College of Computing

Academic Year 2023/24 - Semester 1

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
CMP4264	2D Game Programming	4	20	10
CMP4266	Computer Programming	4	20	10
CMP4267	Computer Systems	4	20	10
CMP4268	Mathematics for Computing	4	20	10
CMP4271	Professional Practice for Game Development	4	20	10
CMP4288	Business Information Systems	4	20	10
CMP4295	Computational Thinking and Professional Development	4	20	10
CMP4296	Introduction to Programming	4	20	10
CMP5320	Networking Technologies	5	20	10
CMP5321	Programming for Network Engineers	5	20	10
CMP5326	Advanced Programming for Digital Forensics	5	20	10
CMP5327	C++ Programming for Games	5	20	10
CMP5332	Object Oriented Programming	5	20	10
CMP5336	The English Legal System and IT Law	5	20	10
CMP5340	Enterprise Systems	5	20	10
CMP5346	Computer Networks and IP Distribution 1	5	20	10
CMP5347	Computer Programming for Engineers	5	20	10
CMP5350	Server Systems	5	20	10
CMP5353	Introduction to Data Science	5	20	10
CMP5358	Software Security	5	20	10
CMP5360	Web Game Development	5	20	10
CMP5362	Game Studio Production	5	20	10
CMP5364	Database Systems Development	5	20	10
CMP5370	Business Process Re-engineering	5	20	10
CMP5371	Operating Systems and DevOps	5	20	10
CMP6173	Business Systems Solutions	6	20	10
CMP6178	Wireless Networking Technologies	6	20	10
CMP6184	Incident Response and Investigation Practice	6	20	10
CMP6187	Mobile Game Development	6	20	10
CMP6189	Network and Internet Forensics	6	20	10
CMP6194	Strategic Information Systems Alignment	6	20	10
CMP6202	Artificial Intelligence and Machine Learning	6	20	10
CMP6206	Artificial Intelligence for Games	6	20	10
CMP6214	User Experience Design	6	20	10
CMP6220	Advanced Firewall Systems	6	20	10
CMP6221	Computing for AI	6	20	10
CMP6230	Data Management and Machine Learning Operations	6	20	10
CMP6234	Business Intelligence	6	20	10
CMP6237	DevOps and Enterprise Automation	6	20	10
CMP6238	Applied AI for Cyber Security	6	20	10

Module Specification

Module Summary Information

1	Module Title	2D Game Programming
2	Module Credits	20
3	Module Level	4
4	Module Code	CMP4264
5	Semester Taught	1

6	Module Overview

This module will introduce you to the basic principles behind programming, for example, language syntax, structure of a computer programme, development of algorithms and use of object-oriented programming. You will use an appropriate professional game engine to develop your skills in 2D game development. Through this engine, you will learn to use and manipulate a range of media assets, examples include working with sprites, animations, programming computer graphics, incorporating simple physics including collision detection strategies, as well as implementing 2D scenes. The learning and teaching strategy is centred on tutorial sessions where tutors provide advice, guidance and formative evaluation in order to develop your understanding of these core skills.

7	Indicative Content

- Introduction to Interactive Development Environments.
- Programming 2D game engines.
- Programming concepts including data structures and algorithms.
- Fundamentals of Object-Oriented Programming for games.
- Working with 2D assets (graphics, animations and audio).
- Graphical User Interfaces.
- Collision detection.

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

9	Module Assessment

Learning Outcome Number *(from table 8)*	Coursework	Exam	In-Person
1- 2			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	Total weekly length of workshop: 4 hours (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	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	

11	Key Texts and Online Learning Resources

Recommended

Bancila M., Rialdi R., Sharma, A. & Esposito, D. (2020) Learn C# Programming : A Guide to Building a Solid Foundation in C# Language for Writing Efficient Programs. ISBN-10 : 1789805864

Bond J.G. (2022). Introduction to Game Design, Prototyping, and Development: From Concept to Playable Game with Unity and C#. ISBN-10: 0136619940

Calabrese D. (2018). Unity 2D Game Development. Packt Publishing. ISBN-10: 1484237714

Tykoski S. (2022). Mastering Game Design with Unity 2021: Immersive Workflows, Visual Scripting, Physics Engine, GameObjects, Player Progression, Publishing, and a Lot More. ISBN-10: 9355512163

Module Specification

Module Summary Information

1	**Module Title**	Computer Programming
2	**Module Credits**	20
3	**Module Level**	4
4	**Module Code**	CMP4266

5	**Module Overview**

Within the module of Computer Programming you will learn the key skills of Programming and how this relates to technology and communications. Programming is an engineering tool that plays a vital role to drive most of the modern technologies surrounding us, including the technological devices for communication, transportation and entertainment. In other words, it can be said that our modern lifestyles are heavily dependent on programming. Moreover, businesses increasingly rely on computers and the software run on them. Programming skills and a broader and deeper understanding of programming are therefore becoming increasingly important to the jobs market.

This introductory computer programming module provides the underpinning knowledge and practice for computing students to design, build and test software components. The module will make use of practical sessions primarily to allow you to apply programming principles and constructs in order to creatively solve problems by means of developing small programs.
Module content and assessment enables learners to acquire programming skills in a modern imperative language.

6	**Indicative Content**

Topics that will be covered include:

- Input/Output
- Built-in Data Structures
- Iterations
- Functions and Parameters
- Objects and Classes
- Documentation
- Unit Testing
- Graphical User Interfaces
- Events and event handling

7	Module Learning Outcomes
	On successful completion of the module, students will be able to:
1	Apply problem solving skills in order to design solutions to programming problems.
2	Implement those solutions in an imperative programming language by using common programming tools (such as editors and interpreters).
3	Use common programming tools and techniques (e.g. IDE, testing APIs and theories) to test, evaluate programs and document findings effectively in appropriate format.

8	Module Assessment		
Learning Outcome			
	Coursework	**Exam**	**In-Person**
1-3	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	90	
Private Study (PS) includes preparation for exams	62	
Total Study Hours:	200	

Module Specification

Module Summary Information

1	Module Title	Computer Systems
2	Module Credits	20
3	Module Level	4
4	Module Code	CMP4267
5	Semester Taught	1

6	Module Overview

Computer Systems is a core component of IOT and as such helps us with mundane but important tasks such as, monitoring our safety and security via smart sensing devices. The module presents a holistic view of how computer systems work, it also provides the underpinning knowledge required for the:

- Design of computer architecture
- Implementations of security principles
- How software interacts with hardware
- Application of electronic principles
- Use of number systems in computing

Learning and Teaching
Within the Computer Systems Module, students gain knowledge and experience of computing in general and are given the chance to experiment with both hardware and software implementations of basic IOT concepts. Computer Systems is delivered weekly by means of lectures and practical sessions. Additional module resources, such as reading material and practical exercises are made available via Moodle and MS Teams. While the lecture sessions are delivered on-line practical contents, in the form of hardware builds, are delivered in-person with actual hardware or by mean of software simulation via a web-browser. The module puts into practice learning done through reading, video lecturers, skills building labs and problem based learning for the acquisition of new knowledge and core practical competencies. Coursework, in the form of a peer review article based on the design and implementation of an IOT device, encourages students to understand/acquire knowledge about new trends and latest developments in preparation for continued academic study.

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 computing 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.

Sustainability
To build awareness of the problem faced by today's society, during lecture and practical sessions students are introduced to examples/case-studies of remote sensing and sampling of the environment. In the current climate, where environmental change is driving government policy, students are encouraged to consider the UN's Sustainable Development Goals (SDG) and how the ability to sense our surrounding environment using IOT devices contribute to Goals 1, 2, 3, 6, 7, 8, 9, 11 and 12 of SDG in the future.

Inclusivity
The following techniques and concepts are employed by the Computer Systems teaching team throughout delivery of the module:

- A diverse assortment of resources introduced by academic staff from a range of backgrounds, for example lecture content based on logic principles and the latest IOT devices as well as digital security considerations. Multiple theoretical concepts and practical problem solving tasks are delivered during lab sessions from the field of computer architecture and IOT in general
- Collaborative learning is encourage to create opportunities for the students to get to know their peers thus reducing assumptions about background, ability, point of view or pre-existing knowledge of a subject.

Accessibility

For students with diverse array of accessibility requirements, module material meet the following criteria:

- Core content is delivered during on-line lecture sessions which are recorded and made available online via Moodle for future use
- Official university accessibility guidelines are followed during the production of module material word and [PDF](PDF) documents
- Adjustment of curriculum content and assessments are guided by the University's ["Student Disability and Mental Health"](#) policy. Regularly engagement with associated module, course and support teams during periods when new content is being introduced and validated helps ensure an appropriate approach to curriculum design.

7	Indicative Content

Computer Hardware
>Computer hardware can be defined as the physical components of a computer. The most common being the electrical and mechanical components which give a computer system its functionality, speed, accuracy and reliability.

Number Systems
>Number systems are how computers view and interpret the world around us. Four common systems employed in computing include Decimal, Binary, Hexadecimal and Octal.

Computer Logic
>Boolean logic is a numbering system with only two possible values TRUE and FALSE. At the hardware level everything is represented by binary numbers even the text you are currently reading.

Operating Systems
>A computers Operating System (OS) is the program which controls all other programs. The OS also manages hardware and enables users to interact with the computer via a user interface.

Computer Architecture
>The capabilities and programming model of a computer represents a good definition of architecture as it is generic and can be used to describe a variety of machine types.

Digital Electronics
>Electronic devices are increasingly dominating our lives. Being able to identify individual components enhances knowledge allowing a user to understand how systems work and communicate.

Programming Languages
>Programs can be written in many languages using a variety of styles. Knowing how they differ allows the user to choose the most appropriate for a particular purpose making the program more effective.

Cloud Computing
>Buzzwords like 5G are increasingly appearing in social media. Often it is not clear what

they actually mean to end consumers. 'The Cloud' is one such term and is associated with a range of technologies.

Managing Open Source Systems

Open-source software (OSS) is a type of software whose source code is released under a special license. The license allows the holder to study, change and distribute the software for any purpose.

Principles of Security

Processes and perceptions of security in the digital age. Device security. GDPR – Privacy and Data protection Blockchain Cyber Security Principles of encryption and decryption.

8	Module Learning Outcomes
	On successful completion of the module, students will be able to:
1	Reflect on the application of computer systems theory.
2	Design a secure digital IOT device using appropriate techniques.
3	Develop a knowledge-based written article addressing an IOT problem statement to a professional academic standard.
4	Demonstrate knowledge of security techniques in computer systems.

9	Module Assessment		
Learning Outcome Number *(from table 8)*	Coursework	Exam	In-Person
1 and 4	Quiz and build (25%)		
2 and 3	Knowledge test and written article (75%)		

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 x 12 3hr lab x 12
Directed Learning (DL) includes placements, work-based learning, peer group learning external visits, on-line	112	Practical labs based on hardware

activity, Graduate+, peer learning, as directed on VLE		
Private Study (PS) includes preparation for exams	20	Reading and general research
Total Study Hours:	200	

11	Key Texts and Online Learning Resources

Barker, J. (2020), Confident Cyber Security: How to Get Started in Cyber Security and Futureproof Your Career, Kogan Page

Brookshear, J.G. (2019), Computer Science: An Overview (13th Edition), Pearson

Monk, S. (2019), Raspberry Pi Cookbook: Software and Hardware Problems and Solutions (3rd Edition), O'Reilly

Nussey, J. (2018), Arduino For Dummies (2nd Edition), For Dummies

Silberschatz, A. Galvin, P.B. and Gagne, G. (2018), Operating System Concepts (10th Edition), John Wiley & Sons

Waher, P. (2018), Mastering Internet of Things: Design and Create Your Own IoT Applications Using Raspberry Pi 3, Packt Publishing Limited

Wilson, K. (2019), Essential Computer Hardware Second Edition: The Illustrated Guide to Understanding Computer Hardware (Computer Essentials), Elluminet Press

Logic.ly - https://logic.ly/

Tinkercad - https://www.tinkercad.com/

Module Specification

Module Summary Information

1	Module Title	Mathematics for Computing
2	Module Credits	20
3	Module Level	4
4	Module Code	CMP4268
5	Semester Taught	1

6	Module Overview

This module covers basic discrete mathematics for computer science. Topics include number theory, formal logic and propositions, sets notations, elementary statistics, introduction to algorithms, permutations and combinations and discrete probability. Further selected topics may also be covered, such as data structure, series, limits and logarithms. You will develop core mathematical and statistical skills which are fundamental in computing and technical work in general.

The module consists of:
- Lecture sessions to introduce topics.
- Workshops to practice the mathematical techniques supported by drop-in sessions.

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 computing and communication industries and at this academic level, this means acquiring:

- The basic knowledge required to recognize the mathematical aspects of related technical
- problems.
- The capability for applying basic mathematical techniques to their technical problems.
- The basic skills for interpretation and critical evaluation of the results.

