Computer Science, Networking and Digital Media Modules for Visiting Students 2024/25

Introduction:
A wide range of modules is available covering the broad areas of Computer Science, Cyber Security and Digital Forensics, Computer Games Programming and Digital Media Technology.

For **computer science**, introductory (level 4) modules assume no prior knowledge and cover the fundamental domain topics of computing fundamentals, programming, professional practice and system designing. Level 5 (intermediate) and level 6 (advanced) modules are increasingly advanced and assume prior knowledge.

These modules cover the latest software innovations, design patterns, algorithms, programming languages, data structures and tools. Students can learn the latest agile project management approaches, data modelling using UML, relational and object-oriented database systems, data processing platforms used for big data applications, processing of data sets with adaptive algorithms driven by machine learning and visualisation of data for business insight.

For **games programming**, level 4 modules develop game programming skills using the industry standard C++. Specialist modules cover 2D and introductory 3D games programming using a C++ game engine, together with the maths and physics required for game development. Higher level modules cover the creation of games using engines such as Unity and Unreal. Students can further develop their C++, C# and 3D graphics and shader programming knowledge.

For **cyber security and digital forensics**, level 4 modules introduce computer security, digital forensics and legal aspects of forensic investigative processes. Students will also develop web technology (e.g. Javascript, HTML, CSS), Java and Python programming skills; and gain a practical insight into the use of specialised tools and operating system environments. Level 5 modules introducer ethical hacking through practical activities (e.g. password cracking, port scanning, anonymous browsing, keyboard logging, screen capture, packet interception, social engineering and malware). Level 6 modules cover encryption algorithms, public-key cryptography systems, network security techniques, security policies as well as live, network and mobile forensics in the context of a security operations centre.

Modules in **digital media technology** cover the fundamentals of media, 2D and 3D computer graphics, programming, motion graphics, UX design and visual effects. Students are able to create sophisticated media-based products, such as animations, moving graphics, compositing, 3D modelling, texturing, lighting, interactive web content and filming.

Updated April 2024/PJW

Entry requirements	GPA of 2.75 or above (out of 4.0) or equivalent.

Computer Science, Networking and Digital Media Modules for Visiting Students 2024/25

KEY TO MODULE DESCRIPTORS
SUITABILITY OF MODULE FOR STUDENTS VISITING KU ON STUDY OPTION:
1: Indicates module is suitable for students visiting KU on Study Option 1 (Whole Year)
2: Indicates module is suitable for students visiting KU on Study Option 2 (Autumn)
3: Indicates module is suitable for students visiting KU on Study Option 3 (Spring)

Notes:

1. All modules are at undergraduate level only.

2. Students enrolled on Study Option 1 are required to study the entire module.

3. Whilst the University makes every effort to ensure that this information is correct at the time of updating (April 2024), it cannot accept responsibility for omissions or subsequent changes. Module availability and content may be subject to change, as part of the University's policy of continuous improvement and development.

4. Details of assessment for students enrolled on either Study Option 2 or 3 where provided are indicative only and may also be subject to change as part of the above policy.

Computer Science, Networking and Digital Media Modules for Visiting Students 2024/25

MODULE CODE	TITLE	SUITABILITY KEY		
LEVEL 4 – INTRODUCTORY				
CI4001	Introduction to Digital Media	1	2	
CI4002	Computer Generated Imagery	1	2	
CI4105	Programming 1	1	2	
CI4250	Computing Fundamentals	1	2	3
CI4305	Requirements Analysis and Design	1	2	
CI4315	Cyber Crime and Digital Forensics	1	2	
CI4450	Professional Environments 1	1	2	3
CI4500	Games Science	1	2	3
CI4515	Games Programming	1	2	
LEVEL 5 – INTERMEDIATE				
CI5001	Digital Motion Graphics and Compositing	1	2	
CI5002	Multimedia Authoring and Design	1	2	
CI5012	Introductory Digital Media and CGI	1	2	
CI5105	Programming II: Software Development	1	2	
CI5210	Networking Concepts	1	2	3
CI5235	Ethical Hacking	1	2	3
CI5250	Computing Systems	1	2	3
CI5320	Database Driven Application Development	1	2	3
CI5330	User Centred Design	1	2	3
CI5450	Professional Environments 2	1	2	
CI5515	Professional Game Development Environments	1	2	
CI5525	3D Graphics Programming and Artificial Intelligence	1	2	3
LEVEL 6 – ADVANCED				
CI6001	Visual Effects	1		
CI6013	Modelling and Animation	1		
CI6015	Cryptography and Network Security	1	2	

Study Option 1 = Whole Year
Study Option 2 = Autumn
Study Option 3 = Spring

LEVEL 6 – CONTINUED				
MODULE CODE	**TITLE**	**SUITABILITY KEY**		
CI6125	Software Development Practice	1	2	
CI6250	Internet Services and Protocols	1	2	
CI6280	Threat Hunting, Analysis and Mitigation	1		
CI6315	User Experience Design Thinking	1		
CI6320	Advanced Data Modelling	1	2	3
CI6415	Digital Entrepreneurship	1		
CI6330	Mobile Application Development	1		
CI6515	Multiplayer and Game Console Programming	1	2	3
CI6535	Game and Media Creation Processes	1		

LEVEL 4 – INTRODUCTORY

Module Code	**CI4001**
Module Title	**Introduction to Digital Media**
Credits	• Full Year: 8 (US) 15 (ECTS) • Single Semester: 4 (US) 7.5 (ECTS)
Level	4
Prerequisites	None
Suitability	• Suitable for Study Abroad/International Exchange students for Study Options 1 or 2. • Not open to Erasmus students, as level 4.
Content	This module covers two areas: one, the key digital media software applications that manipulate still and moving imagery as well as audio production, and two, the practice of acquiring digital assets through photography and filming, for creative media production. This will entail use of lights, cameras, and editing. The theory is delivered through the lectures and the practice through workshops which underpin all skills acquisition and development.

