory and practice, which will inspire you to investigate taught material further through post-session activities. The module provides the opportunity for formative assessment and feedback. Inclusivity To support inclusivity, in a welcoming environment for students from a wide variety of backgrounds, our approach to curriculum design, assessment design, as well as regular teaching and learning of the curriculum will be guided by the following concepts: • Encouraging collaborative learning and discussion as well as coverage of relevant, real-life examples/case studies drawn, not only from various industries/sectors, but also from a varying array of life experiences (e.g., cultures, countries, genders, geographies, socio-economic classes, etc). • Adopting literature/models of authors from diverse backgrounds when considering theoretical concepts and solving practical problems within the curriculum and in the field in general. • Exploring specific ethical and legal issues associated with the storage and processing of data belonging to people from diverse groups, with particular care and attention placed on developing our understanding of the related ethical issues that may arise from naïve approaches to developing solutions in an increasingly data-driven world, and how we, as Data Scientists / Machine Learning Engineers, might tackle these problems.	

Accessibility

To ensure accessibility to the curriculum for students with a diverse array of accessibility requirements / preferences, the course team will provide materials that meet the following criteria:

- Face-to-face lectures for the core content that can also be delivered online will be designed and provided to you.
- Any online supplementary lectures will be recorded for future use/reference and transcripts will be recorded.
- Written materials will be provided while giving specific attention to the official accessibility guidelines for producing [word](#) and [PDF](#) documents
- Appropriate adjustments for students when engaging with day-to-day curriculum content and assessments will be guided by the University's "[Student Disability and Mental Health](#)" policy, the module team will also regularly engage with the [support team](#) during periods where curriculum content is being transformed (created/updated) to help ensure an appropriate approach to holistic curriculum design is adopted.

Sustainability

By adopting the inclusivity practices set out in this guide, this module contributes to goal number 4 of the UN Sustainable Development Goals (SDGs). This module also contributes to SDG goal number 9 by way of providing relevant tools and skills to enhance transformation in AI, and subsequently enhance industry investment in AI. Details on the UN SDG goals is [here](#).

Employability

This module will allow you to reflect upon your learning styles and develop relevant transferable skills and proficiencies pertinent for personal development, employability, as well as contribution to society and community. Going on from this module, you will have opportunities to develop the crucial skills such as problem-solving skills, analytical skills, research skills, collaborative skills, and communication skills, which will strengthen their employability opportunities and career enhancements. The module will align with IBM content, which will offer the students industrial badges to increase their ability to operate in an independent and self-directed manner leading to greater employability and connectivity with industry as well as opportunities of engaging in industry-mentored projects that would lead to enhanced relevance for students in the employment market.

7	Indicative Content
	• Evolution of AI • Principles of AI • AI Systems, Tools, and Techniques • Ethical consideration on the adoption of AI systems • Time Series Prediction

8	Module Learning Outcomes		
	On successful completion of the module, you will be able to:		
	1	Describe foundational principles of Artificial Intelligence.	
	2	Recognise risks and ethical implications of the adoption of Artificial Intelligence.	
	3	Apply traditional techniques of statistical analysis on realistic datasets.	
	4	Assess statistical conclusions of the selected datasets.	

9	Module Assessment		
Learning Outcome Number	Coursework 60%	Exam	In-Person 40%
1 - 2			x
3 - 4	x		

10	Breakdown Learning and Teaching Activities		
Learning Activities		Hours	Details of Duration, Frequency and other comments
Scheduled Learning (SL) includes lectures, practical classes and workshops as specified in timetable		48	2hr lecture x12, 2hr Lab/Seminar x12)
Directed Learning (DL) includes placements, work-based learning, peer group learning external visits, on-line activity, Graduate+, peer learning, as directed on VLE		60	Work-based learning, online activities, practical exercises (3 x 12)
Private Study (PS) includes preparation for exams		92	Coursework preparation (7.6 x 12)
Total Study Hours:		200	

11	Key Texts and Online Learning Resources
Books	
- Ertel, W., 2018. <i>Introduction to artificial intelligence</i>. Springer.S.J. Russell & P. Norvig, "Artificial Intelligence: A modern approach", 2nd Edition. Prentice-Hall, 2002. (main textbook) S. Pinker. "How the Mind Works", W.W. Norton & Company, 1999. A. Cawsey. "The Essence of Artificial Intelligence". Prentice-Hall. 1998.	

- Eisenstein, Jacob. *Introduction to Natural Language Processing*. MIT Press, 2019.
- Loper, Edward, Bird, Steven, Klein, Ewan. *Natural Language Processing with Python*. O'Reilly, 2009.
- Gonzales, Rafael C., Woods, Richard E. *Digital Image Processing*. Fourth Edition, Pearson, 2017.
- Alpaydin, Ethem. *Introduction to Machine Learning, Fourth Edition*. MIT Press, 2020.

Journals

- CVPR Conference Proceedings

ICLR Conference Proceedings IEEE Transactions on Pattern Analysis and Machine Intelligence

Journal of Machine Learning Research

IEEE Transactions on Audio, Speech and Language Processing.

Module Specification

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Module Summary Information

1	Module Title	Cyber Security Fundamentals
2	Module Credits	20
3	Module Level	4
4	Module Code	CMP4298
5	Semester Taught	2

6	Module Overview
The module introduces the fundamental elements of cybersecurity and its body of knowledge. It aims to develop a firm grounding in the underpinning knowledge and skills required to protect organisations from cyber-attack. You will be introduced to cybersecurity principles and implications of threats, vulnerability and risks facing these organisations. You will acquire theoretical knowledge and practical skills in cybersecurity that you will build on as you progress through the course. You will learn about security protection measures and mitigation strategies to enable you to protect and respond to cyber-attacks. The module emphasises on the development of practical skills supported by a variety of learning activities, including lectures, practice labs, self-directed and online through Virtual Learning Environments (VLE). The weekly hands-on practical labs give you the opportunities to practice with industry-recognised tools and broaden your skills.	

7	Indicative Content
The module will introduce you to the following topics: • Starting a career in Cyber Security • Roles and responsibilities in Cyber security • Network Security concepts • Types of threats • Protecting systems and home networks • Internet safety and social media • Data Security and information Sharing • Basic IoT security • Fundamentals of Cryptography • Human aspect of cybersecurity	

8	Module Learning Outcomes On successful completion of the module, students will be able to:	
	1	Describe and assess the principles of cybersecurity as applied to a given scenario.
	2	Identify common cybersecurity threats and appraise mitigation strategies.
	3	Apply appropriate tools to determine and evaluate the security state for a given system.
	4	Develop effective security policies for a given scenario.

9	Module Assessment		
Learning Outcome Number <i>(from table 8)</i>	Coursework	Exam	In-Person
1 - 2	X In-class Moodle test (40%)		
3 - 4	X Logbook report (60%)		

10	Breakdown Learning and Teaching Activities	
Learning Activities	Hours	Details of Duration, Frequency and other comments
Scheduled Learning (SL) includes lectures, practical classes and workshops as specified in timetable	48	2 x 12hr Lecture Sessions 2 x 12hr Practical Lab Sessions
Directed Learning (DL) includes placements, work-based learning, peer group learning external visits, on-line activity, Graduate+, peer learning, as directed on VLE	48	4hrs/wk Review weekly Moodle contents Participate in industry workshops and seminars when required.
Private Study (PS) includes preparation for exams	104	Read directed material around the discipline as instructed by the tutor/module team. Case studies, pre-reading articles and exercises
Total Study Hours:	200	

11	Key Texts and Online Learning Resources
Key Texts	

Goutam, R.K., 2021. Cybersecurity Fundamentals: Understand the Role of Cybersecurity, Its Importance and Modern Techniques Used by Cybersecurity Professionals (English Edition). BPB Publications.

Andress, J., 2019. Foundations of information security: a straightforward introduction. No Starch Press.

Ozkaya, E., 2019. Cybersecurity: The Beginner's Guide: A comprehensive guide to getting started in cybersecurity. Packt Publishing Ltd.

Du, W., 2022. Computer Security. Wenliang Du.

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Module Summary Information

1	Module Title	System Security Attacks and Defences
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5319
5	Semester Taught	2

6	Module Overview
The module has been designed to provide you with the necessary theoretical framework, foundations and practical support for understanding security solutions with reference to the application of security controls and a wider range of security attack categories and defensive approaches. This is underpinned by providing an understanding of the use of asymmetric cryptography for key management associated with the use of symmetric cryptography, cryptographic certificates and public key infrastructure (PKI) and access control measures. This module provides practical skills through the use of various security tools and software. The module also covers other content such as cyber security strategies, security frameworks, and infrastructure protection. The module emphasises the concept of systems security and its associated body of knowledge to identify threats and implement defensive measures. These topics are considered to help provide a security foundation within courses including Cyber Security, Forensics and Networking and Security in order to place other aspects of these courses within a structured understanding of security theory and practice. This module will be taught using practical labs covering some of the indicative contents. Lectures will be provided in order to outline the theoretical content and the relationship with practical application. Supported classes will be supplemented through student reading and completion of lab materials provided via Moodle.	

7	Indicative Content
• Cryptography - Asymmetric and symmetric cryptography • Access Control - Discretionary access control and mandatory access control • Firewalls and VPNs • Security attacks and defences • Cyber security strategies • Security frameworks • Risk Management • Human aspects of cyber security • Protection of critical infrastructure • Network enumeration • Security posture • Password security • Malware	

8	Module Learning Outcomes On successful completion of the module, students will be able to:		
	1	Describe the application of cryptographic techniques and access control measures.	
	2	Discuss the main classes of security attacks and how to defend against them.	
	3	Identify and analyse security vulnerabilities and their associated risks to networked systems.	
	4	Evaluate the main cyber security frameworks and their role in improving the security posture.	

9	Module Assessment		
	Coursework	Exam	In-Person
Learning Outcome Number <i>(from table 8)</i>	Coursework 80%	Exam 20%	
1		X	
2-4	X		

10	Breakdown Learning and Teaching Activities		
Learning Activities	Hours	Details of Duration, Frequency and other comments	
Scheduled Learning (SL) includes lectures, practical classes and workshops as specified in timetable	48	Lecture: 1hr x12=12 hrs Practical Labs: 3 x 12= 36 hrs	
Directed Learning (DL) includes placements, work-based learning, peer group learning external visits, on-line activity, Graduate+, peer learning, as directed on VLE	80	Moodle engagements and lab activities = 80 hrs	
Private Study (PS) includes preparation for exams	72	Moodle engagements, coursework, and exam preparation = 72 hrs	
Total Study Hours:	200		

11	Key Texts and Online Learning Resources		
	- Cyber operations: building, defending, and attacking modern computer networks, O'Leary, Mike, author (2019) - Financial Cryptography and Data Security, Goldberg, Ian (2019) - Cybersecurity for beginners, Meeuwisse, Raef, author (2017)		

- Computer and network security essentials (2017)
- Security and privacy in cyber-physical system (2018)
- Cryptography and network security: principles and practice: Stallings, William, author (2017)
- Security engineering: a guide to building dependable distributed systems (2008)
- Implementing SSL / TLS Using Cryptography and PKI, Joshua Davies (2011)
- Linux+: study guide: Smith, Roderick W
- <https://www.sans.org/security-resources/?msc=main-nav>