7	Indicative Content

- Number theory (binary/hexadecimal, number types, e.g., real numbers, irrational numbers)
- Formal logic and propositions (truth tables)
- Manipulation of sets their notations (enumerate and predicate forms of writing sets)
- Elementary statistics (e.g., standard deviation, deviation and MAD)
- Introduction to algorithms (for and while loops, if and assignment functions)
- Permutations and combinations
- Discrete probability
- Series and limits
- Logarithms
- Technical terms

8	Module Learning Outcomes
	On successful completion of the module, students will be able to:
1	Apply conversions between different number systems and number representations.
2	Apply elementary statistics and discrete probabilities to numerical data.
3	Implement logical reasoning and algorithmic plans to solve structured problems.
4	Perform mathematical operations with univariate and multivariate linear algebra.

9	Module Assessment		
Learning outcome number			
	Coursework	**Exam**	**In-Person**
1, 2, 3 and 4		X (75%)	
1, 2 and 4	X (25%)		

10	Breakdown Learning and Teaching Activities	
Learning Activities	**Hours**	**Details of Duration, Frequency and other comments**
Scheduled Learning (SL) includes lectures, workshops as specified in timetable	48	*2hr lecture x12, 2hr 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	90	Please use pre-sessional and post-sessional activities which are provided per session/week on Moodle and also the mid-term quiz and in-class tasks
Private Study (PS) includes preparation for exams	62	Please use the library material links which are provided per session/week on Moodle and through reading list and also the materials accessible through digital library
Total Study Hours:	200	

11	Key Texts and Online Learning Resources
	1) Grossman, P., 2002. *Discrete mathematics for computing.*
	2) Lehman, E., Leighton, T. and Meyer, A.R., 2010. Mathematics for computer science. Technical report, 2006. Lecture notes.
	3) Graham, R.L., Knuth, D.E., Patashnik, O. and Liu, S., 1989. Concrete mathematics: a foundation for computer science. *Computers in Physics*, *3*(5), pp.106-107.
	4) Vince, J., 2020. *Foundation mathematics for computer science.* Springer.

Module Specification

Module Summary Information

1	Module Title	Professional Practice for Game Development
2	Module Credits	20
3	Module Level	4
4	Module Code	CMP4271

5	Module Overview

This module will help you to develop important academic and professional skills. Team work, project and time management, as well as research, verbal and written communication skills are core skills that a graduate will need to demonstrate. In order to help you develop these types of skills the module will be delivered using a problem based learning approach. Each week you will join a team to explore a topic relating to game design, the game industry or be related employability skills. Each week teams will be rotated which will help you appreciate the importance of collaboration and compromising on differing views as you work together to solve a problem.

6	Indicative Content

- Investigate different game mechanics used in the development of games.
- Assess human factors in the development of games.
- Team work.
- Project management.
- Problem solving skills.
- Written and oral communication skills.

7	Module Learning Outcomes On successful completion of the module, students will be able to:
1	Present evidence of being able to design games.
2	Produce a written report on the development of games.
3	Produce evidence describing the range of behavioural skills needed for employability.
4	Formulate academic, personal development and career planning in the context of the Games Industry.

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 weekly tasks and complete your final report.	
Total Study Hours:	200	

Module Specification

Module Summary Information

1	Module Title	Business Information Systems
2	Module Credits	20
3	Module Level	4
4	Module Code	CMP4288
5	Semester Taught	1

6	Module Overview

This module focuses on the social and technical factors which underpin the business context of organisations and drive the need for information. You will explore how these factors influence each other and the design of business information systems. You will apply systems concepts to interrogate the dynamic relationship between people, technology, organisational structure and business process to understand the relationship between business information requirements and IT. The module establishes the systems engineering view of business systems developed throughout the rest of the programme.

The main module topics will be delivered via lectures followed by structured workshops based on an 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, you 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

- Systems Theory
- Systems thinking
- Information Systems
- Soft Systems Methodology
- Socio-technical systems
- Requirements gathering
- Design Thinking

8	Module Learning Outcomes On successful completion of the module, students will be able to:	
	1	Describe systems theory and its application in organisations
	2	Appraise ethical and legal practices in organisations when designing systems.
	2	Analyse the information needs of an organisation using appropriate techniques.
	3	Develop relevant conceptual system models for an organisation.

9	Module Assessment		
Learning Outcome Number *(from table 8)*	Coursework	Exam	In-Person
1 and 2	40%		
3 and 4			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*	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 and 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
Bell, S. et al. (2015) *Rich pictures: encouraging resilient communities*. London: Routledge.
Beynon-Davies, P., (2020), *Business Information Systems*, Third Edition. London: Red Globe Press.
Cox, S. A., (2014), *Managing Information in Organizations: A Practical Guide to Implementing an Information Management Strategy*, Palgrave Macmillan, Basingstoke.

Laudon, K. C. & Laudon, J. P. (2019) *Management information systems: managing the digital firm*. Pearson Education.

Stair, R., Reynolds, G. & Chesney, T., (2015), Principles of Business Information Systems, Cengage Learning EMEA, China.

Wilson, B., (2015), *Soft Systems Thinking, Methodology and the Management of Change*, Palgrave. Chichester

Module Specification

Module Summary Information

1	Module Title	Computational Thinking and Professional Development
2	Module Credits	20
3	Module Level	4
4	Module Code	CMP4295
5	Semester Taught	1

6	Module Overview

In this module you will be given an extended induction into professional, mathematical and cognitive skills needed to be successful in a business computing career. Skills such as critical thinking, mathematics, time management, and a computational approach to problem-solving will be developed through a variety of hands-on activities.

The module will focus on supporting the development of mathematical skills to aid in your understanding of computing theory and developing your computational thinking skills needed to solve problems using modern IT systems.

7	Indicative Content

- Problem-solving and critical thinking
- Reflection and professional development
- Maths as a tool in computing
- Foundations of computational thinking
- Problem identification
- Problem abstraction
- Problem decomposition
- Algorithms
- Pseudocode
- Evaluating solutions
- Ethical considerations for an IT professional.

8	Module Learning Outcomes On successful completion of the module, students will be able to:
1	Apply mathematical techniques to solve applied computational thinking problems.
2	Design and implement algorithms to solve a given computing problem
3	Reflect on a range of applications of computational thinking methods and techniques in the computing discipline.

9	Module Assessment		
	Coursework	*Exam*	*In-Person*
Learning Outcome Number *(from table 8)*	**Coursework**	**Exam**	**In-Person**
1, 2,	60%		
3			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*	Workshop and hands-on activities (4 hours x 12) 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 (reading articles shared on Moodle to facilitate discussion). 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

- Beecher, K. (2017). Computational Thinking: A beginner's guide to problem-solving and programming. BCS.

- Bott, F. (2014) *Professional Issues in Information Technology*, 2nd edition, BCS, The Chartered Institute for IT.

- Edmonds, J., 2008. How to think about algorithms. Cambridge University Press.

- Mailund, T. (2021). Introduction to Computational Thinking. Problem Solving, Algorithms, Data Structures, and More. Apress, Berkeley, CA
- Shemmell, P. (2022) Introduction to algorithms, *LinkedIn Learning - Collection*, [online] Available at: https://www.linkedin.com/learning-login/share?account=42288921&forceAccount=true&redirect=https%3A%2F%2Fwww.linkedin.com%2Flearning%2Fcollections%2F6927616742290554880%3Ftrk%3Dshare_collection_url%26shareId%3Dr%252FadCrr1Rcy2h2yjO3yMsg%253D%253D. [Last Accessed 10 May 2022].

- Wassberg, J. (2020). Computer Programming for Absolute Beginners: Learn essential computer science concepts and coding techniques to kick-start your programming career. Packt Publishing Ltd, Birmingham-Mumbai.

- Weckert, J & Lucas, R. (2013) Professionalism in the Information and Communication Technology Industry. ANU Press.

Module Specification

Module Summary Information

		Introduction to Programming
		20
		4
		CMP4296
		1

Programming is a core skill for any career within the IT industry, even if you are working in a non-technical role (such as consultant or business analyst). As more businesses incorporate digital technologies into their operations, a basic understanding of computer programming as a minimum requirement is now essential. Future roles in IT will focus on being a creator of digital systems (rather than just a passive consumer).

In this module you will be introduced to the essential components of software development. It will give you an overview of the most basic concepts to learn how to program, which will then allow you to apply these skills to different programming languages (and types of programs) in the future.

You will develop these skills with hands-on practical activities (which relate to the content covered in the Computational Thinking module). This module also covers core material to prepare you for entry level programming certifications such as the Certiport Information Technology Specialist. Through a programming challenge, a workable software solution will be developed to capture and process information. This module provides a grounding for you to develop your skills further in the Level 5 modules and potentially your final year project.

- Software development methodologies
- Troubleshooting & debugging
- Basic program structure
- Program syntax
- Tools & techniques
- Working with data

	1	Create basic software programs to a given specification.
	2	Conduct fault-finding and debugging within code elements.
	3	Test and evaluate an application using appropriate quality assurance standards and procedures.
	4	Effectively communicate technical requirements to a specific audience.

9	Module Assessment

	Coursework	Exam	In-Person
Learning Outcome Number *(from table 8)*	**Coursework**	**Exam**	**In-Person**
1, 2			**70%** viva
3, 4	**30%** includes a report		

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 (4 hours x 12: 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**

- Clark, N. (2018) *Computer Programming for Beginners: Fundamentals of Programming Terms and Concepts*. United States: Createspace Publishing.
- Code Academy (2022) *Learn to Code for Free*. Available at: www.codeacademy.com. [Accessed 01 February 2022]
- Microsoft Learn (2022) *Developers on Microsoft Learn.* Available at: https://docs.microsoft.com/en-us/learn/roles/developer. [Accessed 01 February 2022]
- Needham, T. (2020) *Python for Beginners: a crash course*. United Kingdom: White Flower Publishing.
- Ozoemena, S. (2021) *Python for Beginners*. Independently published.
- W3 Schools (2022) *W3 Schools Online Web Tutorials*. Available at: http://www.w3schools.com. [Accessed 01 February 2022]

Module Specification

Module Summary Information

1	**Module Title**	Networking Technologies
2	**Module Credits**	20
3	**Module Level**	5
4	**Module Code**	CMP5320

5	**Module Overview**

In this module you will have the opportunity to learn and critically reflect on the skills required for Network Technologies. This module builds your knowledge and underpinning theory for the networking modules and you will review the requirements from a small to medium scale network deployment engineering context.

The module consists of:

- Subject specific lectures/laboratory sessions to introduce knowledge and skills relevant to network and information systems, along with communication architecture
- Lectures/ laboratory sessions to introduce principles and techniques for information communication within a network and ensuring effective communication.
- Global views on information system communication.

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**

The students will investigate the following areas:
Layer 2 networking technologies
Static and dynamic routing protocols
IP addressing and mathematics within networking systems

7	Module Learning Outcomes	
	On successful completion of the module, students will be able to:	
	1	Explain the theoretical aspects of OSI layer 2; Ethernet switching concepts, VLANs and VLAN trunking.
	2	Compare and contrast the concepts and functionality of Static and Dynamic Routing.
	3	Demonstrate network device configuration in small enterprise networks.
	4	Design various IP Address provision and flow within a network.

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 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	

BIRMINGHAM CITY
University

Module Specification

Module Summary Information

1	Module Title	Programming for Network Engineers
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5321

5	Module Overview

This module builds on your foundational programming knowledge and skills developed during the Level 4 Computer Programming module to extend and focus these towards the area of network engineering. It provides an essential skillset for network engineers to manage and develop networks/networking applications. This aids the management of complex networks by allowing the automation of regular tasks and the potential reduction of human error when configuring multiple devices.

The module consists of:
- Subject specific lectures/laboratory sessions to introduce knowledge and skills relevant to network programming/scripting.
- Practical laboratory sessions to provide an opportunity to both apply knowledge gained through pre/post session activities and lectures, and also to investigate and develop the skills necessary to solve network based programming problems.

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 computer networking and programming, 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 deliver the following area:
Basic Python programming for network engineers
TCP/IP Sockets
Network Forensics
Network Monitoring
Network Security

7	Module Learning Outcomes
	On successful completion of the module, students will be able to:
1	Critically evaluate the choice of advanced programming concepts to meet the needs of networking scenarios.
2	Analyse different approaches to network configuration using appropriate programming/scripting methods.
3	Design an application that interacts with network services to meet a defined specification.
4	Implement a designed application to interact with network services.

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 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

Module Summary Information

1	Module Title	Advanced Programming for Digital Forensics
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5326

5	Module Overview

Digital forensics software such as EnCase and FTK provide an automated solution to processing image files to identify notable data for example. However they are general purpose software that caters for different types of investigation and therefore lack focus or timely processing of data. Being able to write programs to focus on extracting and processing data is an important skill in the digital forensics area in order to quickly triage devices or deal with new files/file formats for example

This module will build on principles taught in Computer Programming. It will focus on developing knowledge and practical skills to enable you to design and implement non-trivial algorithms for problem solving in the context of digital forensic analysis. The main programming language for this module is Python and continues from the Computer Programming module. The module will help with enhancing your programming skills to automate processing of digital evidence. Sample data will be used that is representative of data in files e.g. log files used in investigations. This module aligns with the programme's philosophy of developing practical skills for conducting complex analysis of digital evidence.

Alignment with Programme Philosophy and Aims
The programme aims to emphasise the important technical skills associated with analysing digital evidence where this module enhances knowledge of programming and using software libraries and tools to extract key data items. Being programming based it also enhances your transferrable skills to other computing disciplines that make use of programming such as software engineering. The module also enables you to develop your confidence in gaining important technical skills and become independent problem solver willing to take on new challenges and experiences.