	➢ **Autumn Semester content: Media Applications (Still Imagery) & Media Production (lights, camera, action)** ❖ ***Media Applications:*** • Introduction to Digital Media • Digital Media Structure • Digital Media Manipulation • Digital Media and Geometry • Digital Media and Aesthetics ❖ ***Media Production (lights, camera, action):*** • Introduction to filming • Camera shots • The colour of light and exposure • Camera tips and Lighting • Sound tracks ➢ **Spring Semester content: Introduction to Media Applications (Moving Images) & Media Production and Post Production (filming & editing)** ❖ ***Introduction to Media Applications (Moving Images)*** • Video fundamentals (structure and formats and editing) • Video application eg Adobe Premier • Audio sampling, compression and creative application • Filters - static, moving, and creative application • Vectors ❖ ***Media Production and Post Production (filming & editing)*** • Story • Editing Styles • Copyright • Looking at the End: End credits, titles and design • Delivery
Teaching	Interactive lectures, workshops, studio based production projects and practical classes
Assessment	Study Option **1**: • Coursework 1: 2D imagery one for still image eg Adobe Photoshop manipulation and the other a video image manipulation eg Adobe Premier (40%) • Coursework 2: filmwork to develop practical media acquisition and manipulation skills embedded in group work (40%) • Portfolio of in-class tests and quizzes (20%)

	Study Option **2**: • Coursework: Photoshop (50%) • CourseworK: Film (50%)
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Module Code	**CI4002**
Module Title	**Computer Generated Imagery (CGI)**
Credits	• Full Year: 8 (US) 15 (ECTS) • Single Semester: 4 (US) 7.5 (ECTS)
Level	4
Prerequisites	None
Suitability	• Suitable for Study Abroad/International Exchange students for Study Options 1 or 2 • Not open to Erasmus students, as level 4
Content	This module introduces students to professional 3D computer graphics and animation. Here students will learn how to construct 3D geometric models, apply shaders using assorted textures, illuminate them and render to static or animated forms. Students will also acquire underlying knowledge to make efficient use of topology for generating 'clean modelling'. The assessment encourages portfolio skills development approach through creation of 3D CGI assets. The module also provides a broad introduction to the fundamental scientific concepts underpinning digitally generated imagery. The module content aims to develop awareness of the six broad areas of 3D Computer Generated Imagery: modelling, texturing, lighting, animation, rendering and the underpinning science based principals that govern these areas. Hence the associated science principals light, waves and motion. Aspects of CG modelling will include working in 3D space co-ordinate systems, vertices, edges, building with primitives, use of polygons including polygonal meshes, introduction to 3D sculpting to more advanced techniques such as bevelling, extrusion, subdividing, polygons, spline based modelling techniques and NURBS curves and surfaces. Aspects of texturing and lighting to include: texture mapping, UV co-ordinates, Shader manipulation and material properties, ambient, occlusion and multiple lit scenes, aspects of

naturalistic and synthetic lighting among many other cg techniques for creating realistic scenes. Introduction to basic animation will include among other topics hierarchies and jointed structures for group manipulation, modifiers, 3D transformations and camera animation techniques.

➢ **Autumn Semester content:**

- **Introduction to 3D:** overview of the Production Pipeline, with a description of the roles and responsibilities of job roles within a Production Workspace. An introduction to the Maya Interface, including the creation of basic Geometry and Navigation
- **Polygons, Components and Modifiers:** An in-depth look at Polygon Primitives. Understanding how to Transform and change the shape of Primitive but adjusting their Components (Faces, Edges and Vertices) in 3D Space. Also what Modifiers are and how to use them to create more complex and detailed Geometry
- **Lighting, Texturing And Rendering:** Looking at the final stages of the Production Pipeline. How to illuminate scenes correctly by creating appropriate lighting and casting shadows. The use of 2D and 3D Textures. Also exploring the creation of Cameras to be positioned and framed ready for Rendering with Maya Software
- **Creating Polygons using Splines:** An in-depth exploration of NURBS Curves, their Components, and how these can be used to quickly generate a large variety of shapes. Also how these can converted to Polygons to add more detail and Texture
- **UV Coordinates:** What are UV Coordinates, and how can these moved and manipulated to create very clean UV Layout for the creation of detailed and precise textures?
- **Light:** Exploring the behaviour of Light and understanding its properties. Looking at Transmission, Reflection, Shadows and Refraction.
- **Waves:** Looking at Light as wave motion. Understanding different Frequencies & Wavelengths. How to understand Refraction in terms of waves, as well as Diffraction & Interference
- **Sound:** Finite speed of sound. Sound as a wave. Frequency dependence of transmission, and the properties of Hearing
- **Motion:** Displacement, Velocity & Acceleration, Newton's Laws, Motion under gravity, Collisions, including "bouncing", the Conservation of Momentum and Kinetic Energy.