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Module Summary Information

1	Module Title	Enterprise Practice Project
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5322
5	Semester Taught	2

6	Module Overview
This module forms part of the Research and Enterprise strand that runs through each programme curriculum from level 4 to 7. It builds on the core concepts, which were introduced to you at level 4 in the practice based computing related modules and the underpinning role innovation plays in this. As you have chosen to major in developing your technical capability, knowledge and skills required for you chosen career path, this module is designed to draw upon your technical learning framework through Reflection, Evaluation, Entrepreneurialism and Management (REEM). REEM forms the principles of this module allowing you to explore and to further build on your strengths and achievements to pursue excellence in a professional context. The module enables you to reflect on your acquired practice based technical skills by reviewing how these have benefitted an enterprise project and their impact on your career development. It will require you to evaluate practices and technologies and validate their relevance in your field thorough academic research techniques. It will intellectually develop you to extend the entrepreneurial impact on a project through its value proposition aligned to an enterprise's strategic goal. It will help to support your proficiency of applying project management methods, techniques and adherence to ethics to deliver a real-world technology project. The module is not based on the technical outputs, but based on a thorough review of a project you are involved in or contributed to, so that you are able to develop a strategic framework and to review its impact on both the enterprise and your career. You can select between either a Professional Project or an Entrepreneurial Project with the agreement of the module team. The types of projects described are categorised below; projects with employer or sponsor opportunities need to be negotiated at programme level and could form part of other level five practice-based modules. Professional Project Industry Projects - Industry sponsored projects supervised by an academic in collaboration with an industry partner, conducted on-campus rather than at workplace site, but could be partially based at a research facility or institute. (Also, known as community projects, industry research projects, consultancy projects or practical projects). Work Simulations - Activities specifically designed to simulate a work environment, using equipment and practices that are standard in the industry. E.g. a case study assessment from a technical module that requires specialist software or equipment. Conducted on-campus rather than at workplace. (Professional practice). Reflection on current employment - Independent and unsupervised reflection on paid current employment. Conducted on-campus rather than at workplace site. Entrepreneurial Project	

Entrepreneurship - Activities in which students develop their own business or social enterprise to address a specific need or fill a niche market need that they have identified. Supervised by an academic often in collaboration with an industry mentor.

Relationship to programme philosophy:

This module provides an opportunity for the student to develop knowledge and skills, which will contribute to the acquisition of key BCU graduate attributes; creative problem solvers, global outlook, enterprising, professional and work ready. In the context of computing and data communication, this means an ability to respond to a critical brief to find practical solutions to problems; evaluate and respond to the opportunities and challenges of interdisciplinary approaches to the realisation of a task; respond flexibly and imaginatively to a set, or group-determined brief within a fixed timescale.

This module is likely to contain the following topics of study:

- Enterprise practise management – business research and business systems.
- Marketing objectives - market portfolio, market development, customer focus, scenario planning and product features vs benefits.
- Marketing strategy - distribution plan, online advertising, target Segments, Objective Options and enterprise proposal
- Business planning
- Cost management - cash flow analysis
- Investment appraisal – payback and NPV
- Investment appraisal - IRR
- Business legal entities - sole trader, partnership, Ltd, LLP, PLC
- Investment appraisal - break even analysis
- Research methods - qualitative research
- Enterprise development - resources and capabilities.
- Project management

	1 Reflect on your acquired practice based technical skills.
	2 Evaluate relevant practices and technologies required for the project.
	3 Apply appropriate project management methods, techniques and ethics.
	4 Construct a strategic framework for a specified business project.

Learning Outcome Number (from table 8)	Coursework	Exam	In-Person
1.2.3.4	100%		

10 Breakdown Learning and Teaching Activities

Learning Activities	Hours	Details of Duration, Frequency and other comments
Scheduled Learning (SL) includes lectures, practical classes and workshops as specified in timetable	48	12X2hr seminar/lecture 12X2hr tutorial practical classes
Directed Learning (DL) includes placements, work-based learning, peer group learning external visits, on-line activity, Graduate+, peer learning, as directed on VLE	40	As directed on VLE
Private Study (PS) includes preparation for exams	112	General reading to broaden understanding of the theory and practice introduced in the module. Review relevant articles and websites that provide theory examples in practice.
Total Study Hours:	200	

11	Key Texts and Online Learning Resources
Purchase There is no specific book you are required to purchase for this module Essential (Books/Journals/Specific chapters/Journal Articles) Anon (2013) Trouble at the lab. The Economist. Available at: http://www.economist.com/news/briefing/21588057-scientists-think-science-self-correcting-alarming-degree-it-not-trouble [Accessed October 27, 2014]. Silverman, D. (2010) Qualitative Research. 3rd ed. London: Sage Publications. Recommended Westwood, J. (2013) 'How to write a Marketing Plan', 4th edition, Kogan Page: London. Blackwell, E. (2008) 'How to Prepare a Business Plan', 5th edition, Kogan Page: London. Lucey, T. (1996) 'Management Accounting', 4th edition, D. P. Publications: London. Dibb, S. Simkin, L., Pride, W. M., Ferrell, O. C. (2001) 'Marketing - Concepts and Strategies', 4th European Edition, Houghton Mifflin: Boston. McDonald, M. (2007) 'Marketing Plans - How to prepare them, How to use them', 6th edition, Elsevier: London. Knight, P. (2004) 'The Highly Effective Marketing Plan', Pearson: Harlow.	

Background

- Harvard Business Review
- Journal of the Institute of Incorporated Engineers
- Journal of General Management Journal of Marketing
- Journal of Marketing Management Financial Times
- Wall Street Journal
- The Times and/or Sunday Times Daily and/or Sunday Telegraphs Guardian
- Observer

Module Specification

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Module Summary Information

1	Module Title	Human Computer Interaction
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5323

5	Module Overview
In this module you will focus on combining theoretical concepts around user experience design with practical “hands-on” approaches widely used in industry and academia to create effective interactive experiences. Current technology developments involve humans using information centred applications, both physically and cognitively. With the advent of ubiquitous computing and connected products, digitalisation has enabled information architectures that are not solely focused in software based applications, but also in tangible computing devices. In this context, you will learn about the user-centred design process that places a core emphasis on designing products and applications for “people”. In particular, you will learn techniques for gathering and understanding a target audience’s requirements, the importance of universal design and accessibility, methods for undertaking rapid prototyping, core principles around aesthetics and visual design, and a range of techniques for designing, running, and analysing user evaluations. You will apply this knowledge to collaboratively design and evaluate an innovative digital prototype using industry standard tools. Relationship to programme philosophy: This module provides an opportunity for the student to develop knowledge and skills, which will contribute to the acquisition of key BCU graduate attributes; creative problem solvers, global outlook, enterprising, professional and work ready. In the context of computing and data communication, this means an ability to respond to a critical brief to find practical solutions to problems; evaluate and respond to the opportunities and challenges of interdisciplinary approaches to the realisation of a task; respond flexibly and imaginatively to a set, or group-determined brief within a fixed timescale.	

6	Indicative Content
Introduction to HCI (module introduction, assessment details, history of HCI and UX, careers in the field.) User Experience Design (explore difference between usability and UX, key criteria for what makes an effective UX.) UX Prototyping (sketching, paper prototyping, interactive wireframes, pros and cons of industry tools, design patterns). Evaluation Techniques (usability testing, cognitive walkthrough, heuristic evaluation, field/diary studies, quantitative vs. qualitative data, process in running a user study, equipment needed.) Aesthetics and Visual Design (techniques and principles for creating aesthetically appealing and	

effective designs – typography, grids, spacing, rules for beauty)

Responsive Design (designing and adapting experiences across multiple devices: screens, tangible computing)

The Future of HCI (innovative technologies that HCI researchers and industry are exploring)

7	Module Learning Outcomes	
	On successful completion of the module, students will be able to:	
	1	Interpret theoretical concepts of Human-Computer Interaction and their application in user experience design.
	2	Identify and develop an interactive user journey for digital products.
	3	Apply the user-centred design process to produce a digital prototype.
	4	Design, Deliver research studies and analyse user evaluations.

8	Module Assessment		
Learning Outcome			
	Coursework	Exam	In-Person
1, 2, 3, 4	X		

9	Breakdown Learning and Teaching Activities	
Learning Activities	Hours	
Scheduled Learning (SL) includes lectures, practical classes and workshops, peer group learning, Graduate+, as specified in timetable	48	
Directed Learning (DL) includes placements, work-based learning, external visits, on-line activity, Graduate+, peer learning, as directed on VLE	102	
Private Study (PS) includes preparation for exams	50	
Total Study Hours:	200	

Module Specification

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Module Summary Information

1	Module Title	Smart Systems
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5324

5	Module Overview
The Internet of Things (IoT) is a system of connected computing devices, electromechanical, digital machines, objects with the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. It is estimated that by 2020 there will approx. 50 billion IoT devices. This module will provide knowledge and skills for the research, synthesis and evaluation of solutions incorporating internet communication systems and devices that can be used to make informed and wise decisions. In this module you will build on the foundations of networking, maths, programming, and computer hardware modules you studied during level 4 to further investigate and apply relevant techniques. It will complement and support your other level 5 modules in particular the HCI, Project, networking, infrastructure and virtualisation content. The module consists of: • Subject specific lectures/laboratory sessions introducing you to the knowledge and skills relevant to smart systems domain including internet based sensors and internet of things platforms and protocols. • Practical laboratory sessions will provide you an opportunity to both apply the knowledge gained through pre/post learning activities for both lectures and tutorials, and also for you to investigate and develop the necessary skills to solve real-world problem-based scenarios around sensing and monitoring. • Project based group learning activities, supported by academic staff. Relationship to programme philosophy: This module provides an opportunity for the student to develop knowledge and skills, which will contribute to the acquisition of key BCU graduate attributes; creative problem solvers, global outlook, enterprising, professional and work ready. In the context of computing and data communication, this means an ability to respond to a critical brief to find practical solutions to problems; evaluate and respond to the opportunities and challenges of interdisciplinary approaches to the realisation of a task; respond flexibly and imaginatively to a set, or group-determined brief within a fixed timescale.	

- **Sensors** are devices that detect and respond to some type of input from the physical environment. These inputs are captured to understand the behaviour of the surrounding (i.e. this could be light, heat, motion, moisture, pressure). These sensors are always used with other electronics to provide the required functionality.
- **Smart Hardware Infrastructure** can be defined as the physical components that can be used in the entire smart systems life cycle. The most common being the electrical, electronic and mechanical components at the end-device, network devices and the backend devices (i.e. servers, data storage devices).
- **IoT Connectivity Technologies** are set of communications protocols that are responsible to transmit the collected data through sensors and electronics boards to remote or local servers for further processing. This can be carried out via different wireless communication protocols such as Smart Bluetooth, Zigbee and Zwave for short range or LPWAN technologies or Cellular- based technologies for long range . In addition, wired communications can be used to transmit data under certain system configurations.
- **Edge/Cloud Computing services** are all the existing solutions and resources that can be used to provide services to the end-users in an efficient and effective way. This service includes device registrations, session management and device firmware update.
- **Data Analytics algorithms** - are set of approaches and techniques that can be used to realize value and create insights and trends from the huge volumes of data generated by connected devices and sensors. This will support the decision making process for the business owners.
- **Data Visualisation and Reporting** are business intelligent tools that displays the current status of metrics and key performance indicators (KPIs) for an enterprise. Dashboards consolidate and arrange numbers, metrics and sometimes performance scorecards on a single screen used for reporting.
- **Security aspects** are various cyber security issues related to smart systems that need to be identified and treated .There are concerns about frauds exploiting security vulnerabilities in smart systems. This will provide the latest security solutions, approach and frameworks that needed to eliminate or mitigate the security risks.
- **Business models for smart systems** are group of business concepts that help the service or product owners to commercialise their commodities through innovative approaches. This will describe how the business is used by its customers and partners. This will provide example of business models for application domains such as industrial 4.0 , Smart Health and Smart cities.