Learning and Teaching Strategy
The main approach to learning is practical based where you will get 'hands-on' experience of developing algorithms and writing programs for automating processing digital evidence in order to quickly obtain details on the operating system or conducting further analysis. 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 of solutions to a number of problems involving the design, implementation and testing of programs to analyse digital evidence. The digital evidence will be based on realistic scenarios and data. The report assesses your ability to develop programs and articulate the development and results obtained

6	Indicative Content

- Python programming.
- Advanced python programming topics.
- Using external libraries.
- Regular expressions.
- File Input/Output.
- Analysing file systems.
- Processing operating system artefacts.
- Analysing SQL databases.
- Processing log files.
- Automating digital forensic tools.

7	Module Learning Outcomes **On successful completion of the module, students will be able to:**
	1	Formulate regular expressions for searching data.
	2	Use external libraries/modules to process data.
	3	Develop algorithms to extract files and metadata from an image.

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

Module Summary Information

1	Module Title	C++ Programming for Games
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5327

5	Module Overview

The study of programming and the development of programming skills are central to any undergraduate course in computing. In recent years, there has been a move towards greater use of object-oriented languages in IT and creative industries. C++ is one of the most important object-oriented programming languages in the game industry and it is also the foundation for several other modern languages. Therefore, this module focuses on C++ programming, helping you to develop your skills in the use of an object-oriented programming language and to learn how to debug, optimise and test C++ programs. The learning and teaching strategy is centred on lab sessions where tutors provide advice, guidance and formative evaluation.

6	Indicative Content

- Software development lifecycle models.
- Managing codebases.
- C++ syntax
- Data structures and algorithms
- Class libraries such as STL
- Memory management and pointers
- Alignment and allocation strategies.
- Object Orientation in C++.
- Source code and compiler optimisation.
- Testing and debugging.

7	Module Learning Outcomes **On successful completion of the module, students will be able to:**
1	Create object-oriented programs in C++ making use of class libraries.
2	Develop and apply testing and debugging strategies to C++ programs.
3	Utilise code optimisations, including compiler optimisations, and apply them to a program.
4	Select and use code profilers to determine performance of a program and devise a strategy to optimise the program to meet space and time 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
Private Study (PS) includes preparation for exams	90
Total Study Hours:	200

Module Specification

Module Summary Information

1	**Module Title**	Object-Oriented Programming
2	**Module Credits**	20
3	**Module Level**	5
4	**Module Code**	CMP5332
5	**Semester Taught**	1

6	Module Overview

Programming is an engineering tool that plays a vital role to drive most of the modern technologies surrounding us, including technological devices for communication, transportation and entertainment. In other words, it can be said that our modern lifestyles are heavily dependent on programming. Moreover, businesses increasingly rely on computers and the software that runs on them. Programming skills and a broader and deeper understanding of programming are therefore becoming increasingly important to the jobs market.

The Computer Science course aims to give students an understanding of the theory and principles underlying the construction of modern computer systems and the development of high-quality software. This module provides an introduction to object-oriented software development. Students will learn to design and implement applications in a widely used object-oriented programming language (e.g., Java). The module covers the fundamental concepts of object-oriented including class design, inheritance and composition, polymorphism, overloading, dynamic binding and interfaces.

This module also has a focus on standard software development practices, including pair programming, test-driven development, code review, and using and generating documentation.

Sustainability

To ensure the students are aware of the crucial role that object-oriented programming plays within the realm of software development. We provide different examples/case-studies throughout both lecture and practical sessions on how the OOP paradigm could be used to structure a software program into simple, reusable pieces of code blueprints (usually called classes), which are used to create individual instances of objects.

Nowadays, OOP are strongly related to most of UN's Sustainable Development Goals (SDG). By enabling students to discuss, analyse, and optimise for these attributes, they are specifically being prepared to contribute to Goals 8, 9, 10 and 11 of SDG in the future. Several use cases will be discussed that can be related to the above goals to practice how they can develop software applications that can support in addressing these challenges.

Inclusivity

To deliver an inclusive module, the following concepts will be included to curriculum/assessment design as well as regular teaching and learning of this module:
- Use a diverse range of resources by including various development environments and use cases related to the different concepts discussed, for example in case-studies, lab-sheets, lecture content, etc. Adopting the modern programming approaches when considering theoretical models and solving practical problems within the curriculum and in the field in general

- 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.
- Learn and pronounce students' names correctly to let them feel valued in the course. This will be done by asking students to state their names before they begin speaking and also by asking students directly about the correct pronunciation of their names.
- Exploring specific ethical and legal issues associated to 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 software engineers, might tackle these problems

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.

Employability

Object oriented technology is an industry standard programming technique and is a vital skill for employability. This module builds on basic programming skills covering the fundamental differences between object-orientation and procedural programming, and how the software engineering process differs between the two programming paradigms. Students will be able to apply advanced techniques and development environments (e.g., UML, Eclipse, unit testing) for designing, implementing, testing and debugging object-oriented programs in the Java programming language.

7	Indicative Content

- Basic Java syntax and semantics
- Classes and objects
- Methods and constructors
- Arrays and collections
- Console and file input/output streams
- Exceptions and error-handling
- Interfaces, information-hiding and message-passing
- Inheritance and polymorphism
- Unit testing using the JUnit framework
- Graphical User Interface
- Using and generating Javadoc documentation

8	Module Learning Outcomes
	On successful completion of the module, students will be able to:
1	Demonstrate knowledge of the fundamental principles of object-oriented programming.
2	Apply object-oriented principles to design and implement programs from high level requirements specifications.
3	Use a unit testing framework in the design, testing and debugging of object-oriented programs.
4	Follow standard software development practices including pair programming and code review.
5	Use and create technical documentation for object-oriented code.

9	Module Assessment		
Learning Outcome Number *(from table 8)*	**Coursework**	**Exam**	**In-Person**
1-5	Java code implementation and group presentation - total mark is 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	1hr lecture x12, 3 hrs lab session x12
Directed Learning (DL) includes placements, work-based learning, peer group learning external visits, on-line activity, Graduate+, peer learning, as directed on VLE	104	Weekly Labs exercises. This will take place each week, for 12 weeks. Recap lecture every week to cover the main topics for the week and topics that requires more attention. Required self-study activities (reading & video lectures) before labs, every week. Group coursework project assessment.

Private Study (PS) includes preparation for exams	48	Students are expected to complete at least 4 hours self-study every week.
Total Study Hours:	200	

11	Key Texts and Online Learning Resources

Purchase

None

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

None

Recommended

Barnes D. J. (2016). *Objects First with Java: A Practical Introduction Using BlueJ.* Pearson

Gaddis T. (2012). *Starting Out with Java: From Control Structures Through Objects.*

Pearson **Background**

Spraul, V. A., (2012) *Think Like a Programmer: An introduction to Creative Problem Solving*, William Pollock

Module Specification

Module Summary Information

1	Module Title	The English Legal System and IT Law
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5336

5	Module Overview

This module provides an introduction to the main features of the English legal system and the substantive law relating to IT. The module aims to give students an overview of the workings of the English legal system as a whole, and then move to a more detailed look at the specific area of IT law which is relevant to the Computer Forensics degree. Understanding how the English legal system is structured and administered provides essential context for the study of IT law.

The module will initially emphasise English law, however, multi-jurisdictional elements of IT law are included due to the global nature and application of IT systems and services. Domestic, European and international IT law and policies are incorporated where appropriate.

The module is delivered through a combination of lectures, seminars and practical exercises supported by a variety of learning activities including self-directed and experiential learning; in person and online through Virtual Learning Environments (VLE).

6	Indicative Content

Features of the English legal system:

The nature of law; Sources of law (International, European and domestic); EU law; The European Convention on Human Rights; Legal Personnel: judges, barristers and solicitors; Juries in criminal trials The criminal justice system; The civil justice system.

Key Areas of IT Law:

Cyber Crime; Online Commerce; Privacy and Data Protection; Intellectual Property Law; The Liability of Professionals

7	Module Learning Outcomes
	On successful completion of the module, students will be able to:
1	Define the structure, administration and personnel of The English Legal System
2	Demonstrate a detailed knowledge of the law relating to IT
3	Apply legal principles to a scenario involving computer crime or civil liability in relation to IT
4	Communicate legal issues in writing and use relevant legal information

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 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

Module Summary Information

1	Module Title	Enterprise Systems
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5340
5	Semester Taught	1

6	Module Overview

The module explores the adoption and implementation of Enterprise Systems (ES) in organisations. You will examine the role of these systems in an organisation and understand how these systems are used to provide timely access to information and improve operational efficiency. The module will help you develop your knowledge of the importance of implementing such systems while also developing core skills in understanding the functionality of ES to support organisations. In addition, you will study the methodologies of implementing an ES and the challenges and risks associated with these projects.

This module builds on the first-year modules, namely Business Information Systems and Business Information Modelling, to extend your understanding of the practical application of systems and highlight how different departments are connected within the system operations.

The module will be taught using a combination of tutorial and practical sessions. Your learning will be supported by various materials and activities, as indicated below:

- Subject-specific tutorial sessions to introduce the core concepts and the integrated processes that Enterprise Systems support.
- Case study challenges understanding the requirements of an organisation and applying enterprise systems concepts to propose a solution that addresses the industrial challenge.
- Practical tutorial sessions focused on using enterprise systems to build the necessary functional knowledge and skills.
- Recommended reading materials to broaden understanding of the theory and practice introduced in the module.

7	Indicative Content

- Introduction to Enterprise Systems (ES).
- ES adoption and implementation
- ES implementation strategy
- Assess and contextual the legal, professional and ethical issues of ES implementation.
- Explore enterprise systems functionality
- Configure ES according to the given requirements
- Evaluate the ES functionality.

8	Module Learning Outcomes On successful completion of the module, students will be able to:
1	Critique the role of enterprise systems in supporting organisation operations.
2	Configure an enterprise system to streamline operations.
3	Appraise the risks of implementing an enterprise system solution.
4	Formulate an enterprise systems implementation strategy for the given challenge.

9	Module Assessment			
Learning Outcome Number *(from table 8)*	Coursework	Exam		In-Person
1 and 3				40%
2 and 4	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	4 hours workshop and Lab x 12.
Directed Learning (DL) includes placements, work-based learning, peer group learning external visits, online 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 tutorials
Total Study Hours:	200	

11	Key Texts and Online Learning Resources

- Magal, S. & Word, J. (2012) Integrated business processes with ERP systems. Hoboken, N.J: Wiley.
- Motiwalla, L. F. & Thompson, J. (2014) Enterprise systems for management. Second edition, Pearson new international edition. Harlow, England: Pearson.
- Nestell, J. G. & Olson, D. L. (2017) Successful ERP Systems: A Guide for Businesses and Executives. New York: Business Expert Press.
- Sagegg, O. J. & Alfnes, E. (2020) ERP systems for manufacturing supply chains: applications, configuration, and performance. Boca Raton, Florida ;: CRC Press.
- Samara, T. (2015) ERP and Information Systems: Integration or Disintegration. 1st edition. [Online]. Hoboken: John Wiley & Sons, Incorporated.

Module Specification

Module Summary Information

1	Module Title	Computer Networks and IP Distribution 1
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5346

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 theory and implementation will be covered in detail, whilst concepts relating to network redundancy and network device security will be implemented.

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

- Packet transfer methods.
- Maintaining path information.
- Logical topologies as applied to data networks.
- Securing network devices.

7	Module Learning Outcomes
	On successful completion of the module, students will be able to:

	1	Critically evaluate switching and trunking concepts relevant to small/medium sized business network topologies.
	2	Critically evaluate the purpose and operation of routing within a small/medium sized business network topologies.
	3	Evaluate appropriate data network security techniques and protocols relevant to small/medium sized business network topologies.
	4	Implement, verify and troubleshoot a small/medium sized business network topology.

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

Module Summary Information

1	**Module Title**	Computer Programming for Engineers
2	**Module Credits**	20
3	**Module Level**	5
4	**Module Code**	CMP5347

5	**Module Overview**

This core computer programming module provides the underpinning knowledge and practice for computing students to design and produce software applications to specified standards.

The module will make use of both taught practical sessions, to allow students to apply programming principles and constructs in order to creatively solve problems by developing software applications. Through a programming project challenge, a workable computer software solution is to be developed to address either a business or social issue.

Module content and assessment promotes an inter-disciplinary approach to programming enabling learners to contextualise solutions relevant to engineering applications. Topics covered include: Input/Output, Data structures, Algorithms, Graphical User Interfaces, Objects and Classes and Event Handling.

6	**Indicative Content**

- Introduction to Computer Programming
- Variables, simple I/O, Decision Structure Lecture
- Python, repetitive structure, Lists
- Functions, modules, local and global variables
- File I/O and runtime exception handling
- Dictionaries and Data sets
- Advanced String Handling
- Object Oriented Programming in Python
- Debugging and Test Plan
- Introduction to GUI Programming in Python
- Introduction to GUI Programming in Python
- Simple Algorithms in Python
- Discuss assignment and obtain formative feedback

7	Module Learning Outcomes
	On successful completion of the module, students will be able to:
1	Demonstrate application of programming design techniques for creative problem solving.
2	Development and test of a computer programme solution.
3	Evaluate your programming solution based on requirements.