➢ **Spring Semester content:**

- **Hypershade and Shader FX:** A comprehensive look at the Hypershade Window, looking at how connections are made and different types of connections of attribute can drive more interesting effects with the use of Utility Nodes. Understanding how to create more complex Shaders with different texture maps to create more realistic looking Materials.
- **Advanced Lighting:** Building on the principles learned, topics will now be explored regarding advanced features of different lights, such as Decay, Volumetric effects and Raytracing effects.
- **Arnold:** a comprehensive look at an advanced renderer, and advanced rendering techniques, looking principles of light interactions in 3D Space such as Direct and Indirect Illumination, Global Illumination and Final Gathering

	• **Stereoscopic Rendering:** Due to the rapid increase of Stereoscopic 3D in Film, these principle of Stereoscopy are vital in understanding current industry trends, as well as how these principles translate to the Games Industry in its use with Virtual Reality • **Overview Principles of Animation** The principles of animation were developed by Disney as tools for an Animator to use to bring characterisation and realism to the way in which everything moves. These principles are still used today by major production studios such as Pixar and Industrial Light and Magic. • **Creating an Animation:** Looking the Maya Interface and using new Windows such as the Graph Editor as a way of understanding the movement of objects, and efficient Tips and Tricks to create simple animations very quickly, such as a Bouncing Ball. Looking at how this translates to a Character Animation. • **Additional Modelling Techniques:** There are many different workflows to create different types of models. This will explore different practices such using Orthographic Projections. Also examples of good and bad practices, as well as topology and edge flow. • **Digital Sculpting:** This is the process of adding in some cases, an incredible amount of detail to a model using Sculpting Programs. The creation of these details is vital in the creation of models in Production of both Films and Games as the demand for more detailed graphics continues to increase. • **Games Specific Techniques: w**ith the line between the quality of models continuing to draw closer and closer, many techniques between the two disciplines are completely transferable, however, due to memory conservation as Games need to render in real-time, traditional shortcuts are used in today's Games. • **Render Passes and Render Layers:** In big budget movies, the goal is usually aim towards complete photorealism. Although this is achievable with programs currently used, it is still common practice for elements of a render to be separated out into separate components for editing and composting later in the production process
Teaching	Lectures, workshops and lab support (one 2-hour lecture and one 2-hour workshop weekly)
Assessment	Study Option **1**: • CGI Coursework Part 1 (30%) • Mathematics & Physics (Light, Sound and Motion) Test (20%) • CGI Coursework Part 2 (50%)
	Study Option **2**: • Coursework: portfolio (100%).
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Module Code	**CI4105**
Module Title	**Programming I**
Credits	• Full Year: 8 (US) 15 (ECTS) • Single Semester: 4 (US) 7.5 (ECTS)
Level	4
Prerequisites	None
Suitability	• Open to Study Abroad/International Exchange students for Study Options 1 or 2 • Not open to Erasmus students (as Level 4)
Content	This module is split 7 sub-modules, of which 3 or 4 are taken over the year. ➢ **Thinking Like a Programmer (Autumn)** • Fundamental programming constructs • Beyond Carol (variables, maths, function parameters and return values) • Introduction to "real" code ➢ **Programming in Javascript (Autumn)** Javascript is one of the basic building blocks of the web. Most modern websites use it to add interactivity to pages. Javascript is also increasingly used in other contexts: games development, mobile applications, server software and much more. • Functions and Variables • HTML and the Document Object Model • Events on the DOM and creating interactivity ➢ **Introduction to Web Programming (Autumn)** • Making Sense of HTML • Images, links & multipage sites • Introduction to PHP • Processing from data in PHP ➢ **Introduction to Java (Spring)** • The Basics of Java Language • Conditional and loop constructs; arrays • Introduction to Object Orientation • "Madness in the Methods": parameters, return values and constructors ➢ **Further Java (Spring)** • Encapsulation and Packaging

	• Arrays (of objects) and Inheritance • Collections • Java Programming in the Real World: IDEs and "bringing it together" ➢ **C++ (Spring)** • Multi-Paradigm Programming • Object-oriented programming • Beyond OO Programming ➢ **Python (Spring)** • Python language constructs • Data Structures • Object-orientation • Python I/O
Teaching	Lectures, tutorials, workshops and exercises (4 hours per week)
Assessment	All Study Options: Portfolio of in-class tests; multiple choice tests; weekly graded exercises; implementations
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Module Code	**CI4250**
Module Title	**Computing Fundamentals**
Credits	• Full Year: 8 (US) 15 (ECTS) • Single Semester: 4 (US) 7.5 (ECTS)
Level	4
Prerequisites	None
Suitability	• Suitable for Study Abroad/International Exchange students for Study Options 1 or 2 or 3 • No open to Erasmus students, as level 4
Content	This module introduces students to the principles behind hardware and software systems, and the important concepts related to modern computer systems. First, following a review of the relevant mathematical principles, students will acquire an understanding of computer architecture, how data are represented, stored and processed, and how the operating system manages hardware and software resources. Second, they will