7	Module Learning Outcomes	
	On successful completion of the module, students will be able to:	
	1	Demonstrate knowledge of the fundamental theoretical concepts underpins smart systems.
	2	Research and Compare various smart systems technologies for given industrial application.
	3	Apply appropriate approach and techniques to transform data into meaningful information.
	4	Develop and evaluate, an appropriate smart business solution to provide a required output.

8	Module Assessment		
Learning Outcome		Coursework	Exam
1 - 4		x	

9	Breakdown Learning and Teaching Activities	
Learning Activities		Hours
Scheduled Learning (SL) includes lectures, practical classes and workshops, peer group learning, Graduate+, as specified in timetable		48
Directed Learning (DL) includes placements, work-based learning, external visits, on-line activity, Graduate+, peer learning, as directed on VLE		102
Private Study (PS) includes preparation for exams		50
Total Study Hours:		200

Module Specification

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Module Summary Information

1	Module Title	Computer Forensics Tools and Techniques
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5328

5	Module Overview
This module develops comprehensive practical skills and theoretical knowledge for the forensic examination of personal computer systems using proprietary and open-source software tools. You will acquire the key skills necessary in conducting and auditing a systematic forensic investigation of a computer system for user activity, operating system operation and configuration and connectivity. The module is delivered through a truly flipped methodology placing significant emphasis on the development of practical skills supported by blended learning and a variety of learning activities including lectures, seminars, practice-led, self-directed and experiential learning; in person and online through Virtual Learning Environments (VLE). Each practical session comprises a series of hands-on analytical experiments to progressively unpack the more advanced aspects of the topic being investigated. All practical sessions will be hosted in the specialist Computer Forensics Laboratory. The post session activities for each week will comprise a short formative Moodle quiz which will provide instant feedback on the theoretical material covered. For each week's lab session, there will be an accompanying video taking you step-by-step through the solutions of the practical lab exercises. In addition to the lab-based analytical experiments, each lab session will also provide you a short set of experiments which are to be conducted on your virtual machine in your own time allowing you to explore the broader aspects of the topic being investigated during the scheduled lab session to help reinforce your learning. Where appropriate, additional surgeries may be held to provide additional guidance, support and feedback.	

6	Indicative Content
	Windows Disk Image Acquisition Software and hardware imaging Signature and hash analysis Common file structure and metadata analysis Keywords, searching and filtering cases Registry analysis Recovering deleted files Recycle bin analysis and file recovery Operating system artefacts Volatile data (memory), Pagefile, and unallocated space analysis Windows Event Logs Timeline analysis and events correlation Password attacks Disk encryption and decryption

7	Module Learning Outcomes
	On successful completion of the module, students will be able to:
1	Administer a comprehensive forensic examination of computer files, metadata, common operating system artefacts and processes on a computer system.
2	Compare and apply computer forensic examination tools based on the specific requirements of a given scenario in a forensically sound manner.
3	Assemble key findings to generate a forensic report for a computer forensic investigation.

8	Module Assessment		
Learning Outcome			
	Coursework	Exam	In-Person
1, 2, 3	X		

9 Breakdown Learning and Teaching Activities	
Learning Activities	Hours
Scheduled Learning (SL) includes lectures, practical classes and workshops, peer group learning, Graduate+, as specified in timetable	48
Directed Learning (DL) includes placements, work-based learning, external visits, on-line activity, Graduate+, peer learning, as directed on VLE	48
Private Study (PS) includes preparation for exams	104
Total Study Hours:	200

Module Specification

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Module Summary Information

1	Module Title	Cyber Security
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5329

5	Module Overview
Computer Scientists need to address the realities of the application of their field within an environment where cyber security threats present unique challenges to application and system developers, in relation to the requirement for secure design and operation. This module provides a foundation for security consideration as required in the design of software expected to perform within a networked and data sharing environment. This module has been designed to provide the necessary theoretical framework, foundations and practical support for effectively pursuing security solutions with reference to the requirement for secure application development. This is underpinned by providing an understanding of software-based access control mechanisms, systems and frameworks, symmetric and asymmetric cryptography, cryptographic hash functions, use of network firewalls, application gateways and virtual private networks, financial and reputation based security, relevant computer law and standards and their respective roles in realising security solutions. This module also covers attack methods including trojans, worms, viruses, cross site scripting (XSS) and request forwarding (CSRF), buffer overflow and SQL injection and side-channel software attacks. This module provides practical skills through the use and study of appropriate security programs, attack simulation and testing. This module will be delivered through lectures and security practical exercises and tutor led class discussion.	

6	Indicative Content
• Asymmetric and symmetric cryptography. • Hash functions. • PKI. • Financial security models. • Discretionary access control, mandatory access control. • Malware. • Firewalls. • VPNs. • Code injection attacks and defences. • Security-relevant legislation and best practice frameworks.	

7	Module Learning Outcomes	
	On successful completion of the module, students will be able to:	
	1	Explain the operation of discretionary and mandatory access control systems.
	2	Examine and evaluate the application of various applied information security mechanisms (e.g. symmetric and asymmetric cryptography and cryptographically secure hash functions, digital signatures, certificates and PKI).
	3	Evaluate network and platform technical security defence and attack methodologies.
	4	Apply compliance with cyber security related legislation, best practices, and financial security models.

8	Module Assessment		
Learning Outcome			
	Coursework	Exam	In-Person
1, 2	X		
3, 4		X	

9	Breakdown Learning and Teaching Activities	
Learning Activities		Hours
Scheduled Learning (SL) includes lectures, practical classes and workshops, peer group learning, Graduate+, as specified in timetable		48
Directed Learning (DL) includes work-based learning, completing practical preparation and tests, module recommended reading, as directed on VLE		80
Private Study (PS) includes preparation for exams		72
Total Study Hours:		200

Module Specification

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Module Summary Information

1	Module Title	Enterprise Network Systems
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5337

5	Module Overview
This module allows you to examine network technology, applications and protocols to enable you to gain a thorough understanding of the developments in this area. Routing and switching will be investigated theoretically and practically using a variety of different network operating systems and devices. The module content builds on the networking technologies introduced previously, and focuses on developing design and implementation skills relevant to achieving industry certification applicable to small and medium enterprise networks. Learning and Teaching Methods The learning and teaching methods are designed to encourage and support independent learning. Students are provided with a guided pathway through the learning resources, which are provided on the Virtual Learning Environment 'Moodle'. These resources include (but are not limited to): • Online curriculum • Video presentations • PowerPoint presentations • External professional published articles, journals, text books, RFCs. • Quizzes, with feedback • Simulator based practical exercises • Laboratory based networking devices • Remotely accessed network devices Wherever possible real life studies will be used to illustrate the learning. Face-to face delivery will predominately be in the form of practical workshops allowing the students to apply and explore the knowledge they have gained from prior reading. Students will receive a series of sessions over a period of weeks allowing them time to work towards the assessment requirements.	

6	Indicative Content
Students will investigate the following networking technologies: • Network design including IP address design • Network protocols both routing and switching for implementation within given network scenario's • Network management and fault finding	

7	Module Learning Outcomes
On successful completion of the module, students will be able to:	
1	Explain the theoretical aspects of redundant campus network design, and implement suitable protocols and technology to support small and medium enterprise networks.
2	Evaluate proprietary and standards-based routing protocols for performance and suitability in small and medium enterprise networks.
3	Evaluate evolving scalable campus network technologies.
4	Implement appropriate technology to monitor, maintain and support the operation of a scalable campus network.

8	Module Assessment		
Learning Outcome			
	Coursework	Exam	In-Person
1, 2, 3, 4	X		

9	Breakdown Learning and Teaching Activities
Learning Activities	Hours
Scheduled Learning (SL) includes lectures, practical classes and workshops, peer group learning, Graduate+, as specified in timetable	48
Directed Learning (DL) includes placements, work-based learning, external visits, on-line activity, Graduate+, peer learning, as directed on VLE	90
Private Study (PS) includes preparation for exams	62
Total Study Hours:	200

Module Specification

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Module Summary Information

1	Module Title	Computer Networks and IP Distribution 2
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5345

5	Module Overview
This module examines network technology, applications and protocols to enable the student to gain a thorough understanding of the technology in this area. Intermediate routing and switching protocols, and network redundancy theory and implementation will be covered in detail, whilst concepts relating to network virtualisation and cybersecurity will be examined. This curriculum provides foundation knowledge in IP networking that is essential for the success in subsequent networking modules and aligns with industry requirements.	

6	Indicative Content
The configuration of routers and switches Aspects of network management. Connecting to service providers and telecommunication services. New network technologies.	

7	Module Learning Outcomes
On successful completion of the module, students will be able to:	
	1 Evaluate appropriate routing, service and security solutions within a given small/medium network.
	2 Critically evaluate existing and evolving WAN technology suitable for a given small/medium network.
	3 Appraise and evaluate current network virtualisation and automation system and technology.
	4 Implement routing, service and security solutions within a given small/medium network.

8	Module Assessment
Learning Outcome	
	Coursework Exam In-Person
1-4	X

9	Breakdown Learning and Teaching Activities	
Learning Activities		Hours
Scheduled Learning (SL) includes lectures, practical classes and workshops, peer group learning, Graduate+, as specified in timetable		48
Directed Learning (DL) includes placements, work-based learning, external visits, on-line activity, Graduate+, peer learning, as directed on VLE		60
Private Study (PS) includes preparation for exams		92
Total Study Hours:		200

Module Specification

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Module Summary Information

1	Module Title	Database Technology
2	Module Credits	20
53	Module Level	5
4	Module Code	CMP5348

5	Module Overview
This module is designed to provide a comprehensive introduction to a vitally important core IT topic (database technology) that is found in almost every IT installation in the world and as such provides extremely valuable transferable skills. The module introduces the student to traditional database skills and knowledge (data models, normalisation, SQL etc.). Once mastered, these database skills will provide a firm foundation for higher-level academic study or a rewarding IT career.	

6	Indicative Content
- Database conceptual modelling including normalisation - Use SQL to create, populate, query, optimise and secure a database - Legal, privacy and security issues related to storing data	

7	Module Learning Outcomes
On successful completion of the module, students will be able to:	
	1 Analyse, document and model the data requirements of a given enterprise using an Entity-Relationship Model (ERM/EERM) into a format appropriate for a business owner.
	2 Implement an optimised and secure database using SQL.
	3 Modify, test and query a database.

8	Module Assessment		
Learning Outcome			
	Coursework	Exam	In-Person
1, 2, 3	X		

9 Breakdown Learning and Teaching Activities	
Learning Activities	Hours
Scheduled Learning (SL) includes lectures, practical classes and workshops, peer group learning, Graduate+, as specified in timetable	48
Directed Learning (DL) includes placements, work-based learning, external visits, on-line activity, Graduate+, peer learning, as directed on VLE	36
Private Study (PS) includes preparation for exams	116
Total Study Hours:	200

Module Specification

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Module Summary Information

1	Module Title	Data Visualisation
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5352

5	Module Overview
The aim of this module is to identify, apply and design data visualisations. The module provides you with the fundamental principles and practice-based activities needed to design data visualisations for different contexts and different types of data. More advanced visualisation concepts and tools for analysing multi-dimensional data and large data sets will also be examined and appraised. You will learn how to employ visualisation as a tool that can help users understand large and/or complex data sets. Finally, upon completing the module, you should be able to decide on the best visualisation for the data and research question at hand, and then implement in the best way possible.	