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

Module Summary Information

1	**Module Title**	Server Systems
2	**Module Credits**	20
3	**Module Level**	5
4	**Module Code**	CMP5350
5	**Semester Taught**	1

6	**Module Overview**

Within the module Server Systems, you will learn that servers are the engines that deliver the data of the worldwide Internet and cloud revolution. In this module you will learn how to design, configure, and troubleshoot servers to provide both the data and network services required in modern networks. You will spend a lot of time actually configuring and troubleshooting servers in this module to give you the hands-on skills required by industry. This will be backed up by theory delivered via videos, reading and short lectures.

This module requires skills gained from your first-year studies of hardware, networking and operating systems and links to the networking and infrastructure and modules in your second year and beyond. The hands-on nature of the teaching and the project-based group assessment mirror the kind of learning environment you will be exposed to in industry, further building key technical and transferable skills. Once the module is complete, you will have the opportunity to gain professional accreditation supported by boot-camps and revision sessions.

Relationship to programme 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-solving, 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**

This module is likely to cover the following topics:

- DHCP
- DNS
- Directory Services (e.g. Active Directory/SAMBA)
- Group Policy
- File Services (NFS, SMB)
- Distributed file systems
- Web/Application Services
- Security and
- Cloud computing
- Troubleshooting server services
- Evaluation of server solutions
- Testing and test documentation
- Presentation and technical demonstration skills
- Peer mentoring and support

- Sustainable computing
- Legal and ethical aspects of service provision

8	Module Learning Outcomes
	On successful completion of the module, students will be able to:
1	Define server services to meet a business need.
2	Configure server services to meet a business need.
3	Troubleshoot server-based services to rectify faults.
4	Adhere to appropriate professional and academic standards.

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

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 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	104	Labs and tutorials
Total Study Hours:	200	

11	Key Texts and Online Learning Resources

- Bresnahan, C. and Blum, R. (2019) LPIC-1 Linux Professional Institute Certification Study Guide: Exam 101-500 and Exam 102-500, 5th edition, Indianapolis, Sybex.
- Clinton, D. and Negus, C. (2020) Ubuntu Linux Bible, 10th ed, Wiley.
- Digital Ocean (2022), Tutorials. Available at: https://www.digitalocean.com/community/tutorials, [accessed 05/06/2022] ·
- Francis, D. (2021) Mastering Active Directory: Design, deploy, and protect Active Directory Domain Services for Windows Server 2022, 3rd Edition, 3rd ed. edition, Birmingham, Packt Publishing.
- Opensource.com (n.d.) Opensource.com. Available at: https://opensource.com/, [accessed 05/06/2022]
- Shotts Jr, W. E. (2019) The Linux Command Line: A Complete Introduction (Fifth Internet Edition, No Starch Press. Free download from - https://sourceforge.net/projects/linuxcommand/files/TLCL/19.01/
- Thomas, O. (2022) Exam Ref AZ-800 Administering Windows Server Hybrid Core Infrastructure, 1st edition, S.l., Microsoft Press.

Additional resources will be signposted to support specific activities within the module.

Module Specification

Module Summary Information

1	Module Title	Introduction to Data Science
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5353

5	Module Overview

Data applicable to organisational bodies for decisions making process are increasing rapidly. Automation of tracking, the increase of new data types (e.g., social media, audio, and video), improved storage of electronic records, re-use of administrative records, and the outburst of modelling data have all amplified the availability of data. However, making full use of these data requires not only right storage and but also advanced analytical capabilities.

Data Science is a multidisciplinary field that deals with technologies, processes, and systems to extract knowledge and insight from data and supports reasoning and decision making under various sources of uncertainty.

The goal of Introduction to Data Science is to teach students how to answer questions with data. The module will enable students to conduct computational investigations needed for vital decisions and prediction of new trends and at the same time enhance students' employability skills.

Learning and Teaching

Students will learn the essential skills to manage and analyse data with case studies. They will learn concepts such as exploratory data analysis, statistical inference and modelling as well as linear algebra and linear regression. They will also learn the necessary skill to develop data products.

The module is designed as an interactive-taught lectures using a chain of group discussions/activities, quizzes as well as workshop/lab exercises using diverse statistical tools and techniques. All class material will be motivated with real life examples involving data. Students will learn and use R programming language as well as other programming language that could be used to analyse large data.

6	Indicative Content

This module is about learning from data, in order to gain useful and actionable predictions and insights. Pre-processing unstructured data and obtaining insights from the data through analysis presents many computational challenges.

The module will introduce students to the following:

- Data Science life cycle
- Data Wrangling
- Introduction to R
- Exploratory data analysis and visualization
- Linear Algebra
- Basic methods for modelling and prediction
- Statistical inference
- Data Science tools and applications

7	Module Learning Outcomes
	On successful completion of the module, students will be able to:
1	Analyse, interpret and effectively communicate Data Science lifecycle including processing different data type using statistical programming language/tools.
2	Learn, apply and professionally report data wrangling and visualisation techniques to clean and shape data for analysis.
3	Explore data using statistical methods to critically examine the validity of statistical analysis
4	Demonstrate an understanding of basic regression model for the purpose of description and prediction.

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	62
Private Study (PS) includes preparation for exams	90
Total Study Hours:	200

Module Specification

Module Summary Information

1	Module Title	Software Security
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5358
5	Semester Taught	1

6	Module Overview

Software is ubiquitous. Not only is it deployed on traditional computing platforms (such as workstations and servers), but it is also embedded in network equipment (such as routers and firewalls) and consumer devices (such as hearing aids and smartphones). In this module, we will explore the foundations of software security, important software vulnerabilities and attacks that exploit them -- such as buffer overflows, SQL injection, and session hijacking. The module explores defenses that prevent or mitigate these attacks, including advanced testing and analysis techniques. You will also learn how product vendors and services should manage exposed vulnerabilities and how vulnerabilities are being disclosed to stakeholders in an ethical way. It continues the software theme that you began at Level 4 when you studied the Computer Programming and Applied Operating Systems module.

Complex software inevitably contains unforeseen defects. By exploiting these software vulnerabilities, an attacker might be able to corrupt or extract data, or to disrupt or take control of a system, for example. In this module, you will encounter common attack mechanisms (such as command injection and buffer manipulation) that exploit programming errors. You will also learn techniques that help security engineers avoid certain types of web and software vulnerability.

7	Indicative Content

- Introduction to Web and software applications, OSI reference model, background on HTTP, HTTPS and security aspects
- Introduction to Modern Databases, their security implications and developing database with Mysql
- Web security- Attacks and defenses
- Common categories of software vulnerabilities, their detection and remediation (buffer overflow, Race Condition etc. (Considering C++ or Python as an example).)
- Client-side vulnerabilities and mitigation (phishing and clickjacking, spamming etc.)
- Ecommerce and Banking Security
- Security aspects of Mobile application
- Static and dynamic analysis tools
- Approaches to vulnerability reporting and handling (e.g., bug bounties, CVE identification) and the challenges of patch management
- Designing and Building Secure Software

8	Module Learning Outcomes On successful completion of the module, students will be able to:		
	1	Recognise and understand the role of software security in the prevention of cyberattacks and data breaches.	
	2	Analyse and critically evaluate reports from vulnerability analysis tools.	
	3	Critically evaluate and apply methodologies for developing secure software applications.	
	4	Develop reports to disclose vulnerabilities demonstrating knowledge of industry best practice, taking into account ethical considerations.	

9	Module Assessment		
Learning Outcome Number	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	2hr lecture x12, 2hr labs x12)
Directed Learning (DL) includes placements, work-based learning, peer group learning external visits, online activity, Graduate+, peer learning, as directed on VLE	140	Completion of assessment tasks
Private Study (PS) includes preparation for exams	12	Assessment support sessions, feedback.
Total Study Hours:	*200*	

11	Key Texts and Online Learning Resources
	1. Rashid et al.: The Cyber Security Body of Knowledge, CyBOK, v1.1, 2022. https://www.cybok.org/knowledgebase/
	2. McGraw, Gary: Software Security: Building Security In, Addison-Wesley, 2006.
	3. Hoglund, Greg: Exploiting Software: How to Break Code, Addison-Wesley, 2004.
	4. Ransome, James and Misra, Anmol: Core Software Security: Security at the Source, CRC

Press, 2014.
5. Mark Dowd , John McDonald, et al.: The Art of Software Security Assessment: Identifying and Preventing Software Vulnerabilities, Addison-Wesley, 2006.
6. Michael Howard, David LeBlanc, John Viega, "24 Deadliest Sins of Software Security"
https://www.oreilly.com/library/view/24-deadly-sins/9780071626750/

7. Mathias Payer "Software Security: Principles, Policies, and Protection (SS3P)"
http://nebelwelt.net/SS3P/

Module Specification

Module Summary Information

1	Module Title	Web Game Development
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5360

5	Module Overview

You will learn about the document object model and how you can dynamically manipulate it with JavaScript to create interactive games for the Web. You will consider accessibility and usability issues, and how you can overcome them. You will learn about website deployment and how you can use it to make your websites accessible to other people. The module will also enable you to present your game online in the form of a website for use in your portfolio.

The modern web has quickly become a viable platform not only for creating stunning, high quality games, but also for distributing those games. The range of games that can be created is on par with desktop and native OS counterparts. With modern Web technologies and a recent browser, it's entirely possible to make stunning, top-notch games for the Web. These developmental improvements supersede old Flash card games or multi-player social games. The variety of genre and type of game that the Web can support has been massively improved by both the power of consumer devices and the toolsets afforded to developers. We can now make 3D action shooters and RPGs, for the Web! There have been massive performance improvements in JavaScript's just-in-time compiler technology and new APIs. These facilitate building games that run in the browser comfortably.

As a game developer, whether you're an individual or a large game studio, you want to know why it makes sense to target the Web with your next game project. This module demonstrates how the Web can help you via a series of targeted workshops, embracing a blended approach to learning.

The module will introduce to topics such as enabling networking in games developed for the Web. Games will be developed using technologies such as Babylon.js, Enchant.js, Three.js, Phaser IO, A-Frame, PlayCanvas or equivalent framework. These will build upon the HTML5 suite of tools supporting features such as Audio, Graphics, Input and Data Persistence.

6	Indicative Content

- Web Audio API
- WebGL (OpenGL ES 2.0)
- Touch events, Gamepad API, device sensors, WebRTC, Full Screen API, Pointer Lock API
- JavaScript (or C/C++ using Emscripten to compile to JavaScript)
- Networking through WebRTC and/or WebSockets
- Storage: IndexedDB or the "Cloud"
- HTML5, CSS, SVG, Social API

7	Module Learning Outcomes
	On successful completion of the module, students will be able to:
1	Incorporate aesthetics and formal concepts of layout and organisation to design visually appealing and effective games for the Web;
2	Utilise contemporary methods for storing information for Web applications and interfaces;
3	Use proprietary or open source game engines to interface with current Web standards in order to produce a game;
4	Integrate networking components to a game and understand the client/server model.

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

Module Summary Information

1	Module Title	Game Studio Production
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5362

5	Module Overview

This module adopts a problem-based learning strategy. You will be assigned to project teams where you will work on developing a game together. Previous examples of this type of work have been submission of games to Microsoft's international student competition, the Imagine Cup as well as working on ideas provided by industry. In your teams you will work with the tutors to guide the development of your ideas. The teams will then work with an appropriate 3D game engine in order to implement it. The emphasis of the module is for you to experience a work-based environment where teamwork, project and time management are essential skills for successful completion of a project which is a valuable skill for future employment.

6	Indicative Content

- Project management.
- Game pitching
- Prototyping
- Costing
- Budgeting
- Forecasting
- Version control
- Code reviews
- Continuous Integration / Continuous Deployment
- Team and group working.
- Assess human factors in the development of games.
- Problem solving skills.
- Written and oral communication skills.

7	Module Learning Outcomes **On successful completion of the module, students will be able to:**
1	Explain recommendations for the development of a game.
2	Implement and present the development of a 3D game.
3	Justify and defend decisions made when developing a 3D game.
4	Demonstrate the value of team and project management strategies.

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 Your time should be devoted to developing your game.	
Total Study Hours:	200	

Module Specification

Module Summary Information

1	Module Title	Database Systems Development
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5364
5	Semester Taught	1

6	Module Overview

This module aims to provide a comprehensive introduction to a vitally important core IT topic (database technology) found in almost every IT installation in the world. The module will provide theoretical and practical knowledge and skills in developing a database system, including reflecting database systems development from understanding the needs through designing and developing database systems. This module allows students to investigate ways to create a robust, secure database that meets the organisation's needs, which complement other skills and knowledge gained from other modules on the course. In addition, the module introduces the student to transferable skills in database design, implementation, optimisation, security and database administration. Once mastered, these database skills will provide a firm understanding of designing and managing databases in organisations.

This module provides an opportunity for the student to develop knowledge and skills, contributing to the acquisition of key BCU graduate attributes, creative problem solvers, global outlook, enterprising, professional and work-ready. In Information Systems, this means solving problems in a real-world context and gaining industry-relevant practical skills.