	understand the main concepts behind databases, network communication, and social media. Finally, students will learn about the essential technologies supporting web development and database management. ➢ **Autumn Semester content:** • **Number Systems and Boolean Logic:** introduction to binary. Developing reasoning skills with Boolean Logic algebra. • **Data Representation:** number and character representations, but also those of text, images, video and audio data. • **Computer Architecture:** functional Units of a computer, processor instruction set and assembly language, Interruptions and external devices • **Web technologies:** the key web technologies of HTML5 and CSS3 ➢ **Spring Semester content:** • **Relational Data:** Databases, Relational Model, SQL introduction, SQL retrieving data from one table, Creating a database from Logical model, SQL - retrieving data from multiple tables. • **Algorithms and Data Structures:** focus on how algorithms are described by pseudocode and flowcharts and learn some basic algorithms, such binary search and bubble sort. In addition, study abstract data types (arrays, records, queues, stacks, trees, graphs, etc) and the algorithms that make use of them. • **Computing Systems:** cover how *interrupt requesting, time slicing* and the concept of a *process* are used to support multi-programming, and how *memory hierarchy, virtual memory* and *paging* techniques allow many processes of arbitrary size share the relatively scarce main memory. Exploration of how files and file systems are implemented on persistent storage devices. • **Communications and Networking:** establishing a basic understanding of the principles underpinning reliable communication between two computers whether neighbours on a company switch or whether between a web client and a remote webserver.
Teaching	Lectures, tutorials, workshops, case studies, exercises, discussion groups, and practice work.
Assessment	Study Option **1**: • Coursework: weekly on-line tests (10 x autumn semester worth 3% each, 10 x spring semester worth 4% each) (100%)
	Study Options **2/3:** • Coursework: weekly on-line tests (100%)

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Module Code	**CI4305**
Module Title	**Requirements Analysis and Design**
Credits	• Full Year: 8 (US) 15 (ECTS) • Single Semester: 4 (US) 7.5 (ECTS)
Level	4
Prerequisites	None
Suitability	• Suitable for Study Abroad/International Exchange students for Study Options 1 or 2 • Not open to Erasmus students, as level 4

Content	The module focuses on the principles, methods, techniques and tools commonly used in the analysis and early design stages of the software development lifecycle (SDLC).
	
	Students work in teams on a software design project, in which they build application prototypes. Projects are framed in an economic, commercial and business context, allowing students to be exposed to professional industry practices in a dynamic and changing environment. Teams will be expected to elicit, analyse and document requirements, applying a variety of software modelling and business modelling principles. Students will be expected to make use of UX and service design principles to understand interactions and the structure of the services, people and processes of an organisation. Prototypes will be designed, created, and demonstrated, in accordance with UX design best practices and requirements will be captured as artefacts via UML models, use cases, user stories, wireframes and other practises.
	
	Topics:
	• Introduction to business, information and systems:
	  ○ Economic, commercial, social and cultural contexts
	  ○ Business model canvas
	  ○ Value proposition design
	  ○ SWOT & PESTLE analysis
	  ○ Nature of information
	  ○ Systems and system boundaries
	  ○ Stakeholders
	• Software development process:
	  ○ Software development life cycles
	  ○ Nature, significance and output of each stage;

	○ Validation of design, control, security, standards. ○ Waterfall, incremental, and agile lifecycles. • Requirements discovery techniques: ○ Research, facilitated workshop, interview, observation, scenarios, prototypes, and personas. • Functional and other types of requirements ○ Documenting requirements via requirements catalogues, use case descriptions, user stories • Requirements analysis and validation • UML modelling ○ Requirements modelling: Use case diagrams and Context diagrams. ○ Process modelling: Business rules, basic business models, e.g. swim lanes, processes, decisions. • Introduction to User Experience/ Service Design: ○ Eliciting usability requirements ○ Cognitive models of the user and tasks e.g. user/ customer mapping/ blueprints, hierarchical task analysis, cognitive walkthrough ○ Selecting appropriate methods for design and evaluation ○ Redesigning according to best practise design principles and heuristics. ○ UX evaluation, design and testing tools ○ Low, medium and high-fidelity prototyping ○ Principles of service design including methods, tools and artefacts. • Demonstration and presentation of a prototype • Presentation of findings and outcomes of analysis and design ➢ **Autumn Semester topics:** • Requirements engineering 1: Stakeholders analysis, Requirements engineering overview, requirements elicitation, functional and non-functional requirements • Requirements engineering 2: Analysis, Prioritisation, Grouping and categorization, description and cataloguing. • Unit case descriptions • Requirements, validation and management • Introduction to Software Development Processes • Introduction to Interaction Design
Teaching	Lectures, workshops, presentations, practical seminars
Assessment	Study Option **1**: • Coursework 1: Analysis, stakeholder and requirements engineering. (40%) • Coursework 2: Design, prototype and usability coursework (40%) • In-class test (20%)
	Study Option **2**: • Coursework: App Design Prototype (100%)

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Module Code	**CI4315**
Module Title	**Digital Forensics Principles and Practices**
Credits	• Full Year: 8 (US) 15 (ECTS) • Single Semester: 4 (US) 7.5 (ECTS)
Level	4
Prerequisites	None
Suitability	• Suitable for Study Abroad/International Exchange students for Study Options 1 or 2. • Not open to Erasmus students, as level 4

Content	This module will introduces the principles and practices of cyber forensics, providing a contextual setting for further modules. In particular, the module has a theoretical perspective (introducing core security concepts and principles, and covering legal, professional and ethical issues, the nature of digital crime and the role of the forensic investigator) as well as a practical technical perspective (gathering, reserving and presenting digital evidence using forensic toolkits).
	