6	Indicative Content
This module applies a variety of data analysis methodologies to real situations and communicate the results using available visualisation tools. Gather relevant information from the data. Make informed decisions on the most suitable methods to analyse a specific dataset. Interpret results and communicate their findings using the appropriate visualisation technique. Also, it provides a hands-on introduction to ggplot2 visualisation tool and explains the graphics grammar on which ggplot2 is based.	

7	Module Learning Outcomes
On successful completion of the module, students will be able to:	
1	Effectively communicate the Key concepts in data visualisation, including approaches, software tools and application contexts.
2	Implement appropriate data visualisation techniques to solve data analytical problems.
3	Interpret and effectively communicate patterns and knowledge discovered as a result of applying data visualisation techniques to data sets and analytical problems.
4	Professionally report the evaluation of data visualization methods based on quantitative and qualitative metrics.

8	Module Assessment		
Learning Outcome			
	Coursework	Exam	In-Person
1-4	X		

9 Breakdown Learning and Teaching Activities	
Learning Activities	Hours
Scheduled Learning (SL) includes lectures, practical classes and workshops, peer group learning, Graduate+, as specified in timetable	48 Lecture/Tutorial Topics (not necessarily delivered in the sequence below and some topics might need more than one tutorial): 1. Introduction: Data visualisation 2. Grammar of graphics 3. Plot layers 4. Displaying distributions 5. Scales, axes and legends 6. Positioning 7. Plot themes 8. Manipulating data 9. Reducing duplications 10. Dashboards 11. Mashups 12. Creating maps and geolocation visualisations Lecture/Core Content Delivery: 12 hours Practical Topics (not necessarily delivered in the sequence below and some topics might need more than one lab session): 1. Developing visualisation solutions using ggplot2 2. Exploring other visualisation tools 3. Assessment support Laboratory/Practical Demonstration/Workshop: 24 hours
Directed Learning (DL) includes placements, work-based learning, external visits, on-line activity, Graduate+, peer learning, as directed on VLE	72 – Independent Study
Private Study (PS) includes preparation for exams	80
Total Study Hours:	200

Module Specification

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Module Summary Information

1	Module Title	Software Design
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5354

5	Module Overview
This module is about software engineering with a focus on software design. It covers three stages of the software engineering life-cycle, requirements, design and implementation, but with a focal point on design and an emphasis on the design theme. The module provides the necessary skills to: (i) construct models of requirements and designs, (ii) synthesise implementations from design models, (iii) and apply software design patterns. The standard UML is used as the modelling language, the vehicle through which important design concepts are explored to convey a software engineering ethos based on getting it right by adequately studying the problem and mindfully constructing designs of software solutions. The module will be delivered using both lectures and practical classes on a weekly basis. The module's provided educational resources will be made available on Moodle; additional resources will be available in the library for self-study. A significant learning component is the group coursework, which will involve constructing a requirements documents and a design of a software-based system following the steps and techniques instilled in the face-to-face teaching and learning activities of the module. The assessment will involve the group coursework, which will be partitioned into deliverables, each with its own report, and an individual assessment. All assessment components are summatively assessed with the final mark attesting the extent to which students have fulfilled the learning outcomes.	

6	Indicative Content
The module's indicative content is as follows: - Identify and explain concepts, notions and approaches related to software design and requirements engineering; - Construct requirements use-case models based on UML use case diagrams and accompanying use-case specifications; - Draw UML class diagrams to describe data (or domain) models - Draw system sequence diagrams to describe interactions of systems with environment - Write operation contracts, based on pre- and post-conditions, using natural language. - Construct UML-based models with behaviour expressed as statecharts. - Validate models using snapshots based on object diagrams. - Synthesise implementations from UML-based designs. - Explain the software engineering notion of design patterns and identify relevant design patterns.	

7	Module Learning Outcomes		
	On successful completion of the module, students will be able to:		
	1	Analyse, model and document the requirements of a system in an appropriate format to derive a clear understanding of the problem	
	2	Construct design models of software-based systems covering both their static and dynamic aspects, documenting in professional manner.	
	3	Synthesise software implementations from software designs.	
	4	Explain the software engineering notion of design patterns, and identify and apply relevant design patterns	

8	Module Assessment		
Learning Outcome			
	Coursework	Exam	In-Person
1-4	X		

9	Breakdown Learning and Teaching Activities	
Learning Activities		Hours
Scheduled Learning (SL) includes lectures, practical classes and workshops, peer group learning, Graduate+, as specified in timetable		48
Directed Learning (DL) includes placements, work-based learning, external visits, on-line activity, Graduate+, peer learning, as directed on VLE		75
Private Study (PS) includes preparation for exams		77
Total Study Hours:		200

Module Specification

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Module Summary Information

1	Module Title	Cyber Security Operations
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5357
5	Semester Taught	2

6	Module Overview
The module provides you with an opportunity to build on the learning and to develop knowledge of cyber security and how it relates to information and network security. This module will allow you to learn how to protect a network system from issues of cybercrime, based on security principles and the principles of how to defend networks from attack. You will cover the following cybersecurity area: • Network concepts • Network security and cloud services • Security Principles • Cryptography • Host based analysis • Types of attacks and vulnerabilities The module consists of: • Subject specific lectures/workshops to introduce knowledge and skills relevant to network and information security. • Lectures/workshops to introduce principles and techniques for secure communication within a network and ensuring security of data in transit. • Global view on information security and the changing requirements for information and data communication security. Relationship to course philosophy: This module provides an opportunity for the student to develop knowledge and skills, which will contribute to the acquisition of key BCU graduate attributes; creative problem solvers, global outlook, enterprising, professional and work ready. In the context of the information and data communication industries and at this academic level, this means an ability to: respond to a critical brief to find practical solutions to problems; evaluate and respond to the opportunities and challenges of interdisciplinary approaches to the realisation of a task; respond flexibly and imaginatively to a set, or group determined brief within a fixed timescale.	

7	Indicative Content
	• Security Principles • Network concepts • Social, legal and ethical considerations • Cryptography • Host based analysis • Types of attacks and vulnerabilities • Security monitoring • SOC's • Risk assessment, analysis and management • Threat modelling, threat analysis and Threat intelligence • Security evasion techniques • Security Information and Event Management • Incident handling and response

8	Module Learning Outcomes
	On successful completion of the module, students will be able to:
	1 Discuss fundamental security concepts.
	2 Discuss the requirements and security challenges raised by network applications.
	3 Explain the requirements for basic cryptography.
	4 Evaluate endpoint attacks, including interpreting log data to identify events on common operating systems.

9	Module Assessment		
	Coursework	Exam	In-Person
1- 4	Coursework (Report 50% In-class test 50%)		

10 Breakdown Learning and Teaching Activities		
Learning Activities	Hours	Details of Duration, Frequency and other comments
Scheduled Learning (SL) includes lectures, practical classes and workshops as specified in timetable	48	<i>2 hours lecture, 2 hours lab per week</i>
Directed Learning (DL) includes placements, work-based learning, peer group learning external visits, on-line activity, Graduate+, peer learning, as directed on VLE	112	
Private Study (PS) includes preparation for exams	40	
Total Study Hours:	200	

11 Key Texts and Online Learning Resources	
• Cisco Systems (n.d.), Cisco Online Material, https://netacad.com • Meeuwise, R (2017), <u>Cybersecurity for Beginners (2nd Edition)</u>, Cyber Simplicity, London • Stallings, W, (2018), <u>Effective Cybersecurity: A Guide to Using Best Practices and Standards</u>, Addison Wesley, Upper Saddle River. • Santos, O, Muniz, J and de Crescenzo, S (2017) CCNA Cyber Ops SECFND #210-250 Official Cert Guide, Cisco Press, Hoboken	

Module Specification

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Module Summary Information

1	Module Title	Computer Graphics
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5359

5	Module Overview
Computer graphics is a sub-field of computer science which studies methods for digitally synthesising and manipulating visual content. Although the term often refers to the study of three-dimensional computer graphics, it also encompasses two-dimensional graphics and image processing. Computer graphics is responsible for displaying art and image data effectively and meaningfully to a user. It is also used for processing image data received from the physical world. Computer graphics development has had a significant impact on many types of media and has revolutionised animation, movies, advertising, video games, and graphic design in general. The aim of this unit is to introduce students to a number of fundamental mathematical concepts that underpin computer graphics used in games development. Through this process the student will develop technical knowledge and skills in computer graphics and learn how to apply these through the programming interfaces for 3D graphics rendering that are commonly used in computer games. This module is an introduction to the techniques used in modern 3D computer graphics. It deals with fundamental techniques that are the basis of work in a range of industries, e.g. entertainment and computer-aided design. This course provides introduction to computer graphics algorithms, software and hardware. Both basic and advanced topics concerned with the production of images of abstract 3D objects are covered, including: the graphics pipeline, 3D representations, transformations and manipulations in graphics, light reflection models, colour theory, perception, shadows and texture mapping, ray tracing and variants.	

6	Indicative Content
Core Graphics Pipeline covering the stages of the real-time graphics pipeline, the graphics APIs that can be used to access it and the hardware that accelerates it. An historical perspective and future trends may also be identified. Rendering, lighting and shading. Concepts and application through the graphics pipeline. Practical shader writing. Graphics within game engines. Scene graphs, spatial partitioning and acceleration structures (quad trees, kd-trees etc), frustum culling, asset management within games. • Numbers, Algebra, Trigonometry; • Discrete Maths including Logic and Truth Tables, Set Theory, Boolean Algebra; • Coordinate Systems, Geometry including an introduction to Curves and Surfaces; • Vectors and Matrices; • Transformations and Quaternions;	

- Practical application of mathematics in computer graphics
 - Rendering methods (such as rasterising and ray tracing), lighting and shading, modelling, animation.

7	Module Learning Outcomes		
	On successful completion of the module, students will be able to:		
	1	Reproduce vector and matrix manipulation for use in computer graphics	
	2	Employ an understanding of the real-time 3D graphics pipeline.	
	3	Demonstrate the use of rendering and lighting in 3D graphics through Computer Graphics APIs for the generation of 3D graphics.	
	4	Analyse how graphics systems are integrated into games and game engines.	