7	Indicative Content

- Introduction to the database concepts
- Introduction to Database Management Systems
- The relational data model
- Database design
- Creating database tables
- Populating database tables
- SQL functions
- Database optimisation techniques: Indexes, Clusters and Partitions
- Database Security: Users, privileges, roles

8	Module Learning Outcomes On successful completion of the module, students will be able to:	
	1	Implement and test a normalised database solution using database technology to solve the given enterprise problem.
	2	Communicate the results of querying the database solution to meet given enterprise data reporting requirements.
	3	Apply database optimisation techniques appropriate for the proposed database solution.
	4	Review database security requirements and implement the security mechanisms suitable for the proposed database solution.

9	Module Assessment			
Learning Outcome Number *(from table 8)*	Coursework	Exam		In-Person
1, 2, 3 and 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	1-hour Lecture and 3 hours Lab (practical activities – including sprint workshop) x 12.
Directed Learning (DL) includes placements, work-based learning, peer group learning external visits, online activity, Graduate+, peer learning, as directed on VLE	72	Practical work, as directed on VLE. Peer learning (such as Moodle Forums to share resources and facilitate discussion).
Private Study (PS) includes preparation for exams	80	General reading to broaden understanding of the theory and practice introduced in the module. Review practical 'how-to guides' and relevant articles that provide examples and practice.
Total Study Hours:	200	

11	Key Texts and Online Learning Resources

Elmasri, R., & Navathe, S. (2017). Fundamentals of database systems (Global;Sev). Boston: Pearson.
Ricardo, C.M. & Urban, S.D. 2017, *Databases illuminated,* Third edn, Jones & Bartlett Learning, Burlington, Massachusetts.
Coronel, C. & Morris, S. 2019, *Database systems: design, implementation, and management,* 13th e. edn, Cengage Learning, Australia;United States;.

Module Specification

Module Summary Information

1	Module Title	Business Process Re-engineering
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5370
5	Semester Taught	2

6	Module Overview

Business processes re-engineering play a fundamental role in promoting products and services, improving customer satisfaction levels, and supporting operational efficiency. This module will help you understand the fundamental concepts of business process re-engineering by introducing you to multiple methodologies and process modelling techniques. The focus will be on industry-standard languages and tools, e.g., Business Process Modelling and Notation using industry standard tools such as ARIS, CAWEMO, and Bonita.

This module builds on the first and second-year modules, specifically Business Information Systems and Enterprise Systems. The module teaches you to explore the logical flow of the integrated end-to-end processes within systems.

You will be taught using a combination of tutorial and practical sessions. Learning will be supported by various materials and activities, as indicated below:

- Subject-specific tutorial sessions to introduce you to the core concepts and integrated processes that Enterprise Systems support.
- Case study challenges will help you understand the requirements of an organisation and apply these to improve existing processes.
- Practical tutorial sessions focused on applying process modelling techniques to provide you knowledge on industrial standards and formal notation.
- Recommended reading materials will be provided to broaden your understanding of the theory and practice introduced in the module.

7	Indicative Content

- Business Process Re-engineering
- Introduction to BPR Methodology
- Introduction to Process Modelling
- Conducting a root cause analysis
- Basic concepts of Process Modelling
- Advanced concepts of Process Modelling
- Developing As-Is and To-Be process models
- Performing Gap Analysis
- Developing a business case for improvement

8	Module Learning Outcomes **On successful completion of the module, students will be able to:**	
	1	Analyse the process requirements to derive a clear understanding of the problem.
	2	Apply business process re-engineering techniques to model the processes from the given organisation.
	3	Formulate a business case to support the recommended business process improvements.
	4	Evaluate the legal, ethical and security risks associated business process re-engineering.

9	Module Assessment		
	Coursework	*Exam*	*In-Person*
Learning Outcome Number *(from table 8)*	**Coursework**	**Exam**	**In-Person**
1, 2, 3 and 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*	Workshop and hands-on activities (4 hours x 12: include 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 (reading articles shared on Moodle to facilitate discussion). 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

- Dumas, M., Rosa, M. L., Mendling, J and Reijers, H. A. (2018). *Fundamentals of Business Process Management*. 2nd ed. Springer, Berlin, Germany
- Harmon, P. (2019). *Business Process Change: A Business Process Management Guide for Managers and Process Professionals*. San Diego, CA, USA: Elsevier Science
- Magal, S. & Word, J. (2012). *Integrated business processes with ERP systems*. Wiley, Hoboken.

Module Specification

Module Summary Information

1	Module Title	Operating Systems and DevOps
2	Module Credits	20
3	Module Level	5
4	Module Code	CMP5371
5	Semester Taught	1

6	Module Overview

This module will introduce fundamental concepts associated with operating systems and will lay the foundations for other computer science modules that will require a broad understanding of operating systems principles. A good understanding of operating systems is very important for computer scientists to design efficient solutions to a wide range of programming problems including concurrent programming, resource management and performance analysis.

This module will introduce you to the key components of operating systems, their role, purpose, and historical background. The module will also cover core themes such as concurrency, scheduling, memory management, security, virtual machines, device management, file systems. It will combine theoretical concepts and fundamentals with practical exercises that will provide hands-on experience in understanding, managing, and manipulating operating systems. These will all be integrated through the lens of "DevOps", providing you with some key foundational skills and knowledge in understanding the use and inner workings of Operating Systems as platforms for the development and deployment of software systems.

The module will be assessed through detailed discussion of your attempt at completing a set of tasks that combine both practical and theoretical aspects of the module. For example: a task may ask you to detail how to compile, install and configure a particular software component within your operating system, and then discuss the importance of this component within the context of the architecture of the system. This is to demonstrate both your practical knowledge (of managing and configuring the system) and your theoretical knowledge (e.g., understanding the functionalities of components and their importance in a wider context).

7	Indicative Content

- Overview of Operating Systems history
- Linux systems administration for DevOps
- Development tools on Operating Systems
- Revision of Computer Architecture as it pertains to Operating Systems software
- Virtualisation
    - Processes
    - Scheduling
    - Memory Management
- Concurrency for Software Developers
    - Multi-tasking
    - Multi-threading
    - Deadlock
- Persistence for Software Developers

o	Devices and Device Management
o	File systems

8	Module Learning Outcomes **On successful completion of the module, students will be able to:**
1	Illustrate the role and purpose of an operating system as a platform for the development and deployment of software systems.
2	Analyse the major components of an operating system and the relationships between these components from a software developer's perspective
3	Demonstrate understanding of the fundamental theoretical concepts which underpin operating systems design.
4	Demonstrate competence in managing, manipulating, and optimising operating systems for the development and deployment of software systems.

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

Anderson, T. and Dahlin, M., 2014. Operating Systems: Principles and Practice. Recursive books.

Arpaci-Dusseau, R.H. and Arpaci-Dusseau, A.C., 2014. *Operating systems: Three easy pieces* (Vol. 151). Wisconsin: Arpaci-Dusseau Books. *Free textbook; chapters can be downloaded from* http://pages.cs.wisc.edu/~remzi/OSTEP/.

Clinton, D., 2018. *Linux in Action*. Simon and Schuster.

Cortesi, D.E., 1982. Inside CP/M: A Guide for Users and Programmers with CP/M-86 and MP/M2. Holt, Rinehart and Winston.

Gift, N., Behrman, K., Deza, A. and Gheorghiu, G., 2019. Python for Devops: Learn Ruthlessly Effective Automation. 1st ed. O'Reilly Media.

Menezes, A., 2021. Hands-on DevOps with Linux. 1st ed. BPB Publications.

Vaticone, O., 2020. C++ System Programming Cookbook. 1st ed. Birmingham, United Kingdom: Packt Publishing.

Ward, B., 2014. *How Linux works: What every superuser should know*. no starch press.

William Stallings, Operating Systems: Internals and Design Principles, 8th edition (2014)

Module Specification

Module Summary Information

1	**Module Title**	Business Systems Solutions
2	**Module Credits**	20
3	**Module Level**	6
4	**Module Code**	CMP6173
5	**Semester Taught**	1

6	**Module Overview**

This module aims to provide you with a conceptual understanding of Business Systems and the practical experience of using an integrated business solution. It focuses on information systems that underpin the business context of organisations. It will provide the underpinning knowledge for designing business processes and understanding the role business systems play in organisations. This module will develop your core skills and knowledge to support organisations in managing business systems and redesigning the business processes. The module will be taught using a combination of tutorial and practical sessions. Independent learning will be supported by various materials and activities delivered using Moodle. This will be supported by:

- Subject-specific tutorial sessions to introduce knowledge and skills relevant to business process modelling and existing business system solution
- Applying understanding business systems and business process concepts to propose solutions that address a given industrial challenge.
- Laboratory sessions focused on the practical use of business systems and process modelling.

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 solving, a global outlook, enterprising, professional and work-ready. In the context of computing, 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 and responding flexibly and imaginatively to a set, or group-determined brief within a fixed timescale.

7	**Indicative Content**

- Recent developments in Business systems
- Analysis and evaluation of existing business system solution
- Enterprise Resource Planning
- Business Systems adoption, implementation, and management
- Integrated Business Processes
- Business process re-engineering
- Business Processes: Modelling

8	Module Learning Outcomes On successful completion of the module, students will be able to:	
	1	Critique the role of business systems in organisations.
	2	Configure a business systems solution to streamline operations.
	3	Apply business process modelling techniques to optimise processes.
	4	Communicate business process improvements and their impact on the organisation.

9	Module Assessment			
Learning Outcome Number *(from table 8)*	Coursework	Exam	In-Person	
1,2, 3 and 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	4 hours workshop and Lab 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 tutorials
Total Study Hours:	200	

11	Key Texts and Online Learning Resources

- Buttle, F. & Maklan, S. (2019) Customer Relationship Management: Concepts and Technologies. London: Routledge, 2019
- Dumas, M. (2018) Fundamentals of business process management. Second edition. Berlin: Springer.
- Harmon, P. (2019) Business process change: a business process management guide for managers and process professionals. Morgan Kaufmann.
- Magal, S. & Word, J. (2012) Integrated business processes with ERP systems. Hoboken, N.J: Wiley.
- Motiwalla, L. F. & Thompson, J. (2014) Enterprise systems for management. Second edition, Pearson new international edition. Harlow, England: Pearson.

Module Specification

Module Summary Information

1	Module Title	Wireless Networking Technologies
2	Module Credits	20
3	Module Level	6
4	Module Code	CMP6178

5	Module Overview

The objective of this module is to provide a solid understanding of various wireless networking technologies ranging from local area networks (LANs) and personal area networks (PANs) to wide area networks (WANs), describing how they differ from wired networks (e.g., wireless channels, signal propagation, interference, mobility, etc.). The module will cover the architecture and protocols of various wireless networks. Deployment and troubleshooting methods will also be discussed. Wireless networks security details will be provided, covering aspects such as encryption techniques and data integrity measures. There will be a brief discussion of advanced wireless systems such as MIMO, noise cancellation and positioning technologies.

The module consists of:

- Lecture and laboratory classes designed to give our students a solid understanding of wireless channels, spectrum regulations, transmit power, signal noise, interference and many more.

- Theoretical and practical material on digital transmission over wireless channels, encompassing extensive lecture and laboratory sessions harnessed to maximise learning through hands-on work and state-of-the-art visualisation tools.

- Lectures and laboratory classes on various methods of encoding digital data transmission on carrier frequency, with an emphases on orthogonal frequency-division multiplexing (OFDM) and frequency-hopping spread spectrum (FHSS).

- Lectures on networking architectures and topologies covering small, medium and enterprise networks, enabling our students to possess key design and troubleshooting skills, at various networking layers.

- Various lectures on core wireless security methodologies and hiding information, including authentication, authorisation and encryption, drawn from research papers, articles and books.

- Lectures on advanced topics of wireless technologies, such as those included in latest WiFi standards standards (e.g., MIMO, positioning techniques, interference cancellation, etc.)

Our students will undertake research based assignment, which include report writing and referencing, with an examination structure that encouraged rote learning.

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

Radio communication, principles and techniques:
- Air interface, path loss, link budget, modulation, channel access and coding schemes
- Wireless network topologies, corresponding technologies (Wi-Fi, Bluetooth, ZigBee etc.)

Further study of Wireless networks:
- Network elements
- Network architecture
- Spectrum utilisation
- Procedures and performance evaluation (QoS/QoE, throughput/delay)
- Wireless security
- Monitoring, troubleshooting and survey tools
- Experiment on the environment impact and characteristics

7	Module Learning Outcomes
	On successful completion of the module, students will be able to:
1	Explain the key characteristics of wireless physical layer fundamentals.
2	Analyse and compare various wireless radio systems and technologies.
3	Critically evaluate and analyse wireless network architectures and standards.
4	Explain the key characteristics of wireless network security.

8	Module Assessment			
Learning Outcome				
	Coursework	**Exam**	**In-Person**	
1-4		X		
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	92 (Please use pre-sessional and post-sessional activities which are provided per session/week on Moodle and also the weekly quiz and in-class tasks)	
Private Study (PS) includes preparation for exams	60 (Please use the library material links which are provided per session/week on Moodle and through reading list and also the materials accessible through digital library)	
Total Study Hours:	200	

Module Specification

Module Summary Information

1	Module Title	Incident Response and Investigation Practice
2	Module Credits	20
3	Module Level	6
4	Module Code	CMP6184

5	Module Overview

This module is essentially divided into two sections. The first section will provide you with the professional knowledge and practical skills essential in formulating and applying a digital forensics incident response plan with particular emphasis on understanding how real-life investigations have to blend technical inquiry with overall management needs. This section of the module will develop practical experience in the entire process of preparing, responding and following up an incident response plan in a fast and effective manner whilst highlighting the importance of observing the precautions and the processes involved in evidence acquisition and handling.