	Topics:
	• Fundamental security terminology
	  ○ CIA triad
	  ○ Assets, threats, vulnerabilities, attacks, risks and controls
	  ○ Basic security methodology
	• Legal principles
	  ○ The British justice system
	  ○ Criminal courts
	  ○ Expert evidence
	  ○ Appropriate laws
	  ○ Admissible evidence
	• Digital forensics
	  ○ The nature of digital crime (eg. fraud, data protection, identity theft)
	  ○ Definitions, sources of digital evidence, overview of acquisition, preservation, analysis and presentation
	  ○ The sub-disciplines (eg. computer forensics, mobile, GPS)
	• Crime scene investigation
	  ○ First responder
	  ○ Forensic methodologies for collecting and preserving digital evidence

- Volatile vs. persistent data
- Documenting the scene, note taking and report writing
- Role of the digital forensics examiner, certification, ethics, professional bodies

- Forensics tools
  - Overview and classes of digital forensics tools
  - Creation of a trusted set of tools for the collection of data
  - Formats (raw, proprietary, advanced forensic format)
  - Tools (console, Linux boot cd, ProDiscover Basic, Access Data FTK imager)
- Windows file systems
  - Boot sequence, disk partition, master boot record, FAT and NTFS file structures
  - Computer time artefacts (MAC times)
  - Registry analysis
- Anti-forensic techniques
  - Hidden disk partitions, cryptographic techniques (bit-shifting, steganography, encryption), passwords
- Data recovery
  - Hidden partitions, deleted files, hidden files
  - Graphic files, encrypted files, link files
  - Carving, thumbnails, passwords
- Validation
  - Hash values
  - Tools (hexadecimal editors, ProDiscover Basic, Access Data FTK imager)
- Application and file forensics
  - Internet history, web and browser caching
  - Email investigations
  - Servers, headers, tracing and logs
  - MS Office applications
  - File signatures, meta data
- Python and digital forensics
  - Introduction to Python
  - Basic python forensic scripts

➢ **Autumn Semester content: Introduction to Digital Forensics & Cybercrime Investigation: Cybersecurity Fundamentals & Cryptography**

- An Introduction to Virtual Machine
- Digital evidence
- Cyber crime
- Cyber security fundamentals
- An Introduction to Steganography
- An Introduction to Cryptography
- Role of the Forensic Scientist
- Introduction to Hash Functions
- Digital crime scene investigations

	• Web browser forensics • digital forensics
Teaching	Interactive lectures/lab sessions
Assessment	Study Option **1**: • Coursework portfolio 1: forensics case study (30%) • Coursework portfolio 2: digital forensics tool, e.g. the FTK, Autopsy and Access Data Mobile Forensics materials (30%) • Forensic Techniques Open-Book Exam: case study (40%)
	Study Option **2**: • Coursework portfolio 1 (100%)
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Module Code	**CI4450**
Module Title	**Professional Environments 1**
Credits	• Full Year: 8 (US) 15 (ECTS) • Single Semester: 4 (US) 7.5 (ECTS)
Level	4
Prerequisites	None
Suitability	• Suitable for Study Abroad/International Exchange students for Study Options 1 or 2 or 3 • Not open to Erasmus students, as level 4

Content	The goal of this module is to prepare students for professional practice firstly by ensuring they acquire suitable employability assets and secondly by equipping them with an understanding of the role of a professional in society and the role of professional bodies. While the bulk of the taught programme focuses primarily on domain knowledge, the module focuses on developing key skills, personal qualities (eg commercial awareness, reliability and punctuality, understanding the centrality of customers and clients), and professional knowledge including the need to engage with continuing professional development. With such assets, students will generate a CV, an employment portfolio, and a professional online presence. Being a professional also means understanding the key legal, ethical and societal issues pertinent to the domain, and understanding the need for continuing professional development (CPD) especially when technology develops at such a rapid pace. The module is designed to support different domain areas and to integrate experience from other professions. The subject areas being studied demand a global perspective which encourages the inclusion of our diverse communities and national practices. The module is designed to support different domain areas and to integrate experience from other professions. The subject areas being studied demand a global perspective which encourages the inclusion of our diverse of communities and national practices. Reflecting the fact that team working is ubiquitous in the modern workplace, a significant proportion of the assessment work on the course is group-work based. There is considerable evidence that group work promotes a much deeper engagement with taught content. It also encourages the development of diverse learning communities. This module will therefore introduce students to best practice in group working covering how to approach group work, how to deal with different types of people, and methods of selecting and managing groups. ➢ **Autumn content:** • **Legal, Ethical and Social issues:** ○ The Impact of Technology on Society ○ Legal Aspects of Professional Practice ○ Ethics and Professional Practice • **Digital Security** ○ Introduction to Security Concepts ○ Introduction to Security Mechanisms ○ Introduction to Security Policy • **Introduction to Communication Skills** ○ Report Structure and Argumentation ○ Teamworking: psychometric testing and organisational culture ○ Research Skills and Referencing