8	Module Assessment		
Learning Outcome			
	Coursework	Exam	In-Person
1-4	X		

9	Breakdown Learning and Teaching Activities	
Learning Activities	Hours	
Scheduled Learning (SL) includes lectures, practical classes and workshops, peer group learning, Graduate+, as specified in timetable	48	
Directed Learning (DL) includes placements, work-based learning, external visits, on-line activity, Graduate+, peer learning, as directed on VLE	62	
Private Study (PS) includes preparation for exams	90	
Total Study Hours:	200	

Module Specification

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Module Summary Information

1	Module Title	Computer Mathematics and Declarative Programming
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5361
5	Semester Taught	2

6	Module Overview
This module embeds core mathematics concepts relevant to programmers, within the context of programming. We will use “well-founded” abstract reasoning techniques to design and produce computer programs within the declarative paradigm. Finally, these solutions will be tested and evaluated against their functional requirements using a number of testing and verification techniques. Rationale <u>Relevance to you</u> Discrete Mathematics is one of the core foundational topics that underpin the field of Computer Science by studying mathematical topics such as logic and set theory you are provided with the opportunity to further develop your skills in abstract reasoning. These ‘thinking’ skills are vital to a sound understanding of the mathematical/scientific principles underpinning the subject of Computer Science and are key to providing you with the kind of knowledge and skills that can result in major breakthroughs within the field. Continuous branches of Mathematics also hold increasing relevance to modern Computer Science, for example the prevalence and importance of continuous structures in Data Science and Machine Learning cannot be overstated. Declarative Programming is a so-called ‘programming paradigm’ it encompasses the sub-fields of Logic and Functional Programming; both sub-fields contain ideas that are vital to the development of a well-rounded Computer Scientist and are useful in developing a wider knowledgebase in the toolbox of professional programmers. By exposing you to different paradigms it should become clear that paradigms are far more important than individual programming languages in how they can help (or hinder) your approach to solving a problem. Alignment with course philosophy The module is intended to further progress you in your journey towards developing a sound theoretical and practical base in Computer Science and Software Development. Our Computer Science programme contains three core threads that are woven throughout: 1. Mathematical and Analytical skills 2. Programming skills 3. Contemporary developments in the computing Industry Whilst it is obvious how points 1 and 2 are relevant to this module (it is of course based on Mathematics and Programming), the topics covered in this module are also vital in developing your understanding of the principles behind many major recent (and of course historical) developments in the Computing industry. An example: Functional Programming techniques have been found to be extremely useful in large scale distributed data processing tasks within data science/analytics; for instance, Google’s own internal web indexing	

systems have seen the application of functional programming concepts to index a sizable subset of the web in a relatively small amount of time. In fact, the ‘Hadoop’ ecosystem now common in Data Science circles is based on Google’s MapReduce framework, a technology that combines distributed computing with functional programming techniques to allow for thread-safe computations over large-scale data-sets (VERY Big Data). Thus, Functional Programming techniques naturally lend themselves to producing concurrent, parallel and even distributed computation systems, which is seeing increasing importance in today’s world of multi-core machines and ‘Big data’ analytics.

Alignment with Learning and Teaching strategy

The learning and teaching approach taken for this module is based on a ‘flipped’ approach to learning, therefore you will be expected to engage in set learning tasks each week in addition to (prior to and after) the formal class contact time. In the interests of motivating your study of the topics covered within this module, we will embed the core mathematical and other theoretical concepts within your study using practical programming tasks and puzzles for you to complete. Your coursework is also directly aligned with the taught topics of each week meaning that there are direct links between the knowledge skills you should learn in the lab exercises and how to apply them to your coursework (in fact some weeks may provide hints/examples on how these topics may be applied to your coursework solutions).

7 Indicative Content

- Review of major programming paradigms
- Introducing Declarative Programming
- Software Development using Declarative Programming techniques
- Types
- Logic and Set theory
- Graph Theory (Graphs and Trees)
- Equational Reasoning
- Recursion
- Higher Order Programming
- Abstract Data Types
- Testing and Verification

8 Module Learning Outcomes

On successful completion of the module, students will be able to:

- | | |
|---|--|
| 1 | Design solutions using appropriate mathematical structures and programming techniques. |
| 2 | Implement programming solutions within the declarative paradigm. |
| 3 | Test and verify program code by applying appropriate methods. |
| 4 | Appraise and present a team-based software solution to stakeholders. |

9 Module Assessment			
Learning Outcome Number (from table 8)	Coursework	Exam	In-Person
1, 2, 3 and 4	Mini-project 60%		
1, 2, 3 and 4		Staged, small scale examinations of key concepts 40%	

10 Breakdown Learning and Teaching Activities		
Learning Activities	Hours	Details of Duration, Frequency and other comments
Scheduled Learning (SL) includes lectures, practical classes and workshops as specified in timetable	48	2 x 2 hour seminar per week
Directed Learning (DL) includes placements, work-based learning, peer group learning external visits, on-line activity, Graduate+, peer learning, as directed on VLE	36	Indicative activity details Review and note-taking of online Video lecture 1 x 1 hour per week Completion of “homework” content 1 x 2 hour per week
Private Study (PS) includes preparation for exams	116	
Total Study Hours:	20 credits = 200 notional learning hours	

11 Key Texts and Online Learning Resources
Online resources Microsoft’s official documentation https://docs.microsoft.com/en-us/ Books Via the ML / Miranda family (F#, OCaml, Standard ML, Haskell, etc) Syme, D., Granicz, A. and Cisternino, A., 2012. <i>Expert F# 3.0</i>. Berkeley: Apress.

Wlaschin, S., 2018. *Domain Modeling Made Functional: Tackle Software Complexity with Domain-Driven Design and F*. Pragmatic Bookshelf.

VanDrunen, T., 2013. *Discrete mathematics and functional programming*. Franklin, Beedle & Associates Incorporated.

Karim, M.R. and Alla, S., 2017. *Scala and Spark for Big Data Analytics: Explore the concepts of functional programming, data streaming, and machine learning*. Packt Publishing Ltd.

Via Python

Harrison, M., Lee, L. and Ramanujam, A., 2013. *Treading on Python*.

WIDMAN, J., 2022. *LEARNING FUNCTIONAL PROGRAMMING*. [S.I.]: O'REILLY MEDIA.

Lott., S., 2018. *Functional Python Programming: Discover the Power of Functional Programming, Generator Functions, Lazy Evaluation, the Built-in Itertools Library, and Monads*. 2nd ed. Packt Publishing.

Normand, E., Steele, G. and Kerr, J., 2021. *Grokking Simplicity*. Manning Publications.

Plachta, M., 2022. *Grokking Functional Programming*. 1st ed. Manning Publications.

Via C++

Cukic, I., 2019. *Functional Programming in C++*. 1st ed. Manning Publications.

Stroustrup, B., 2018. *A Tour of C++*. Addison-Wesley Professional.

Lospinoso, J., 2019. *C++ crash course: a fast-paced introduction*. No Starch Press.

Module Specification

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Module Summary Information

1	Module Title	Game Engine Architecture
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5363
5	Semester Taught	2

6	Module Overview
This module will build on the principles taught in the level 4 module 3D Game Programming. It will focus on 3D game engine functionality and how it manages and works with 3D objects, worlds, and spaces. The programme emphasises the important technical skills associated with making computer games, where this module enhances knowledge of game engine concepts and programming skills with a game engine in several different contexts such as high-specification and low-specification PCs and converting (porting) source code to other operating systems. Being programming-based, the module also enhances your transferrable skills in other computing and software engineering disciplines. Other skills acquired can be applied to other areas of the programme for example, when programming for games consoles and using low-level 3D graphics APIs. The module also enables you to develop your confidence in gaining important technical skills and to become an independent problem solver willing to take on new challenges and experiences. Our teaching approach is practical based, where you will get 'hands-on' experience of programming with a game engine. You will investigate how to utilise game engine features to enhance 3D graphics performance and/or aesthetics. Practical sessions will be augmented with mini-lectures and tutorials covering important concepts that underpin game engine programming practice. In addition, there will be opportunities to gain formative feedback on programmes developed in sessions and on the assessment.	

7	Indicative Content
• Game engine architecture. • Game engine subsystems including, rendering, collision, physics, character animation and game world object models • Scene management and scene object types. • Models and animation. • Materials and textures. • Input management and movement. • Cameras. • Collision detection and simple rigid body physics. • Procedurally generated scene objects. • 3D maths for games. • Managing build configurations. • Performance analysis and optimisation. • Porting source code. • Using shaders to implement advanced rendering techniques. • Special effects particle systems, lighting, shadows, fog, reflections, billboards. • 2D graphics, sprites, text/font and user interface (UI).	

8		Module Learning Outcomes
		On successful completion of the module, you will be able to:
	1	Develop a prototype 3D game level scene using a graphics/game engine to meet a number of criteria and establish baseline performance, e.g., RAM, CPU.
	2	Analyse and present baseline performance results from a prototype game scene.
	3	Develop a fully optimised 3D game level scene using a game engine and port it to different operating systems gathering performance data.
	4	Present a longitudinal evaluation of the performance of a fully optimised and ported 3D game scene.

9	Module Assessment		
Learning Outcome Number (from table 8)	Coursework	Exam	In-Person
1, 2, 3, 4			X

10			Breakdown Learning and Teaching Activities
Learning Activities	Hours	Details of Duration, Frequency and other comments	
Scheduled Learning (SL) includes lectures, practical classes and workshops as specified in timetable	48	2 x 2h per week x 12	
Directed Learning (DL) includes placements, work-based learning, peer group learning external visits, on-line activity, Graduate+, peer learning, as directed on VLE	92	Programming tasks to complete each week	
Private Study (PS) includes preparation for exams	60	Preparation time for milestones and presentations	
Total Study Hours:	200		

11	Key Texts and Online Learning Resources
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Purchase

None

Essential (Books/Journals/Specific chapters/Journal Articles)

Gregory, J. (2018). Game Engine Architecture, 3rd Edition (A K Peters/CRC Press). ISBN-10: 1138035459.

Hussain, F. (2018). Learn OpenGL: Beginner's guide to 3D rendering and game development with OpenGL and C++, 1st Edition (Packt Publishing). ISBN-10: 1789340365

Pouhela, F. (2022) Cross-Platform Game Engine Development: Learn how to build a cross-platform game engine using C++ and SDL2. Independent. ISBN-13: 979-8784772916

Recommended

Lengyel, E. (2016). Foundations of Game Engine Development, Volume 1: Mathematics, 1st Edition (Terathon Software LLC). ISBN-10: 0985811749

Lengyel, E. (2019). Foundations of Game Engine Development, Volume 2: Rendering, 1st Edition (Terathon Software LLC). ISBN-10 : 0985811757

Kosarevsky, S., Latypov, V. (2021). 3D Graphics Rendering Cookbook: A comprehensive guide to exploring rendering algorithms in modern OpenGL and Vulkan, 1st Edition (Packt Publishing). ISBN-10: 1838986197

Online

Lazy Foo' Productions SDL and OpenGL 2 tutorials,
https://lazyfoo.net/tutorials/SDL/50_SDL_and_opengl_2/index.php

Lazy Foo' Productions OpenGL tutorials, <https://lazyfoo.net/tutorials/OpenGL/index.php>

Module Specification

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Module Summary Information

1	Module Title	Applied Programming
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5368
5	Semester Taught	1

6	Module Overview
In this module you will gain the underpinning knowledge for developing software applications. The focus is on software development, including requirements gathering, software design, programming and testing. All of the topics covered in the module will form the basis of the design, implementation and evaluation of a functional software application. The module will be taught using a combination of tutorial and practical sessions. Independent learning will be supported by a range of materials and activities delivered using Moodle. This will be supported by: • Flipped learning methods used throughout the module, whereby the aim is to provide the theoretical material before the tutorial. • Details of each tutorial and case-based resources (such as videos, online tutorials and example case studies). • Recommended reading to broaden understanding of the theory and practice introduced in the module. • Moodle Forums for sharing resources and to facilitate group tasks. • Guidance on how to approach the assessment and opportunities to submit draft work for formative feedback. This module allows you to develop your technical skills in developing systems; this will include converting system requirements to specification and system design. In addition, you will build on skills and knowledge from first-year modules to build, test and deploy an application system to meet a given set of requirements. This module builds on the first-year modules Introduction to Programming and Computational Thinking and Professional Development. It also relates to the level 5 module Database Systems Development and the level 6 module Application Solutions Development.	