The second section of the module is designed to provide you with an understanding of the legal controls over computer use and misuse together with sufficient of the laws of evidence (civil and criminal) for the purposes of compiling and delivering expert testimony (orally or in writing) in a Court of Law. Multi-jurisdictional elements of IT law will be emphasised owing to the global nature and application of IT systems and services and digital crime in general. Domestic, European and international IT law and policies are incorporated where appropriate.

The module will foster your skills in conducting a forensic investigation and employ complex problem solving by applying investigative skills within the strict boundaries of the law and in keeping with ethical and professional codes of practice.

The module is delivered through a combination of lectures, seminars and practical exercises supported by a variety of learning activities including self-directed and experiential learning; in person and online through Virtual Learning Environments (VLE).

This module will make use of guest speakers where appropriate.

6	Indicative Content

Incident Response
Stages of response and recovery
Digital forensics incident response plan
Identification of an incident
Investigation of an incident (including triage)
Containing the incident and eradicating its source
Recovering from the incident

Management of Incident Response (IR)
IR team role
Incident response management team and its remit
Considerations required for critical decision making and subsequent implications

Legal Requirements and Limitations
Global nature and implications of computer crime
Meeting the requirements for ISO17020, ISO17025, ISO27001
Forensic Science Regulator
ACPO Guidelines and other best practice requirements

Collection and Handling of Potential Evidence & the Law of Evidence
Collection procedures and best practice guidelines
Precautions taken in the collection, preservation and transportation of digital evidence
Laws and practices of criminal evidence production and use of evidence in criminal trials
Nature of evidence, asset recovery, civil proceedings and criminal investigation

The Investigation Process and Procedures
Investigative techniques
Keeping audits
Keeping records of decisions and actions

Forensic Readiness Programmes within "Disaster Recovery"
Forensic Readiness Programmes
Legal and regulatory compliance issues for organisations

Role of an Expert Witness and Report Writing
Role of an expert witness
Report writing for an expert witness
Fundamental requirements and managing compliance
Expressing independent views and arguing your conclusions.

Courts, Expert Witness Testimony and Cross Examination
Structure of Court
Codes of Practice and the Rules of Court
Knowledge and skills in presenting effective evidence
Techniques lawyers use in cross-examination
Expressing opinion based on the foundation of fact
Giving confident and clear testimony under cross-examination

7	Module Learning Outcomes On successful completion of the module, students will be able to:		
	1	Identify, appraise and apply up-to-date digital forensics practices including formal good practice guidelines and regulatory requirements.	
	2	Formulate an appropriate incident response plan for a digital investigation.	
	3	Compose an appropriate report in respect of a digital crime investigation and examination.	
	4	Present a clear and concise overview of the investigations supported by justified conclusions appropriate for both a legal and lay audience.	

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

Module Specification

Module Summary Information

1	Module Title	Mobile Game Development
2	Module Credits	20
3	Module Level	6
4	Module Code	CMP6187

5	Module Overview

The rapid emergence and proliferation of mobile computing platforms, such as smartphones and tablets, has led to a more accessible way of playing and publishing computer games. The establishment of mobile games has created opportunities and demand for professionals skilled in their design and development.

The module will provide students with a theoretical foundation underpinning the design and development of mobile games in combination with practical elements for the implementation of mobile games on mobile platforms (such as iOS). Furthermore, this module will provide students with an insight into the practices of the mobile gaming sector, in particular issues relating to their publishing, marketing and commercialisation.

6	Indicative Content

- Introduction to Game Design and Development on Mobile Platforms (e.g. iOS, Android)
- Sprite Animation and Actions (e.g. using SpriteKit in iOS)
- Physics and Particles (e.g. using SpriteKit in iOS)
- Light, Sound, Camera (e.g. using SpriteKit in iOS)
- Additional Game frameworks (e.g.using GamePlayKit for AI in iOS)
- Debugging and Optimizing Apps (e.g. using XCode and Optimization tools for iOS)

7	Module Learning Outcomes
	On successful completion of the module, students will be able to:
1	Research, formulate and present a design proposal for mobile game application showing an awareness of the design patterns, principles and frameworks of a chosen mobile platform.
2	Design and implement intuitive user interfaces for a mobile game.
3	Implement and evaluate a prototype game application on a chosen mobile platform.
4	Justify design and implementation decisions made in the development of commercially viable mobile game projects.

8	Module Assessment		
Learning Outcome			
	Coursework	Exam	In-Person
1			X
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		52
Private Study (PS) includes preparation for exams		100
Total Study Hours:		200

Module Specification

Module Summary Information

1	Module Title	Network and Internet Forensics
2	Module Credits	20
3	Module Level	6
4	Module Code	CMP6189
5	Semester Taught	*Both*

6	Module Overview

This module provides students with knowledge and practical skills essential for the acquisition, analysis and interpretation of evidence obtained from wired and wireless networked computers. Emphasis is also placed on the evidence harboured by network hardware devices, such as routers and switches. You will also learn how to effectively retrieve, analyse and interpret valuable information from internet browser activity logs, email exchanges and personalised configuration settings (browser and operating system) as a source of digital evidence.

The module is delivered through a 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 either the specialist Computer Forensics Laboratory or the Networking Laboratory (as appropriate).

Where appropriate, additional surgeries may be held to provide additional guidance, support and feedback.

7	Indicative Content

Network Forensics Principles
Sources of Network-Based Evidence
Network investigation and the Microsoft Network Structure
Ports and Services
Analysing System Logs

Network Device Evidence
Routers, firewalls, servers, Intrusion Detection Systems

Deciphering a TCP Header
TCP header analysis
Source and destination ports, SYN and ACK numbers, TCP flags)
Deciphering TCP segments
TCP signature analysis

Wireless Network Analysis
Capturing wireless packets
Investigating wireless routers and switches

Active Directory Principles and Techniques
The Windows Active Directory - application and features.
Introduction to Active Directory PowerShell
Working with Users and Groups
Querying AD data

Email Forensic Analysis
Email protocols
Email identities and data
Email investigation techniques
Email client evidence
Webmail Evidence

Web Browser Forensics
Common browsers and their artefacts and features
Private browsing and data caching
Activity files and formats
Analysis tools and techniques
Registry data
Private browsing mode evidence

Incorporating Network Forensics into Incident Response Plans
Investigation methods
Incident Response (IR)
Web site compromise: search engine spam and phishing
Legal implications and considerations

8	Module Learning Outcomes
	On successful completion of the module, students will be able to:
1	Perform monitoring of network traffic and recovery of digital evidence including log files from various networked systems using a variety of software utilities.
2	Conduct a forensic analysis of captured network traffic and log files by applying appropriate principles of digital forensics and report findings from the investigation.
3	Conduct a forensic analysis of operating system artefacts and configurations relating to network and internet hardware and software.
4	Examine and evaluate internet browser and email activity as a source of digital evidence.

9	Module Assessment		
	Coursework	*Exam*	*In-Person*
1 and 2	*Technical Report 50%*		
3 and 4	*In-Class Test 50%*		
Learning Outcome Number *(from table 8)*	**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 as specified in timetable	*48*	*2 x 12hr Lecture/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 assessment*
Total Study Hours:	*200*	

11	Key Texts and Online Learning Resources

Key Texts

- Lillard, T. Digital Forensics for Network, Internet, and Cloud Computing. 1st ed. Massacheusetts: Syngress
- Anson, S. et al. Mastering Windows Network Forensics and Investigation. 2nd ed. Indiana: Wiley& Sons
- Davidoff, S. and Ham, J. Network Forensics: Tracking Hackers through Cyberspace. 1st ed. Massachusetts : Prentice Hill
- Joshi, R. and Pilli, E. Fundamentals of Network Forensics. 1st ed. Jaipur: Springer
- Liu, D. et al. Cisco Router and Switch Forensics: Investigating and Analyzing Malicious Network Activity. 1st ed. Massacheusetts: Syngress
- EC-Council, Investigating Network Intrusions and Cybercrime. 1st ed. New York: Cengage Learning
- EC-Council. Computer Forensics: Investigating Wireless Networks and Devices. 1st ed. New York: Cengage Learning
- Datt, S. Learning Network Forensics. 1st ed. Birmingham: Packt Publishing Ltd.
- Buchanan, W. Introduction to Security and Network Forensics 1st ed. Florida: CRC Press

Online Learning 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

Module Summary Information

1	**Module Title**	Strategic Information Systems Alignment
2	**Module Credits**	20
3	**Module Level**	6
4	**Module Code**	CMP6194
5	**Semester Taught**	1

6	Module Overview

Organizations operate in dynamically changing environments, responding to opportunities and threats. All organizational resources, including information, systems, and technology must be aligned to achieve the organization's strategy. In this module, you will gain experience in applying strategic analysis tools, soft systems tools, and design thinking tools to analyse complex organizational situations and propose innovative information systems to address wicked problems. The module builds on the information systems foundation of the Level 4 module Business Information Modelling, and the Level 5 module Enterprise Systems to explore the role of sustainable strategic information systems in the digital society.

During the module, you will work individually and in groups to analyse challenges in an organization and assess the role of information to improve the situation and contribute to the achievement of its strategy. Live case studies will be used where possible, supported by recent research and industry practice.

The module is designed as a series of challenge-based workshops. In teams, you will use case-based materials to apply a range of socio-technical analytical tools, develop analytical and communication skills, as well as gain confidence in presenting analysis using a range of methods. During the workshops, class discussions, master classes, and mini interactive lectures will introduce specific theories to support teams as required. Workshops will conclude by providing formative feedback to assist with the assessment.

Independent learning will be supported by a range of materials and activities delivered using Moodle, including:

- Case-based resources (such as videos, interview transcripts, and organizational documents).
- Guidance on how to approach the assessment and opportunities to submit draft work for formative feedback.
- Learning resources (such as practical 'how-to guides', master classes, and links to relevant articles and websites).
- Quizzes to check understanding of key theories, providing immediate formative feedback.
- Recommended reading to broaden understanding of theory and practice.

7	Indicative Content

- Strategic Information Systems
- Socio-Technical Systems.
- Business Models
- Internal and External Strategic Analysis Tools
- Soft Systems Analysis Tools.
- Design Thinking Tools.
- Wicked Problem Solving Tools and Plays.
- Formulating Strategic Information Systems Proposals.

- Role of Problem Structuring and Strategic Information Systems in Digital Transformation.

8	Module Learning Outcomes
	On successful completion of the module, students will be able to:
1	Apply appropriate analytical tools and critically reflect on their effectiveness.
2	Analyse the opportunities and challenges emerging from the application of the analytical tools.
3	Critically evaluate the suitability, effectiveness and sustainability of the opportunities identified from the analysis.
4	Develop a robust information systems proposal to align with the organization's business strategy, demonstrating regular progress.

9	Module Assessment		
	Coursework	*Exam*	*In-Person*
1 and 3	*Essay 70%*		
2 and 4			*Presentation 30%*
Learning Outcome Number *(from table 8)*	**Coursework**	**Exam**	**In-Person**
1	**Slide stack 25%**		
2	**Slide stack 25%**		
3	**Slide stack 25%**		
4	**Slide stack 15%**		**Check-in Progress Review 10%**

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		24 x 2 hour workshops
Directed Learning (DL) includes placements, work-based learning, peer group learning external visits, on-line activity, Graduate+, peer learning, as directed on VLE	112		10 x 10 hours Weekly directed learning including: - Set readings and associated exercises. - Flipped learning preparation (including videos, reviewing case materials) - Online quizzes. 1 x 12 hours to complete the weekly activities and become familiar with the assignment case materials.
Private Study (PS) includes preparation for exams	40		Completing 4 x 10 hour sprints for the coursework
Total Study Hours:	200		

11	Key Texts and Online Learning Resources

Bell, S., Berg. T. & Morse, S., (2016), Rich Pictures; Encouraging Resilient Communities (Earthscan Tools for Community Planning), Routledge.

Bentley, J. & Toth, M., (2020), Exploring Wicked Problems: What Are They and Why are They Important?, Archway Publishing.

Cox, S. A., (2014), Managing Information in Organizations: a Practical Guide to Implementing an Information Management Strategy, Palgrave Macmillan, Basingstoke.

Cox, S. A., (n.d.) ISDABS. Available at: http://www.isdabs.co.uk/ [Accessed date: 05/06/2022]

Finn, E., Wylie., R,. (2021), 'Collaborative Imagination: A Methodological Approach', Futures, 132, 102788.

IDEOU (2022) Introduction to Design Thinking. Available at: https://www.ideou.com/pages/design-thinking [Accessed date: 05/06/2022].

Ilmudeen, A., Bao, Y. & Alharbi, I.M., (2019), "How does Business-IT Strategic Alignment Dimension Impact on Organizational Performance Measures: Conjecture and Empirical Analysis", Journal of Enterprise Information Management, 32(3), pp, 457-476.