	➢ **Spring content:** • **Employability** ○ Introduction to an Employability Asset Model ○ Creating a CV ○ Creating a LinkedIn Account ○ Psychometric Testing ○ Interview skills • **Commercial awareness** ○ Commercial Challenges for Sustainable Cities ○ Understanding the Customer ○ Competitors, Segments, and Targetting ○ Developing the Business Plan and finding funding ○ The Pitch
Teaching	Interactive lectures/lab sessions
Assessment	Study Option **1**: • Communications skills portfolio - 3 technical reports (30%) • Employability portfolio - Pebblepad workbooks and construction of a web portfolio (40%) • Commercial awareness coursework: pitch and pitch panel (40%)
	Study Option **2**: • Individual portfolio: two technical reports • Employability portfolio
	Study Option **3:** • Commercial awareness coursework: pitch and pitch panel • Employability portfolio
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Module Code	**CI4500**
Module Title	**Games Science**
Level	4
Suitability	• Full year: 8 (US) 15 (ECTS) • Single semester: 4 (US) 7.5 (ECTS)
Credits	4
Pre-requisites	• None for study options 1 or 2 • For Study Option 3, prior study of freshman-level maths and basic understanding of C++
Content	The module gives essential background in applied mathematics and physics for computer games developers. This will be done with a strong focus on practical engineering aspects and all the theoretical concepts will be introduced as elements of solutions of real problems typically encountered during the games development process. Topics covered include: ➢ **Autumn Semester topics: Mathematics** ❖ ***Data and their Representation:*** • Number Systems& Binary Calculations • Binary Calculations (signed numbers) • Representation of Numbers in Computing ❖ ***Geometry and Trigonometry*** • Boolean and Bitwise Logic • Trigonometry and Geometry ❖ ***Algebra of Vectors*** • Vector Algebra • Vector Practice • Vector Multiplication: Dot & Cross Product • How to Solve Triangles with Vector Algebra, Equation of Motion, Projection & Distance ❖ ***Numerical Simulation*** • Calculations in Physics and Game Engines ➢ **Spring Semester topics: Physics**

Content	❖ ***Vehicles and Particles*** • Mechanics of Cars • Aircraft, Flight Simulation and Space Flight • Particle Systems
Teaching	Lectures/workshops/tutorials
Assessment	Study Option **1** • Three 30-minute maths tests (20%) • Three 30-minute physics tests (20%) • Game science project (40%) • Portfolio of assessed workshop activities (20%)
	Study Option **2**: • Portfolio of tests/workshop activities (100%)
	Study Option **3**: Portfolio (100%)
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Module Code	**CI4515**
Module Title	**Games Programming**
Credits	4
Prerequisites	• Full year: 8 (US) 15 (ECTS) • Single semester: 4 (US) 7.5 (ECTS)
Credits	4
Suitability	• Suitable for Study Abroad/International Exchange students for Study Options 1 or 2 • Not open to Erasmus students, as level 4.

Content	This module provides an introduction to computer games development. It encompasses computer and games systems, games development tools and environments, games testing and games design. Students will be introduced to the design and the development of a simple 2D and 3D game as part of the assessment.
	
	➢ **Autumn Topics:**
	
	• Game Analysis: Games Ludology and Cybernetics
	• Introduction to C++ programming language
	  ○ Computer and Game Systems
	  ○ Data Variables and Operators
	  ○ Languages and Compilers
	  ○ Control Statements and Loops
	  ○ Functions
	  ○ Text Handling
	  ○ Object oriented principles
	
	• More advanced C++ concepts
	• The GFC 2D Game Engine and application
	• Games programming theory
	
	➢ **Spring Topics:**
	
	• 2D game development studio practice
	• 3D graphics technology and 3D game engine
	• 3D game development theory
	• 3D game development workshop

Teaching	Lectures/workshops
Assessment	Study Option **1**: • C++ Programming Test (5%) • 2D Games Programming -Assessed Workshops (6%) • Games Programming Test (5%) • Assignment – 2D game (individual) (40%) • 3D Games Programming Test (4%) • Assignment – 3D game (pairs or individual) (40%)

	Study Option **2**: • C++ Programming Test • 2D Games Programming • Games Programming Test • Assignment – 2D game (individual)
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LEVEL 5 – INTERMEDIATE

Module Code	**CI5001**
Module Title	**Digital Motion Graphics and Compositing**
Credits	• Full year: 8 (US) 15 (ECTS) • Single semester: 4 (US) 7.5 (ECTS)
Level	5
Prerequisites	Successful completion of introductory level modules such as CI4001 and CI4002, requiring a reasonable knowledge of Adobe Photoshop, Premier or at least some imaging experience.
Suitability	Study Options 1 and 2

Content	This module builds on the foundations of introductory (level 4) study and develops knowledge and skills in creating and manipulating motion graphics assets, managing the editing process and compositing multi layered as well as multi nodal visual effects. This includes still images, video, audio, paint, and video based animation and effects. These skills are further developed to a high level of appreciation, in particular for the flow of work for digital editing and contemporary composting in 2D and 3D spaces. The students will acquire knowledge, develop skills and synthesis media products for self and tutor assessment. Professional level motion graphics, editing and compositing software will be employed. Furthermore studio based green/blue screen filming will be undertaken to create original material for visual effects project work. ➢ **Autumn Semester: Introduction to Digital Motion Graphics & Intermediate Motion Graphics** • Introduction and review of contemporary digital Motion Graphics software • Identifying and use key of elements of the interface eg workspace, panels, menus etc • Composition tools for creating mixed media Motion Graphics • Explore layering techniques using 2D, 2.5D and 3D spaces • Animating a variety of media and techniques eg layers, key-frames, editing, motion path...etc • Keying, masking and their use within Motion Graphics • Explore Effects and their applications • Exporting to various formats and compatibility issues • Project planning and workflow ➢ **Spring Semester: Introduction to Compositing** • Interface to non-linear methods of working ie node based workflow • Post production workflow eg. DV capture, rough cut, final cut • Introduction to colour management e.g. multiple colour models, colour correction, gamma, blackpoint/whitepoint, log and linear col space, normalization, multiply, add, gamma...etc • Keying eg. chroma, luma, difference, channels...etc • Introduction to rotoscoping eg splines, transformations, soft/hard edges...etc • Introduction to digital matte painting eg to generate background plate • Tracking and image stabilisation • Introduction to combining CGI multipasses appropriately eg. diffuse, shadow, highlights...etc • Integration with other software applications • Rendering eg multiple format output
Teaching	Interactive lectures, workshops and studio-based production projects.