7	Indicative Content
• Application Architectures and Development Principles • Software Testing and Debugging Principles • Version control • Code/Peer reviews • Application deployment • Build tools • Database integration	

- Client-side and Server-side frameworks
- XML and JSON for application data
- Using and writing APIs
- Developing for desktop and mobile platforms
- Webservices /Microservices development and usage

8	Module Learning Outcomes On successful completion of the module, students will be able to:	
	1	Evaluate different methods implemented in software to meet business requirements.
	2	Design the software logic and algorithms to meet the given business requirements using appropriate tools and techniques.
	3	Develop a functional software solution for a given business problem
	4	Test, evaluate and reflect on the software solution.

9	Module Assessment		
Learning Outcome Number (from table 8)	Coursework	Exam	In-Person
1,2,3, and 4			100% demonstrations and viva

10	Breakdown Learning and Teaching Activities	
Learning Activities	Hours	Details of Duration, Frequency and other comments
Scheduled Learning (SL) includes lectures, practical classes and workshops as specified in timetable	48	1-seminar, 2 hours Lab and 1 Hour sprint workshop x 12.
Directed Learning (DL) includes placements, work-based learning, peer group learning external visits, on-line activity, Graduate+, peer learning, as directed on VLE	72	Online learning, peer learning, and as directed on VLE.
Private Study (PS) includes preparation for exams	80	Labs and coding tutorials
Total Study Hours:	200	

11	Key Texts and Online Learning Resources
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|---|
| <ul style="list-style-type: none">• Fowler, M. (2015) <i>Patterns of enterprise application architecture</i>. Boston, MA: Addison-Wesley.• Hudgens, J. (2017) <i>Skill Up: A Software Developer's Guide to Life and Career</i>. Birmingham, UK: Packt Publishing.• Hyde, R. (2020). <i>Write Great Code, Volume 3</i>. San Francisco, CA: No Starch Press• Romano, F., Hillar, G. and Ravindran, A. (2018) <i>Learn web development with Python</i>. Birmingham, UK: Packt Publishing.• Wieruch, R. (2022). <i>The Road to React</i>. Self-published. |
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Module Specification

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Module Summary Information

1	Module Title	Applied Cyber Forensics
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5372
5	Semester Taught	2

6	Module Overview
This module begins with an introduction to the core principles and processes of a typical computer forensic investigation. It aims to develop a firm grounding in the underpinning knowledge and skills required to analyse and evaluate the authenticity of data from a computer and related data storage devices in a forensically sound manner. The module will teach you the fundamental data structures applicable to computer forensics and how various software tools can be employed to analyse these structures in a variety of case types. You will acquire wide-ranging practical skills necessary in conducting and auditing a systematic forensic investigation of a computer system for user activity, operating system operation and configuration and connectivity. The module emphasises a “hands-on” approach to learning forensic computing techniques using open-source and commercial forensic tools. The module is delivered through a truly flipped methodology placing significant emphasis on the development of practical skills supported by blended learning and a variety of learning activities including lectures, seminars, practice-led, self-directed and experiential learning; in person and online through Virtual Learning Environments (VLE). Each practical session comprises a series of hands-on analytical experiments to progressively unpack the more advanced aspects of the topic being investigated. Where appropriate, additional surgeries may be held to provide additional guidance, support and feedback.	

7	Indicative Content
Introduction to the Computer Forensics Profession and Investigations. Formal Best-Practice Guidelines and Regulations Data Storage Devices and Data Acquisition/Imaging Principles File Signature Analysis and File Validation Common File Structure and Metadata Analysis Keywords, searching and filtering cases Registry analysis Recovering deleted files Recycle Bin Analysis and File Recovery Operating System Artefacts Data Hiding Techniques Volatile data (memory), Pagefile, and unallocated space analysis Timeline analysis and events correlation	

8	Module Learning Outcomes	
	On successful completion of the module, students will be able to:	
	1	Demonstrate the practical application of key principles that underlie a digital forensic investigation process as part of a cybersecurity incident response plan.
	2	Identify and assess the authenticity of digitally stored computer data using cyber forensic strategies.
	3	Administer a comprehensive forensic examination of computer files, metadata, common operating system artefacts and processes on a computer system.
	4	Formulate and present a clear and concise overview of a cyber forensic investigation supported by justified conclusions appropriate for a given audience.

9	Module Assessment		
Learning Outcome Number (from table 8)	Coursework	Exam	In-Person
1-3	In-class Test (75%)		
4			In-Person Presentation (25%)

10	Breakdown Learning and Teaching Activities		
Learning Activities	Hours	Details of Duration, Frequency and other comments	
Scheduled Learning (SL) includes lectures, practical classes and workshops as specified in timetable	48	2 x 12hr Practical Demonstration Sessions 2 x 12hr Practical Lab Sessions	
Directed Learning (DL) includes placements, work-based learning, peer group learning external visits, on-line activity, Graduate+, peer learning, as directed on VLE	48	4hrs/wk – - Review weekly Moodle-based session videos - Complete DL practical exercises using lab-based and open-source tools as directed Participate in industry workshops and seminars and when required.	
Private Study (PS) includes preparation for exams	104	Read directed material around the discipline as instructed by the tutor/module team; Prepare for practical digital forensic investigation test; Prepare for presentation of evidence for a cyber forensic investigation	
Total Study Hours:	200		

11	Key Texts and Online Learning Resources
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Key Texts

Johansen, G., 2020. *Digital forensics and incident response: Incident response techniques and procedures to respond to modern cyber threats*. Packt Publishing Ltd.

Oettinger, W., 2022. *Learn Computer Forensics: Your one-stop guide to searching, analyzing, acquiring, and securing digital evidence*. Packt Publishing Ltd.

Kävrestad, J., 2020. *Fundamentals of Digital Forensics*. Springer International Publishing.

Online Resources

Forensic Focus, for digital forensics and eDiscovery experts: <http://www.forensicfocus.com>

Digital Forensics Magazine: <http://www.digitalforensicsmagazine.com>

The International Journal of Digital Forensics & Incident Response:
<http://www.journals.elsevier.com/digital-investigation>

Module Specification

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Module Summary Information

1	Module Title	Consultancy and IT Management
2	Module Credits	20
3	Module Level	6
4	Module Code	CMP6172
5	Semester Taught	2

6	Module Overview
This module enables you to gain an understanding of the processes, scope and role when providing guidance or advice in a professional consulting capacity. It will also assist you if you join a larger organisation with the aspiration to become a leader and manager. The module provides awareness on the wider consulting profession and practice, the consulting role in computing and the management of client relationships. The focus will be to analyse and evaluate the frameworks, processes and techniques applied by computing consultants, managers and leaders. The module will instil you with the mind-set of a practitioner. Starting with the founding phases of contractual projects, you will work with life-like ambiguous scenarios, progressing from here to help resolve client problems and address business objectives. It helps individuals to further realise their specialisms and technical expertise they have acquired in Level 4 and 5 modules and their contribution to enhancing the client's business requirement. Practice-Based: In this module, you will collaborate with experts in the form of corporate partners who will provide guest lectures and live work briefs. The real-life scenarios will ensure that what you learn on this module is state-of-the-art with respect to professional practice. International: The nature of the module embeds culture and regional dimensions when practising management techniques and models, for example the topic of globalisation and encompasses international code of practices from the Institute of Consulting and Chartered Institute of Management allied with the professional bodies of the practitioners such as Institute of Engineering and Technology and Chartered Institute of Information Technology (British Computing Society). Relationship to programme philosophy: This module provides an opportunity for the student to develop knowledge and skills, which will contribute to the acquisition of key BCU graduate attributes, creative problem solvers, global outlook, enterprising, professional and work ready. In the context of computing and data communication, this means an ability to respond to a critical brief to find practical solutions to problems; evaluate and respond to the opportunities and challenges of interdisciplinary approaches to the realisation of a task; respond flexibly and imaginatively to a set, or group-determined brief within a fixed timescale.	

7	Indicative Content
• <i>Professional Practice and Ethics</i> • <i>Equality, inclusion and equity</i>	

- *The consultancy lifecycle*
- *Consultancy Frameworks*
- *IT Management*
- *Project management frameworks*
- *Proposal development*
- *Business analysis tools*
- *Risk assessment in projects and IT*
- *Project specification*
- *Sources of funding*
- *Digital Business Management Platforms*

8	Module Learning Outcomes		
	On successful completion of the module, students will be able to:		
	1	Critically evaluate applications of management frameworks, methods and techniques.	
	2	Apply phases of consultancy to propose a professional solution based on client needs.	
	3	Communicate concisely and professionally in a style appropriate to the intended audience.	
	4	Reflect on own professional development and plan for graduate employment	

9	Module Assessment		
Learning Outcome Number <i>(from table 8)</i>	Coursework	Exam	In-Person
1, 2,3	Consultancy Portfolio 100%		

10 Breakdown Learning and Teaching Activities		
Learning Activities	Hours	Details of Duration, Frequency and other comments
Scheduled Learning (SL) includes lectures, practical classes and workshops as specified in timetable	48	1 hr lecture 3 hour seminar/workshop
Directed Learning (DL) includes placements, work-based learning, peer group learning external visits, on-line activity, Graduate+, peer learning, as directed on VLE	72	Weekly activities provided on Moodle VLE, and in-class tasks.
Private Study (PS) includes preparation for exams	80	Library material links and resources which are provided per session/week on Moodle and through reading list; materials accessible through digital library and electronic resources.
Total Study Hours:	200	

11	Key Texts and Online Learning Resources
<i>Biggs, David. Management Consulting: a Guide for Students. Andover: South-Western Cengage Learning, 2010. Print.</i> <i>Burtonshaw-Gunn, Simon A. Essential Tools for Management Consulting Tools, Models and Approaches for Clients and Consultants. Chichester, West Sussex: John Wiley & Sons, 2010. Print.</i> <i>Hughes, Bob et al. Project Management for IT-Related Projects: 3rd Edition. Swindon: BCS Learning & Development Limited, 2019. Print.</i> <i>Markham, Calvert. "The Top Consultant Developing Your Skills for Greater Effectiveness." Kogan Page, 2004. Print.</i> <i>Paul, Debra et al. Business Analysis. Fourth edition / Debra Paul, James Cadle, Malcolm Eva, Craig Rollason, Jonathan Hunsley. London: BCS, 2020. Print.</i> <i>Witzel, Morgen. Management Consultancy. London ;: Routledge, 2016.</i>	

Module Specification

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Module Summary Information

1	Module Title	Ethical Hacking
2	Module Credits	20
3	Module Level	6
4	Module Code	CMP6176

5	Module Overview
The module provides you with an opportunity to learn and critically reflect on the skills of Ethical Hacking and information security within a global context. This module builds on the knowledge and underpinning theory from the networking modules and reviews the requirements for a secure network communication system. The module consists of: • Subject specific lectures/workshops to introduce knowledge and skills relevant to network and information security. • Lectures/workshops to introduce principles and techniques for secure communication within a network and ensuring security of data in transit. • Global view on information security and the changing requirements for information and data communication security. Relationship to programme philosophy: This module provides an opportunity for the student to develop knowledge and skills, which will contribute to the acquisition of key BCU graduate attributes; creative problem solvers, global outlook, enterprising, professional and work ready. In the context of the information and data communication industries and at this academic level, this means an ability to: respond to a critical brief to find practical solutions to problems; evaluate and respond to the opportunities and challenges of interdisciplinary approaches to the realisation of a task; respond flexibly and imaginatively to a set, or group-determined brief within a fixed timescale.	