ISDABS framework: www.isdabs.co.uk

Kaplan, J. D., (2018), Strategic IT Portfolio Management: Managing Enterprise Transformation, Create Space Independent Publishing.

Lewrick, M., Link, P. & Leifer, L., (2020), The Design Thinking Playbook: Mindful Digital Transformation of Teams, Products, Services, Businesses and Ecosystems, Wiley.

Lewrick, M., Link, P. & Leifer, L., (2020), The Design Thinking Toolbox: A Guide to Mastering the Most Popular and Valuable Innovation Methods, Wiley.

Mangnus, A. C., Renbel, K. T., Vervoort, J. M., Dotinga, R-A., Hoogdendoorn, E., Driessen, P. P. J, Haher, M. A., (2022), 'Picture the Future, Play the Present: Re-Imagining Sustainable Cities Through a Large-Scale Location-Based Game', Futures, 135, 103858.

Őri, D. & Szabó, Z., (2019), "Analysing Strategic Alignment Problems Using Inter-Domain Matches of Enterpreise Architecture Models", 9th Enterprise Engineering Working Conference, EEWC 2019; Lisbon; Portugal; 20-24 May 2019, in: Lecture Notes in Business Information Processing, 374, pp, 135-146.

Wang, Y. and Wang, K. (2017), "How do firms tackle strategic change? A theoretical model of the choice between dynamic capability-based and ad hoc problem-solving approaches", Journal of Organizational Change Management, Vol. 30 No. 5, pp. 725-743.

Whittington, R., Regnér, P., Angwin, D., Johnson, G & Scholes, K., (2019), Exploring Strategy Text and Cases, Pearson.

Wujec, T. (2013) Got a wicked problem? First, tell me how you make toast. [video] Available at: https://www.ted.com/talks/tom_wujec_got_a_wicked_problem_first_tell_me_how_you_make_toast?language=en [Accessed date: 05/06/2022].

Module Specification

Module Summary Information

1	Module Title	Artificial Intelligence and Machine Learning
2	Module Credits	20
3	Module Level	6
4	Module Code	CMP6202

5	Module Overview

Artificial Intelligence (AI) is a core component of computer science, aiming at developing intelligent agents that mimic human's cognitive capability in learning, reasoning, and problem solving. As a branch of AI, machine learning (ML) allows to create software that adapts and learns (from examples), rather than being explicitly programmed for a particular outcome. Both AI and ML rely on managing, processing and analysis of large datasets, something that Data Science (DS) is concerned with. Many services provided by technology giants such as Google, Microsoft, IBM, Facebook, Amazon, etc. are powered by DS, ML and AI. The recent advances in these subjects have already led to significant industrial applications such as self-driving cars and Industry 4.0.

This module aims to lay the foundation for the students to get into these ever-growing areas by exposing them to a wide range of data pre-processing, analysis, visualisation and machine learning techniques. The students will learn different algorithms to solve regression, classification and clustering tasks representing real life problems and how to program them in Python. Finally, the students will be introduced to Agent Technology and Reinforcement Learning that drive modern AI solutions.

The module will be delivered using both lectures and practical classes on a weekly basis. Additional resources will be available on Moodle and in the library for self-study. A substantial part of the learning process will take place while working on the group coursework, which involves finding a dataset, formulating a research problem related to this dataset, and developing a data analytics solution to address the problem.

6	Indicative Content

- Artificial Intelligence, Machine Learning and Data Science overview, concepts and tools
- Programming for AI and ML
- Data pre-processing and visualisation
- Algorithms for classification, regression and clustering
- Building ML predictive models
- Deep Learning
- Agent Technology and Game Theory
- Reinforcement Learning

7	Module Learning Outcomes
	On successful completion of the module, students will be able to:
1	Compare the different aspects involved in the modern Artificial Intelligence, Machine Learning and Data Science.
2	Critically evaluate and practice a range of Machine Learning algorithms, Data Science tools, and frameworks for developing AI solutions.
3	Apply the learned algorithms, tools and frameworks to solve real life problems.
4	Demonstrate skills in formulating research problems and writing technical reports.

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	72	
Private Study (PS) includes preparation for exams	80	
Total Study Hours:	200	

BIRMINGHAM CITY
University

Module Specification

Module Summary Information

1	**Module Title**	Artificial Intelligence for Games
2	**Module Credits**	20
3	**Module Level**	6
4	**Module Code**	CMP6206

5	**Module Overview**

Artificial intelligence is concerned with the goal of building intelligent computing machines. It is multi-disciplinary and as such spans several other subjects, such as computer science (of which it is often viewed to be part), robotics, economic behaviour, psychology. AI techniques are also employed in the rapidly expanding field of predictive analytics in data mining. A good grasp of mathematical reasoning and logic is important therefore, and the study of the topics presented here will help further develop these skills.

Advances in visualization technology have enabled games developers to produce visually compelling, realistic and challenging computer games. These advances in game aesthetics allow further improvements to be made in game design and logic. For this developers need a range of deterministic and non-deterministic techniques, the latter normally associated with the field of artificial intelligence, to imbue games characters with behaviours and strategies which give the illusion of intelligence.

Topics covered within this module include a range of techniques in artificial intelligence: basic mathematics for games, particularly in the field of two-dimensional and three dimensional geometry; movement in computer games which give the illusion of intelligence, such as seeking, fleeing, wandering, steering, obstacles, object intersection and collision avoidance; game physics: aiming and shooting, projectiles, targeting, predator / prey dynamics. Game and game actor states as modelled by finite-state machines, both deterministic and non-deterministic.

More advanced techniques such as game theory for optimising play and decision strategy, and biologically-inspired behaviour such as flocking and emergence, pattern recognition using artificial neural networks and genetic algorithms will also be covered.

6	**Indicative Content**

- Finite State Machines and Behaviour Trees
- Sensors and Agents
- Path Finding (Informed and Uninformed)
- Tree Searching
- Flocking and Crowds
- Decision Making
- Fuzzy Logic
- Neural Networks
- Reinforcement Learning
- Genetic Algorithms

7	**Module Learning Outcomes**	
	On successful completion of the module, students will be able to:	
	1	Demonstrate competence in basic mathematics and physics for games, particularly in the field of two-dimensional and three dimensional geometry, and Newtonian mechanics
	2	Solve problems associated with game AI techniques, such as searching, autonomous movement, state-driven game agent behaviour
	3	Demonstrate competence in using advanced AI techniques such as fuzzy logic, uncertain reasoning, path finding and state managers
	4	Develop complete or partial computer games which incorporate character behaviour and strategies informed by deterministic and non-deterministic game AI techniques

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	92	
Private Study (PS) includes preparation for exams	60	
Total Study Hours:	200	

Module Specification

Module Summary Information

1	Module Title	User Experience Design
2	Module Credits	20
3	Module Level	6
4	Module Code	CMP6214

5	Module Overview

This module will focus on combining theoretical concepts around user experience design with practical "hands-on" approaches used widely in industry and academia to create effective interactive experiences.

You will learn about the user-centred design process that places a core emphasis on designing products, applications, and software for "people". In particular, you will learn techniques for gathering and understanding a target audience's requirements, the importance of universal design and accessibility, and methods for undertaking rapid prototyping.

An emphasis will also be placed on gaining practical experience in designing and conducting usability studies, as well as how to incorporate key findings back into the design process. You will apply this knowledge to design and evaluate an innovative digital prototype using industry standard tools.

6	Indicative Content

- User Experience Design
- Universal Design and Accessibility
- Information Architecture
- Low/High Fidelity Prototyping
- Visual Design and Aesthetics
- User Evaluation and Usability Testing
- User Experience for Innovative Technologies

7	Module Learning Outcomes
	On successful completion of the module, students will be able to:
1	Design and create an interactive prototype through applying user-centred design principles.
2	Critically appraise techniques utilised within a user-centred design methodology.
3	Evaluate a digital prototype to assess the usability of an interactive application.
4	Propose and implement updates to interface designs based on analysis of usability data collected.

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	40	
Private Study (PS) includes preparation for exams	112	
Total Study Hours:	200	

Module Specification

Module Summary Information

1	**Module Title**	Advanced Firewall Systems
2	**Module Credits**	20
3	**Module Level**	6
4	**Module Code**	CMP6220

5	**Module Overview**

The module provides you with an opportunity to gain experience and critically reflect on the skills of software 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**

It is expected that this module will develop the following areas:
- Security Architecture Planning
- Infrastructure Device Configurations
- Cybersecurity Policies
- Application Software Identification
- Antivirus, Anti-Spyware and File Blocking
- Uniform Resource Locator Filtering

7	Module Learning Outcomes			
	On successful completion of the module, students will be able to:			
	1	Critically evaluate the requirements for designing a security architecture.		
	2	Design security policy to prevent attacks for a given network architecture		
	3	Critically evaluate resulting data from security systems to recommend remedial actions and define the requirements for application identification within a given network environment.		
	4	Critically appraise the role of network security 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		
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

Module Summary Information

1	Module Title	Computing for AI
2	Module Credits	20
3	Module Level	6
4	Module Code	CMP6221

5	Module Overview

Computing proficiency is essential in modern data science and a firm grounding is required before the more technical themes of Artificial Intelligence (AI) can be studied. This is the introductory module for the programme where no prior computational foundations are assumed. A holistic view of computing will be provided covering the important themes of data management, programming and security considerations. The module will start from principles of data structures and algorithms, using Python for implementations, which will then be applied to database structures, both SQL and NoSQL, enabling learners to construct programs using standard industrial practices. The assessment will hinge on the successful creation of a portfolio of programs performing essential AI tasks, such as successfully retrieving, analysing and displaying formatted data.

Learning and Teaching

As the first module in the programme the learning and teaching framework will scaffold learners, starting with alignment in the basic principles of practical programming and transitioning towards independent critical learning. The contact sessions will blend taught lectures with practical instructor-led activities, which will gradually build up to prescribed self-directed study problems for learners to work through.

The module provides the opportunity for formative assessment and feedback. The opportunity for formative assessment is included within the assessment brief along with specific dates for submission. This module is very practical, and students will be expected to complete all exercises in the order that they are presented. This approach will enable students to build their knowledge and skills effectively.

6	Indicative Content

This module will cover the following topics:

Data structures and Algorithm Fundamentals
Object Oriented Programming using Python
Relational Databases
NoSQL Databases
Information Security

7	Module Learning Outcomes
	On successful completion of the module, students will be able to:
1	Evaluate efficiency for fundamental data structures and algorithms.
2	Demonstrate a critical understanding of the principal types of databases
3	Implement and appraise programs interfacing with practical database solutions for specified use-cases.
4	Appraise information security risks for algorithms to discuss mitigation strategies.

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 hours	
Directed Learning (DL) includes placements, work-based learning, external visits, on-line activity, Graduate+, peer learning, as directed on VLE	60 hours	
Private Study (PS) includes preparation for exams	92 hours	
Total Study Hours:	200 hours	

Module Specification

Module Summary Information

1	Module Title	Data Management and Machine Learning Operations
2	Module Credits	20
3	Module Level	6
4	Module Code	CMP6230
5	Semester Taught	1

6	Module Overview

This module covers the rapidly growing area of Machine Learning Operations (MLOps) and its coupling with the management and governance of data.

What is Data Management?
Data management is a set of tools, techniques and concepts concerned with the lifecycle of data, from its creation to its usage, through to its retirement. To successfully leverage Data in the modern world, organisations need to provide controlled mechanisms for the progression of data to and from each stage within this lifecycle. In practice, Data management aims to minimise the risk and cost of storing and utilising data in an efficient manner that ensures regulatory compliance, while avoiding legal complications, and security breaches. It also entails the provision of efficient access to accurate data when and, where it is needed, to facilitate effective provision of data-powered services and data-driven decision making.

How this relates to the module
This module covers the acquisition, organization, storage and processing of large volumes of data including developing an understanding of relevant security and privacy issues from both an ethical and a legislative perspective. Since the structure, storage and efficient usage of data is a vital part of Data Science, this module provides input to the other modules on the programme and builds directly upon other modules such as the level 5 database module, Introduction to Data Science and Data Visualisation.

What is ML Ops?
Machine Learning Operations (MLOps) is the Data Science equivalent to the term "DevOps" used in Software Engineering, namely it covers appropriate practices and strategies for organisations to successfully apply Machine Learning techniques in a structured, explainable, repeatable and, importantly, production-ready manner.

How this relates to the module
As well as covering more traditional topics in Data Management and its application to analytics tasks, we will also be exploring some of the issues that Data Scientists may encounter when attempting to deploy solutions in production. A deployed, production Data Science pipeline tends to have various important differences in comparison to what you might deal with in smaller-scale projects. We will explore some of these important differences so that you are aware of some of the key concerns when planning, deploying, managing, and monitoring a production Machine Learning system.

Learning and Teaching.
This module will introduce Data Management techniques through a combination of practice-based activities and theoretical discussions associated with real world issues a Data Science team might encounter. This will be further enhanced by reviewing how MLOps can be used to enhance the capability of organisations through the deployment of Machine Learning systems in a production setting.

You will gain knowledge pertaining to the application of Data Management and MLOps techniques through practical experience, theory in practice and by exploring 'real world' issues via a range of software tools. In addition, you will learn about relevant ethical and legal issues associated with security and privacy when storing large amounts of data, particularly when it relates to personal information.