Assessment	Study Option **1**: • Coursework 1 Digital Motion Graphics (40%) • Coursework 2 Compositing (40%) • Portfolio of in-class tests and quizzes (20%)
	Study Option **2**: • Coursework (100%)
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Module Code	**CI5002**
Module Title	**Multimedia Authoring and Design**
Credits	• Full year: 8 (US) 15 (ECTS) • Single semester: 4 (US) 7.5 (ECTS)
Level	5
Prerequisites	Successful completion of introductory level modules such as CI4001 and CI4002, requiring some imaging experience e.g. Photoshop, Animate...etc and familiarity with basic coding
Suitability	Study Options 1 and 2

Content	The primary aim of this module is to develop a range of skills in the creation of Multimedia products, through the study and production of sophisticated content driven interactive material using industry standard multimedia authoring software. Students will also be taught to write computer code (script) to a high level using a scripting language in order to generate interactive content, animation, navigation and data storage/retrieval. **Content:** • Introduction, history and key concepts of contemporary multimedia software • Explore the key elements of an authoring environment, including tools, libraries, properties, scripting windows, timelines, objects, and frames etc. • Explore content creation techniques using 2D and 3D spaces. • Explore animation techniques eg. vector tween: shape, motion, path...etc. • Principles of interactive design, animation and navigation. • Vector data sets eg. properties, alpha levels, clip properties and interactions. • Raster data sets eg. image properties and interactions. • Video data sets eg. movie clip properties and interactions. • Audio data sets eg. audio clip properties, manipulation and interactions. • Programming concepts: creating, optimizing, testing and debugging. • Creating script instructions; decision statements, functions, logic, arrays, tweening, connectivity to external data files etc. • Incorporating triggers; actions and event handlers into applications. • Adding and developing a range of interactive controls and digital assets for user interaction. • Creating games, using one or more animated elements, or objects via the time line, or using scripting techniques. ➢ **Autumn Semester: Multimedia; Animation** ❖ ***Multimedia:*** • Design Concepts • Storyboards, layouts and Typefaces • Xd Grids and Artboards • Gestalt, Interactive Prototypes and testing ❖ ***Animation:*** • Animation and Introduction to Adobe Animate • Principles of Animation • Frames and Animation • Graphics, Symbols & Buttons • Interactive timeline control and Event listener
Teaching	Lectures, workshops and lab support to replicate an industry environment.

Assessment	Study Option **1**: • Multimedia coursework 1: Xd Prototypes (20%) • Multimedia coursework 2: Interactive multimedia (30%) • Multimedia coursework 3: Animation & code (50%)
	Study Option **2**: • Multimedia coursework (100%)
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Module Code	**CI5012**
Module Title	**Introductory Digital Media and CGI**
Credits	• Full year: 8 (US) 15 (ECTS) • Single semester: 4 (US) 7.5 (ECTS)
Level	5
Prerequisites	Successful completion of introductory level modules such in digital media, such as CI4001 and CI4002 or similar.
Suitability	Study Options 1 and 2

Content	Students will learn the underlying principles of digital imaging in both its static and moving forms. The theory will be supported by workshops using professional imaging, and video editing software, as well as software tools for manipulating audio. The CGI Foundation part introduces students to the use of a professional 3D computer graphics and animation application. Students will learn how to build 3D models, shade them using assorted textures, illuminate them and render them out as images. They will learn how to make an efficient use of data, and appreciate the underlying topology of the geometry that makes up that model. ➢ **Autumn Semester: Introduction to Digital Media; Introduction to CGI** ❖ ***Introduction to Digital Media*** • Digital Media Structure • Digital Media Manipulation • Digital Media and Geometry • Digital Media and Aesthetics ❖ ***Introduction to CGI*** • Polygons & Modelling • Materials and Texturing • Lighting & Rendering • Curves & Modelling ➢ **Spring Semester: Introduction to Digital Media 2; Introduction to CGI** ❖ ***Introduction to Digital Media 2*** • Video fundamentals (structure and formats) • Video application eg Adobe Premier • Audio sampling, compression and creative application • Filters - and application • Vectors ❖ ***Introduction to CGI 2: 3D Graphics*** • Principles of Animation • UV Mapping & Texturing • Rendering & Lighting in Arnold • Polygon Modelling & Digital Sculpting • Games Specific Techniques
Teaching	Interactive lectures, workshops and studio-based production projects.

Assessment	Study Option **1**: • Coursework: Photoshop (20%) • CGI coursework Part 1 (20%) • Coursework: Premiere (20%) • CGI coursework Part 2 (20%) • Quizzes (10%) • In-class test (10%)
	Study Option **2**: • Coursework: Photoshop (20%) • CGI coursework Part 1 (20%)
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Module Code	**CI5105**
Module Title	**Programming II: Software Development**
Credits	• Full year: 8 (US) 15 (ECTS) • Single semester: 4 (US) 7.5 (ECTS)
Level	5
Prerequisites	Successful completion of Programming 1 CI4105 or equivalent
Suitability	Study Options 1 and 2