6	Indicative Content
It is expected that this module will develop the following areas: • Ethical hacking methodology • Pre-attach reconnaissance • How to fingerprint and enumerate targets • How to perform network scanning and sniffing • How to perform system vulnerability assessments • How to create attack vectors • Web attacks such as XSS, directory traversals and SQL injection • How to plan and initiate cyber-attacks in order to prevent them • How to think like a criminal hacker in order to defeat them	

7	Module Learning Outcomes	
	On successful completion of the module, students will be able to:	
	1	Critically evaluate the requirements for penetration testing and ethical hacking.
	2	Design security assessment experiments to expose security vulnerabilities.
	3	Critically evaluate resulting data from security assessment experiments to recommend remedial actions.
	4	Critically appraise the role of security testing within the wider context of continuous security improvements to the information assurance processes within an organisation.

8	Module Assessment		
Learning Outcome			
	Coursework	Exam	In-Person
1-4	X		

9	Breakdown Learning and Teaching Activities	
Learning Activities		Hours
Scheduled Learning (SL) includes lectures, practical classes and workshops, peer group learning, Graduate+, as specified in timetable		48
Directed Learning (DL) includes placements, work-based learning, external visits, on-line activity, Graduate+, peer learning, as directed on VLE		90
Private Study (PS) includes preparation for exams		62
Total Study Hours:		200

Module Specification

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Module Summary Information

1	Module Title	Network Security
2	Module Credits	20
3	Module Level	6
4	Module Code	CMP6183

5	Module Overview
The module is an opportunity for you to learn and critically reflect on the skills of network and information security within a global context. This module builds on the knowledge and underpinning theory from the networking modules and reviews the requirements for a secure network communication system. The module consists of: • Subject specific lectures/workshops to introduce knowledge and skills relevant to network and information security. • Lectures/workshops to introduce principles and techniques for secure communication within a network and ensuring security of data in transit. • Global view on information security and the changing requirements for information and data communication security. Relationship to course philosophy: This module provides an opportunity for the student to develop knowledge and skills, which will contribute to the acquisition of key BCU graduate attributes; creative problem solvers, global outlook, enterprising, professional and work ready. In the context of the information and data communication industries and at this academic level, this means an ability to: respond to a critical brief to find practical solutions to problems; evaluate and respond to the opportunities and challenges of interdisciplinary approaches to the realisation of a task; respond flexibly and imaginatively to a set, or group-determined brief within a fixed timescale.	

6	Indicative Content
This module will review the following areas: • Network Security Threats • Network Security Design • AAA implementation • IPS and IDS • Firewalls • Cryptographic systems and Mathematics	

7	Module Learning Outcomes	
	On successful completion of the module, students will be able to:	
	1	Design security solutions for a given network scenario.
	2	Implement a secure network including remote access for a given network design.
	3	Critically evaluate LAN security considerations and implement endpoint and layer 2 security features.
	4	Critically evaluate a security policy in relation to the operational and business requirements of a commercial computer network.

8	Module Assessment		
Learning Outcome			
	Coursework	Exam	In-Person
1-4		X	

9	Breakdown Learning and Teaching Activities	
Learning Activities		Hours
Scheduled Learning (SL) includes lectures, practical classes and workshops, peer group learning, Graduate+, as specified in timetable		48
Directed Learning (DL) includes placements, work-based learning, external visits, on-line activity, Graduate+, peer learning, as directed on VLE		90
Private Study (PS) includes preparation for exams		62
Total Study Hours:		200

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Module Summary Information

1	Module Title	Mobile Device Forensics
2	Module Credits	20
3	Module Level	6
4	Module Code	CMP6186

5	Module Overview
Mobile devices present a number of challenges to the forensic examiner when extracting data from them. These include non-removable storage, the wide variation in devices and operating systems, built-in security features and encryption measures, and often the need to turn the device on. They present significant problems to the forensic examiner to ensure all the data is extracted correctly and in keeping with good computer forensic practices. This module will build on the principles taught in Computer Forensics Tools and Techniques. It will focus on extracting data from mobile devices using industry standard tools such as XRY. This module aligns with the programme's philosophy of developing wider appreciation of conducting a forensic analysis on a variety of devices. You will gain 'hands-on' experience of underlying principles of extracting data from mobile devices and apply them to a variety of mobile devices such as mobile phones and tablets. Alignment with Programme Philosophy and Aims The programme aims to emphasise the important technical and investigative skills associated with extracting and previewing data from devices and this module enhances knowledge of extracting data from mobile devices such as mobile phones and tablets. The module also enables you to develop your confidence while acquiring important technical skills and to become an independent problem solver willing to take on new challenges and experiences Learning and Teaching Strategy The main approach to learning is practically based where you will get 'hands-on' experience of handling and extracting data from mobile devices. Practical sessions will be augmented with mini-lectures and tutorials covering important concepts that underpin mobile device forensics practice. In addition, there will be opportunities to gain formative feedback on extractions carried out in sessions and on the assessment. Assessment Strategy This module is assessed by a technical report comprising questions on mobile device forensics, write-ups of contemporaneous notes and analysis of case study extractions. The report assesses your ability to articulate mobile device concepts, perform extractions on devices and analyse the results to draw conclusions based on a given scenario. Guest lecturers will be invited to contribute to this module where appropriate.	

6	Indicative Content
	• Cellular network structure and concepts • Sim cards • Mobile phone concepts • Logical extraction • Physical extraction • Android forensics • iPhone forensics • Dumb/feature phone forensics • Mobile phone file systems • App analysis • Other mobile device forensics, e.g. tablet PCs, vehicle forensics, drone forensics, etc.

7	Module Learning Outcomes
	On successful completion of the module, students will be able to:
	1 Appraise and explain key terms and concepts in mobile device technology.
	2 Apply appropriate logical and physical extraction techniques for mobile device data.
	3 Compose an Expert report detailing a critical reflection of extraction the process and results.

8	Module Assessment		
Learning Outcome			
	Coursework	Exam	In-Person
1, 2, 3	X		

9	Breakdown Learning and Teaching Activities
Learning Activities	Hours
Scheduled Learning (SL) includes lectures, practical classes and workshops, peer group learning, Graduate+, as specified in timetable	48
Directed Learning (DL) includes placements, work-based learning, external visits, on-line activity, Graduate+, peer learning, as directed on VLE	62
Private Study (PS) includes preparation for exams	90
Total Study Hours:	200

Module Specification

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Module Summary Information

1	Module Title	Modern Data Stores
2	Module Credits	20
3	Module Level	6
4	Module Code	CMP6207

5	Module Overview
This module will introduce NoSQL databases and distributed data storage frameworks through practice based activities. Through guided hands-on tutorials, you will become familiar with techniques using non-structured and semi-structured data examples. Also, you will gain knowledge on managing and processing data in a distributed infrastructure. This course will improve your development skills and provide experience with many different data systems This module will be delivered by means of lectures, tutorials and practical lab work aimed at developing the knowledge and skills required to appreciate the issues, opportunities and practical approaches. While the lectures will cover the theory and concepts, the labs will cover the practical aspects. You are expected to investigate the topics before sessions. This approach will enable you to gain an insight into how modern data stores are being used in organisations before you learn supporting theory and practical application through the use of software. You are expected to come to sessions prepared and having completed all the exercises and activities set. Finally, this module is very practical and you will be expected to complete all set practical exercises in the order which they are presented. This approach will enable you to build your knowledge, skills and practice the embedded transferable employability skills.	

6	Indicative Content
This module covers two topics; NoSQL databases and distributed data storage. The first part introduces non-relational data storage options and covers the creation, storage, access, and management of data in different storage options. NoSQL databases are generally built to be distributed and partitioned across many servers. They're built to scale out for high availability and to be flexible enough to handle semi-structured and unstructured data. Hence, the second part of the module will cover distributed file systems, frameworks for distributed processing of large data sets across clusters of computers using simple programming models like map/reduce, and big data storage solutions.	

7	Module Learning Outcomes	
	On successful completion of the module, students will be able to:	
	1	Appraise and effectively communicate the different principal types, theories and technologies associated with NoSQL databases.
	2	Critically compare, analyse and evaluate traditional Relational databases and NoSQL databases.
	3	Design, implement and professionally report a NoSQL application for a real enterprise or a complex case study together with sound justification for the approach adopted.
	4	Demonstrate sufficient knowledge and skills on installing, configuring and managing distributed data management frameworks.

8	Module Assessment		
Learning Outcome			
	Coursework	Exam	In-Person
1, 2, 4	X		
3			X

9	Breakdown Learning and Teaching Activities	
Learning Activities	Hours	
Scheduled Learning (SL) includes lectures, practical classes and workshops, peer group learning, Graduate+, as specified in timetable	Lecture/Tutorial Topics (not necessarily delivered in the sequence below and some topics might need more than one tutorial): 1. Introduction: NoSQL databases 2. Graph databases 3. XML databases 4. Key-value stores and document databases 5. Key-value stores and document databases 6. Column stores 7. Object databases 8. Extensible record stores 9. Distributed database systems 10. Data fragmentation 11. Replication and synchronisation 12. Consistency Lecture/Core Content Delivery: 12 hours Practical Topics (not necessarily delivered in the sequence below and some topics might need more than one lab session): 1. Basics of JavaScript and JSON 2. Introduction to MongoDB 3. Creating, Updating and Deleting Documents in MongoDB 4. Querying in MongoDB 5. Indexing in MongoDB 6. Aggregation in MongoDB 7. Replication and Sharing in MongoDB 8. Installing and Configuring Apache Hadoop 9. Running MapReduce in Hadoop	

	Laboratory/Practical Demonstration/Workshop: 24 hours Total: 48 hours
Directed Learning (DL) includes placements, work-based learning, external visits, on-line activity, Graduate+, peer learning, as directed on VLE	Independent Study : 72 hours
Private Study (PS) includes preparation for exams	80 hours
Total Study Hours:	200 hours

Module Specification

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Module Summary Information

1	Module Title	Cloud Computing
2	Module Credits	20
3	Module Level	6
4	Module Code	CMP6210

5	Module Overview
One of the major objective of the computer science program is to introduce the theory, principles and technologies underlying the construction of modern computing systems. This module introduces, Cloud Computing which is the technology that enables on-demand computing resources (everything from applications to data centres) over the internet. This technology has revolutionized modern computing by allowing users to access infinite pool of computing services and resources on a pay-per-use basis. This module introduces the fundamental concepts and technologies related to cloud computing architecture, platforms and services. The module follows a practical approach to equip the students with hands-on experience of cloud computing by using a public Cloud service such as Amazon Web Services. This module will also aim at preparing students to obtain a professional certification such as AWS Certified Cloud Architect. In some cases where a partnership with a public cloud provider (such as Amazon), students will receive a voucher to access online content and take a certification exam at significant discount.	

6	Indicative Content
On the Cloud: Computing, networking, storage, databases Automation, Load Balancing, Scaling Security, Monitoring	

7	Module Learning Outcomes
On successful completion of the module, students will be able to:	
1	Identify current technologies, features and trends of Cloud Computing.
2	Analyse application development in cloud computing with respect to the end-to-end software design lifecycle and the impact of commercial and organisational elements (such as cost and availability).
3	Apply problem solving skills to design and deploy a professionally representative application using a leading cloud platform (such as AWS or Azure) using a range of offered services.
4	Demonstrate the ability to document and present and compare with alternatives, a team-produced cloud based software solution.