The module is designed as a series of pre-reading, lectures, interactive discussions, and workshop/lab exercises using a variety of tools and techniques.

To gain a good understanding you are expected to investigate the topics before sessions and to engage with post-session activities and reading. This approach will enable you to gain an insight into how specific Data Management techniques are currently being used in organisations and how these can be augmented using concepts and techniques from the realm of MLOps. This can then aid your understanding of supporting theory and practical application using appropriate software tools. You are expected to come to sessions prepared, having completed all the exercises and activities set.

This module is a mixture of practical application and theory and (unless otherwise specified) you will be expected to complete all set practical exercises in the order which they are provided. This approach will enable you to build your knowledge, skills and practice various embedded, transferable, employability skills.

7	Indicative Content

The following section outlines indicative content for the module and is subject to regular review by the module and course leadership team, elements are subject to change where the team believes it will improve the teaching experience.

- Introducing relevant Data Management theories and methods
    - Relational vs Non-Relational data storage
    - Introduction to Data Warehousing concepts
        - Online Analytics Processing
            - OLAP vs OLTP
        - Deploying a data storage system
            - Locally managed vs cloud
            - Choosing an appropriate storage system
        - Structuring your Data
            - Dimension modelling
            - The ETL Process
                - Data Extraction
                - Data Transformation
                - Data Loading
        - Serving your data
            - Query languages (SQL)
            - Alternative methods of Data Access
        - Data Storage Security
            - Issues
            - Precautions
            - Mitigations
            - Reporting
    - Ethical and Legislative dimensions relevant to data security and information privacy

- Introduction to MLOps theories and method
    - Machine learning project lifecycle
    - Introducing Machine Learning pipelines in production
    - Deploying Machine Learning in production
        - Serving analytics results
        - Scalability
        - Locally managed vs Cloud
        - Containers
        - Assessing a model is production ready (offline testing and evaluation)
    - Managing Machine Learning in production
        - Day-to-day management
        - System updates
        - Technical debt
    - Monitoring Machine Learning in production
        - Monitoring system performance
            - Detecting issues with System health
            - Dealing with system health issues in production
        - Monitoring model performance
            - Online testing and evaluation
            - Detecting drift
            - Dealing with model issues in production

8	Module Learning Outcomes On successful completion of the module, students will be able to:	
	1	Model and effectively communicate data management requirements for analytical operations.
	2	Implement an appropriate structure for the storage, retrieval and analytical processing of data using appropriate software.
	3	Generate insight based on organisational needs by applying appropriate tools to process and analyse stored data.
	4	Evaluate and communicate the ethical and legal issues which underpin concerns related to the security and privacy of data.

9	Module Assessment		
Learning Outcome Number *(from table 8)*	Coursework	Exam	In-Person
1-4	Report 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 Hour lecture / discussion x 12 3 Hour workshop / lab 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	80		Weekly pre- and post-session learning activities and reading as directed on Moodle
Private Study (PS) includes preparation for exams	72		Assessment preparation
Total Study Hours:	200		

11	Key Texts and Online Learning Resources

- Kimball, R., Ross, M. (2013) The Data Warehouse Toolkit: The Definitive Guide to Dimensional Modelling (3rd Edition) , J. Wiley & Sons, ISBN 978-1-118-53080-1
- Inmon, W. (2005) Building the Data Warehouse, 4th Edition, J. Wiley & Sons, ISBN 978-0-7645-9944-6
- Golfarelli, M., Rizzi, S. (2009) Data Warehouse Design: Modern Principles and Methodologies, McGraw Hill, 2009, ISBN 978-0-07-161039-1.
- Raj, E. (2021) Engineering MLOps. Packt Publishing. ISBN 978-1800562882
- Treveil, M., Omont, N., Stenac, C., Lefavre, K., Phan, D., Zentici, J., Lavoillotte, A., Miyazaki, M. and Heidmann, L. (2020) Introducing MLOps. O'Reilly Media, Inc. ISBN 978-1492083290
- Brinkmann, D. (2021) [podcast] MLOps.community. Available at: https://anchor.fm/s/174cb1b8/podcast/rss [Accessed 25 June 2021].
- Charrington, S. (2021) [podcast] TWIML. Available at: https://twimlai.com/shows/ [Accessed 25 June 2021].

Module Specification

Module Summary Information

1	**Module Title**	Business Intelligence
2	**Module Credits**	20
3	**Module Level**	6
4	**Module Code**	CMP6234
5	**Semester Taught**	1

6	Module Overview

The module focuses on applying analytical methods for processing the data generated by organisations to gain insights that inform decisions. The module will introduce you to business intelligence techniques and methodologies to describe, predict and inform decision-making in all aspects of the business. You will have hands-on experience applying tools and techniques, providing knowledge and an analytical mindset to interpret the results generated from the analysis undertaken.

The module adopts a problem-based learning strategy to support you in your learning and promote self-directed learning. The lectures will introduce you to the core theoretical concepts of business intelligence and the tutorials will open discussions to provide you with a richer and more meaningful learning experience. The lab-based activities will develop your practical expertise and skills that can be applied to inform decision-making. Also, working in a team would encourage you to improve soft skills such as communication skills and team-working abilities. Flipped learning methods will be used throughout the module by providing theory before each interactive practical lab.

7	Indicative Content

- Introduction to business intelligence
- Key performance indicators
- Data extraction, loading and transformation
- Introduction to Descriptive Analytics
- Introduction to Predictive Analytics
- Visualisation and interactive dashboards
- Data insights using data storytelling

8	Module Learning Outcomes On successful completion of the module, you will be able to:
	1	Critique business intelligence concepts and methodology.
	2	Select and apply appropriate analytical techniques to model complex datasets recognising the limitations of the techniques employed.
	3	Communicate data analysis results to inform business decisions.

9	Module Assessment		
Learning Outcome Number	Coursework	Exam	In-Person
1-3	100% Portfolio (Technical Report 70% and Video Q&A 30%)		

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 and hands-on activities (4 hours x 12: 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 (reading articles shared on Moodle to facilitate discussion). 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
	• Albright, S.C. and Winston, W.L. (2019) *Business Analytics: Data Analysis and Decision Making*. (7th Ed.), Cincinnati, OH: South-Western College Publishing.
• García, M. & Harmsen, B. (2012) QlikView 11 for Developers. Olton: Packt Publishing, Limited.
• Lachev, T. and Price, E., (2018) *Applied Microsoft Power BI Bring your data to life!* Prologika Press.
• Laursen, G. H. N. & Thorlund, J. (2016) *Business analytics taking business intelligence beyond reporting.* 1st edition. Hoboken, N.J: Wiley.
• Wexler, S. et al. (2017) *The big book of dashboards: visualizing your data using real-world business scenarios.* Hoboken, New Jersey: Wiley.

Module Specification

Module Summary Information

1	Module Title	DevOps and Enterprise Automation
2	Module Credits	20
3	Module Level	6
4	Module Code	CMP6237
5	Semester Taught	1

6	Module Overview

DevOps and infrastructure as code (IaC) are massive shifts to the way systems have previously been managed and developed. According to a Businesswire study of 2021, there will be annual job growth of 19% in the area between 2020 and 2026.

While these practices have their history in the shell/batch scripts written by systems administrators, the complexity and scope of what can be achieved with modern tools are much greater. The rise in large scale datacentres, cloud-based virtual server farms and serverless services has led to the need to manage vast infrastructures in consistent, secure, and efficient ways. As such, manual configuration is often no longer an option for organisations.

In this module, you will learn to apply DevOps practices, tools, and techniques to real-life problems. The module builds on the programming, networking, and operating systems skills from previous years' modules. Specifically, it takes some of the skills from the server systems module and extends them to the realm of enterprise automation.

The module will be assessed mainly by vivas where you will demonstrate your practical work, and a presentation covering theoretical aspects. There will also be an element of peer review where you comment and provide feedback to other students, a key skill expected of those working in this field.

7	Indicative Content

- DevOps core practices and techniques
- Infrastructure as code (including tools such as Ansible and Terraform)
- Virtualisation and containerisation (including tools such as Xen and Docker)
- Microservices and serverless computing
- Continual integration and delivery
- Troubleshooting skills and techniques
- Configuration and code management
- System and code security
- System monitoring
- Systems testing
- Legal and ethical aspects of cloud and datacentres
- Sustainability of enterprise solutions
- Feedback and peer review processes

8	Module Learning Outcomes
	On successful completion of the module, students will be able to:
1	Critically evaluate DevOps and infrastructure skills, tools, and techniques
2	Develop a system automation solution using appropriate tools

	3	Provide constructive feedback on technical and professional work of others, using methods such as peer-review.
	4	Assess the legal, ethical, and sustainability credentials of a computing infrastructure

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

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*		*24 x 2 hour 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*		Online learning, peer learning, and as directed on VLE. This will include watching videos, taking quizzes, background reading etc.
Private Study (PS) includes preparation for exams	*104*		*Assessment preparation, background research and reading around the topic.*
Total Study Hours:	*200*		

11	Key Texts and Online Learning Resources

- Agarwal, G (2021), *Modern DevOps Practices: Implement and secure DevOps in the public cloud with cutting-edge tools, tips, tricks, and techniques*, Birmingham: Packt Publishing.
- Ansible (2022) *Introduction to playbooks — Ansible Documentation* Available at: https://docs.ansible.com/ansible/latest/user_guide/playbooks_intro.html [Accessed 4 May 2022].
- Bullington-McGuire, R., Dennis, A. and Schwartz, M. (2020) *Docker for Developers.* Birmingham: Packtt Publishing.
- Geerling, J. (2020) *Ansible for DevOps: Server and configuration management for humans.* Victoria, British Columbia: Midwestern Mac, LLC.
- Gilbert, J. (2018) *Cloud native development patterns and best practices: practical architectural patterns for building modern, distributed cloud-native systems.* Birmingham: PACKT Publishing
- Goniwada, S. (2021) *Cloud Native Architecture and Design: A Handbook for Modern Day Architecture and Design with Enterprise-Grade Examples.* New York: Apress.

Module Specification

Module Summary Information

1	Module Title	Applied AI for Cyber Security
2	Module Credits	20
3	Module Level	6
4	Module Code	CMP6238
5	Semester Taught	1

6	Module Overview

As cyberattacks grow in volume and complexity, artificial intelligence (AI) is a vital tool assisting security operations analysts to stay ahead of threats. Looking after threat intelligence from millions of research papers, blogs and news stories, AI technologies like machine learning provide rapid insights to cut through the noise of daily alerts, drastically reducing response times. AI is a powerful tool for identifying vulnerabilities, threats, and attacks in cyberspace. AI-based cybersecurity can detect and analyse enormous amounts of data, seeking malicious patterns and providing necessary recommendations.

This module equips you with an understanding of the theory and practice of Artificial Intelligence (AI) in the context of cybersecurity. You will be introduced to a wide range of tools to deepen your knowledge and skills in this rapidly evolving area where the demand for expertise is expected to grow.

The module gives you the basics of Machine learning in cybersecurity. You will explore different machine learning domains to build the right foundation. You will implement various machine learning models such as models to detect spam and fraudulent emails, and malware threats, and implement network anomaly detection. Moreover, you will learn to employ machine learning algorithms such as classification and regression with complex datasets to implement cybersecurity concepts and solve real-world problems.

The module emphasises the development of practical skills supported by a variety of learning activities, including lectures, practice labs, and self-directed and online through Virtual Learning Environments (VLE). The weekly practical hands-on labs allow you to practice with industry-recognised tools and broaden your skills.

7	Indicative Content

1. Introduction to AI for Cyber Security
2. How to evaluate cyber security AI model's performance:
3. Cyber security Dataset Analysis
4. Machine Learning algorithms categories for cybersecurity
5. Tools, technologies and techniques for AI in cybersecurity
6. Detecting Email Cybersecurity Threats with AI
7. Malware Threats Detection
8. Network Anomaly Detection with AI

8	Module Learning Outcomes **On successful completion of the module, you will be able to:**
1	Critically review recent trends in AI for cybersecurity.
2	Design intelligence systems that detect attacks and suspicious patterns.
3	Implement AI models to identify and predict security threats.
4	Evaluate the effectiveness of developed AI cybersecurity models.

9	Module Assessment		
Learning Outcome Number *(from table 8)*	**Coursework**	**Exam**	**In-Person**
1-2	**X** **(**40% in class Moodle test)		
3-4	**X** **(**60% Practical lab-based in class test)		

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 X 12hrs Lecture* *3 X 12hrs Practical labs 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

- Parisi, A. (2019). Hands-On Artificial Intelligence for Cybersecurity: Implement smart AI systems for preventing cyber-attacks and detecting threats and network anomalies, Packt Publishing Ltd.

- Halder, S. and Ozdemir, S., 2018. Hands-On Machine Learning for Cybersecurity: Safeguard your system by making your machines intelligent using the Python ecosystem. Packt Publishing Ltd.

- Das, R., 2021. Practical AI for Cybersecurity. Auerbach Publications.

- Chio, C. and Freeman, D., 2018. Machine learning and security: Protecting systems with data and algorithms. " O'Reilly Media, Inc.".

- Gupta, B.B. and Sheng, Q.Z. eds., 2019. Machine learning for computer and cyber security: principle, algorithms, and practices. CRC Press.