8	Module Assessment		
Learning Outcome			
	Coursework	Exam	In-Person
1, 2, 3	X		
4			X

9	Breakdown Learning and Teaching Activities	
Learning Activities	Hours	
Scheduled Learning (SL) includes lectures, practical classes and workshops, peer group learning, Graduate+, as specified in timetable	48	
Directed Learning (DL) includes placements, work-based learning, external visits, on-line activity, Graduate+, peer learning, as directed on VLE	72	
Private Study (PS) includes preparation for exams	80	
Total Study Hours:	200	

Module Specification

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Module Summary Information

1	Module Title	Mobile and Wearable Application Development
2	Module Credits	20
3	Module Level	6
4	Module Code	CMP6213

5	Module Overview
Mobile technologies, particularly in the form of smart phones, are now the de-facto mode for us to communicate and navigate information. Building on this success, wearables have the potential to make computer technology ubiquitous. Although encompassing many forms, probably the most prevalent example of wearables is seen in the emergence of powerful 'smart watches'. This module explores the direction mobile and wearable technologies are taking and aims to equip students with the essential design and programming skills to develop their own robust, usable and ubiquitous applications for at least one of the most popular mobile and smart watch platforms (such as Google's Android / Wear and Apple's iOS / watchOS).	

6	Indicative Content
• Ubiquity in computing – use cases • Wearable technologies – state of the union • Software architectures and design patterns • (Students present their idea for an app) • User Interface issues and guidelines • Application development platforms and toolsets for mobile and wearable devices – review • Implementing basic applications on a smart watch platform (e.g. iOS / Apple Watch) • (Progress check on prototyping of app) • Testing and optimising smart watch applications • Review and evaluation of design and implementation	

7	Module Learning Outcomes
On successful completion of the module, students will be able to:	
1	Identify opportunities and challenges for mobile and wearable applications.
2	Architect a mobile/wearable application.
3	Select an appropriate set of technologies to use on an application development project.
4	Develop software for deployment on mobile and wearable devices.

8	Module Assessment		
Learning Outcome			
	Coursework	Exam	In-Person
1, 2			X
3, 4	X		

9	Breakdown Learning and Teaching Activities	
Learning Activities	Hours	
Scheduled Learning (SL) includes lectures, practical classes and workshops, peer group learning, Graduate+, as specified in timetable	60	
Directed Learning (DL) includes placements, work-based learning, external visits, on-line activity, Graduate+, peer learning, as directed on VLE	60	
Private Study (PS) includes preparation for exams	80	
Total Study Hours:	200	

Module Specification

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Module Summary Information

1	Module Title	Deep Neural Networks
2	Module Credits	20
3	Module Level	6
4	Module Code	CMP6228
5	Semester Taught	2

6	Module Overview
Deep learning (also called deep neural network) is a sub-field of Artificial Intelligence (AI), aiming at extracting knowledge automatically from large datasets in a hierarchical way. Deep learning, which is considered as the state-of-the-art in data science and AI, is inspired by the structure of human brain. Now well established and accepted in industry, deep learning provides both predictive and descriptive analytics solutions that can be applied to a wide range of applications from business to scientific and governmental applications. In this module, you will be taught the internal mechanisms of developing deep learning methods. Also, you will be taught how to use modern deep learning tools to build and numerically validate models and cope with different types of data (e.g. structured and unstructured). You also will be able to analyse a problem domain and apply suitable deep learning techniques. Learning and Teaching This module will introduce both the mathematical theory behind deep learning techniques and their application through practice-based tasks associated with real world problem scenarios. Theory will rely on mathematical background such as Linear Algebra and Calculus while you will gain knowledge of the application of deep learning techniques by exploring 'real world' issues via a range of deep learning software tools and packages. This module is very practical, and you will be expected to complete all set exercises in the order that they are presented. This approach will enable you to build your knowledge, skills and practice the embedded transferable employability skills.	

7	Indicative Content
- Fully connected Artificial Neural Networks - Convolutional Neural Networks - Recurrent Neural Networks - Autoencoders - Ensemble Learning	

8 Module Learning Outcomes		
On successful completion of the module, students will be able to:		
	1	Evaluate different deep learning techniques for suitability to a given knowledge discovery problem.
	2	Validate deep learning methods using modern deep learning tools.
	3	Professionally report deep learning results providing clear solutions to the identified knowledge discovery problems.
	4	Critically appraise recent trends in deep learning literature and industry relevant to your work.

9 Module Assessment			
Learning Outcome Number	Coursework 1	Coursework 2	In-Person
1	20%		
2		40%	
3		20%	
4		20%	

10 Breakdown Learning and Teaching Activities		
Learning Activities	Hours	Details of Duration, Frequency and other comments
Scheduled Learning (SL) includes lectures, practical classes and workshops as specified in timetable	48	1hr lecture x12 and 3hr workshop x12.
Directed Learning (DL) includes placements, work-based learning, peer group learning external visits, on-line activity, Graduate+, peer learning, as directed on VLE	62	Homework assignment per session and reading research articles.
Private Study (PS) includes preparation for exams	90	Assessments preparation, reading assigned tutorials, and implement and develop ideas.
Total Study Hours:	200	

11	Key Texts and Online Learning Resources
• Charniak, Eugene. Introduction to deep learning. The MIT Press, 2019. • Deep Learning Book (MIT): http://www.deeplearningbook.org • Learning from data: https://www.edx.org/course/learning-data-introductory-machine-caltechx-cs1156x-0 • Zaki, Mohammed J., and Wagner Meira Jr. Data Mining and Machine Learning: Fundamental Concepts and Algorithms. Cambridge University Press, 2019. • Bhatia, Parteek. Data Mining and Data Warehousing: Principles and Practical Techniques. Cambridge University Press, 2019. • www.fast.ai	

Module Specification

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Module Summary Information

1	Module Title	Console Game Development
2	Module Credits	20
3	Module Level	6
4	Module Code	CMP6229
5	Semester Taught	2

6	Module Overview
The games console industry is a very lucrative market appealing to consumers of all ages and backgrounds. Game consoles are still one of most important ways of publishing AAA game titles. In recent years, AAA game studios no longer exclusively use commercial game engines, with many vendors keen that students get the opportunity to work with them too. This module will provide you with the opportunity to explore how to develop games for consoles working with industry standard technology. This will give you further opportunities to add industry-relevant skills to your portfolio, increasing opportunities for employment in the games industry. Our teaching approach is practical-based learning, and you will get hand-on experience of programming with a game engine used in developing games for consoles. Practical sessions will consist of tutorials covering important issues associated with console game development. In addition, you will be provided with formative feedback on the programme you write during sessions, as well as the assessment.	

7	Indicative Content
• Using toolchains on different game console platforms. • Multi-threaded programming for game consoles. • Console game development using game engine. • Performance analysis and optimisation. • Asset workflow. • Handling input from different types of game pad/controller. • Managing game processing load on CPU/GPU. • CPU/GPU memory management. • Backend systems such as party/matchmaking systems. • Managing source code for different game console platforms. • Managing source code build configurations. • Debugging and interpreting core dumps. • Advanced GPU techniques. • Deploying to game console and requirement checks.	

8	Module Learning Outcomes
On successful completion of the module, you will be able to:	
1	Design and develop a prototype game based on a specific game theme and mechanics to run on a game console.

	2	Present preliminary results from the prototype game scene and propose a development plan for fully featured game.
	3	Implement a fully featured and optimised game deployed to a game console.
	4	Present a critical analysis of developing a game for a game console.

9 Module Assessment			
Learning Outcome Number <i>(from table 8)</i>	Coursework	Exam	In-Person
1, 2, 3, 4			X

10 Breakdown Learning and Teaching Activities		
Learning Activities	Hours	Details of Duration, Frequency and other comments
Scheduled Learning (SL) includes lectures, practical classes and workshops as specified in timetable	48	4hr x 12 lab sessions
Directed Learning (DL) includes placements, work-based learning, peer group learning external visits, on-line activity, Graduate+, peer learning, as directed on VLE	62	Console development on-line activity
Private Study (PS) includes preparation for exams	90	Preparation for game pitch/presentation/demonstrations
Total Study Hours:	200	

11 Key Texts and Online Learning Resources
Essential resources The majority of resources for the module, including documentation, will be derived from game console vendors. Recommended Gregory, J. (2018). Game Engine Architecture, 3rd Edition (A K Peters/CRC Press). ISBN-10: 1138035459.

Module Specification

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Module Summary Information

1	Module Title	Application Solutions Development
2	Module Credits	20
3	Module Level	6
4	Module Code	CMP6235
5	Semester Taught	2

6	Module Overview
The rapidly changing nature of business operations and working conditions means that the ability to respond digitally to business needs is vitally important. Every company must deal with necessary, but repetitive business processes that consume time and energy. Automation is a critical factor for successful businesses, but both the time and monetary cost to develop automated solutions can often be too great. Low code/no-code development platforms help developers and businesses move faster when creating custom business applications. As such, it is estimated that, of the number of new enterprise applications developed by 2025, 70% will be developed via 'low code' or 'no code' technologies (Garner, 2021). This module explores methods for automating business processes via low code/no-code solutions, reducing costs and minimising errors. A case study approach to learning and teaching will be utilised throughout the module. You will work individually and in groups to identify business requirements and work within the application development lifecycle to develop and evaluate a solution. Once the module is complete, you will have an opportunity to gain a certification to enhance your graduate profile and increase your employability prospects.	

7	Indicative Content
• Business Process Solutions • Application Lifecycle Management • Requirements analysis and documentation • Role of Power Apps & Power Automate and low code solutions • Evaluation of potential software platforms • Form Customisation • Automating Processes • Connectors • Model Driven Apps • Power Virtual Agents • Common Data Services	

8	Module Learning Outcomes
On successful completion of the module, students will be able to:	
1	Critically evaluate business requirements using appropriate tools and techniques.
2	Design a solution to automate and optimise business processes.
3	Develop an automated business process solution.
4	Critically reflect on the ethics and Target Operating Model issues of the solution developed.

9 Module Assessment			
Learning Outcome Number (from table 8)	Coursework	Exam	In-Person
1, 2, and 4	50% includes a report, practical activities, and quiz.		
3			50% viva

10 Breakdown Learning and Teaching Activities		
Learning Activities	Hours	Details of Duration, Frequency, and other comments
Scheduled Learning (SL) includes lectures, practical classes and workshops as specified in timetable	48	Workshop, labs, and hands-on activities (6 hours x 8 weeks: quizzes, formative feedback, and plenary sessions.
Directed Learning (DL) includes placements, work-based learning, peer group learning external visits, online activity, Graduate+, peer learning, as directed on VLE	112	Peer learning (labs and exercises shared on Moodle). Review practical 'how-to guides' and relevant articles that provide examples and practice.
Private Study (PS) includes preparation for exams	40	General reading to broaden understanding of the theory and practice introduced in the module.
Total Study Hours:	200	

11 Key Texts and Online Learning Resources	
- Mendoza, E (2021) Microsoft Power Apps Cookbook: Become a pro Power Apps maker by applying practical use cases to solve ever-evolving business challenges, Packt Publishing. - Microsoft (n.d.) Microsoft Learn. Available at: https://docs.microsoft.com/en-us/learn/ [last accessed: 05/06/2022]. - Nair, S (2021) Digital Transformation with Dataverse for Teams: Become a citizen developer and lead the digital transformation wave with Microsoft Teams and Power Platform, Packt Publishing. - Yack, J and Yack D (2021) Microsoft Dataverse: The Power Platform Series: Leveraging Microsoft Dataverse to build real world business solutions, We Speak, You Learn, LLC.	