Content	This module seeks to extend students' understanding and proficiencies in the fundamental concepts of programming, giving them the ability to build complex applications across a variety of platforms and channels. Students will be exposed to different programming paradigms including a comprehensive treatment of the object-oriented paradigm, selection and use of data structures, use of libraries and APIs including user interface components. It will also introduce important tools and techniques used by software development teams in such as integrated development environments, revision control systems, dependency management, code profiling and optimisation techniques. Although the module focuses on the implementation stage, it links this stage with different software development methodologies. It also provides links with the other stages of the software development life cycle. ➢ **Autumn Semester: Fundamentals of Software Development** • Java Classes, Objects and Interfaces • Java APIs: Java Collection Framework and Input/Output (java.io, java.nio) • Java APIs: Graphical User Interfaces (javax.swing) ➢ **Spring Semester: Software Application Development & Advanced Programming** ❖ ***Software Application Development*** • Development Environments, Processes and Planning • Implementing and Testing a Model • Desktop Application Development - GUI and MVC ❖ ***Advanced Programming Concepts*** • Regular Expressions • Recursion • Functional programming ("Lambda")
Teaching	Interactive lectures and workshops
Assessment	➢ Study Option **1:** • Gateway Test 1: Java Classes, Objects and Interfaces Test (20%) • Gateway Test 2: JCF and I/O; Java APIs: Java Swing (30%) • Swing portfolio of four weekly exercises (20%) • Java Software Application Development (30%) ➢ Study Option **2:** • Gateway Test 1: Java Classes, Objects and Interfaces Test (40%) • Gateway Test 2: JCF and I/O; Java APIs: Java Swing (60%)
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Module Code	**CI5210**
Module Title	**Networking Concepts**
Credits	• Full year: 8 (US) 15 (ECTS) • Single semester: 4 (US) 7.5 (ECTS)
Level	5
Prerequisites	Successful completion of introductory university-level computer science.
Suitability	Study Options 1 or 2 or 3

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Content	With a strong emphasis on understanding the Internet protocols, this module will develop students' your understanding of the basic principles of networking. They will become familiar with current LAN and WAN technologies and their role in building domestic and corporate networks. This knowledge will underpin the skills required to design and simulate small company networks including identifying the physical components required and to design an appropriate IP addressing schemes for such network. It will also underpin the understanding of how network services such as mobile apps and network-based games are implemented. **Topics:** • Layering principles including encapsulation • Roles of the different OSI layers i.e. the application, presentation, session, transport, network, link and physical layers and their relationship to TCP/IP protocols • Naming and address schemes such as DNS names, and MAC and IP addresses • Distributed application artitectures such as client/server and peer-to-peer • Error control (retransmission techniques, timers) • Flow control (acknowledgements, sliding window) • Performance issues (pipelining) • The TCP and UDP protocols • Routing techniques • IP Protocol • Switching • 802.11 (Wifi) networks • Network specific threats and attack types (e.g., denial of service, spoofing, sniffing and traffic redirection, man-in-the-middle, message integrity attacks, routing attacks, and traffic analysis) • Use of cryptography for data and network security ➢ **Autumn Semester:** • ***Introduction to Network Concepts***: Introduction to the key networking concepts of packetization, encapsulation and protocol layering. A review of OSI Reference Model and responsibilities and issues of each layer. The role of common network components such as LANs and routers. • ***Introduction to Network Technologies****:* The basic network hardware components of corporate and domestic networks. Understanding how the typical wired (Ethernet) and wireless LAN technologies work and a review of typical WAN services.

	• ***Introduction to TCP/IP*** The TCP/IP protocol stack and the role of IP, TCP, UDP, DNS and ports. Routing concepts including domains, subnets, routing tables and routing protocols. The role and structure of IP Addresses and their relationship with MAC Addresses. Transport layer mechanisms including ports, segmentation and connection-oriented vs. connection-less delivery. ➢ **Spring Semester:** • ***Introduction to Routing Protocols*** The concepts of "distance vector" and "link state" routing. The RIP2, OSPF, EIGRP and BGP protocols. Configuring access control lists for routers. • ***DNA and DHCP*** Mechanisms for translating between IP addresses and textual domain names, and for automatically configuring hosts connected to a network. • ***Socket Programming*** Writing simple programs to communicate with each other across the Internet, using the network socket API.
Teaching	Two two-hour classroom-based sessions weekly
Assessment	Study Option **1**: • Coursework 1: *Network Design Portfolio* of physical design, IP addressing scheme design, and address assignment tasks (30%) • Coursework 2: Network simulation or socket programming practical exercise (30%) • Two-hour exam (40%)
	Study Option **2**: • Physical and IP Addressing System Design (100%)
	Study Option **3**: • Design, Configuration and Troubleshooting of Network Routing Protocols (100%)
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Module Code	**CI5235**
Module Title	**Ethical Hacking**
Level	5
Suitability	Study Options 1 or 2 or 3.
Credits	• Full year: 8 (US) 15 (ECTS) • Single semester: 4 (US) 7.5 (ECTS)
Pre-requisites	Successful completion of introductory university-level computer science.

Content	This highly technical module commences by introducing students to the fundamental steps and frameworks needed for practical and ethical hacking exercises. They are then introduced to the Python programming language and the use of Python scripts for various ethical hacking activities, examples of which may include; password cracking, port scanning, anonymous browsing, keyboard logging, screen capture and packet interception.
	
	Overall topics:
	
	• Introduction to ethical hacking terms and concepts
	  ○ Reconnaissance: social engineering, ping, HTTrack, Google, Whois
	  ○ Scanning: port scanning, vulnerability scanning, penetration
	  ○ Exploitation: password resetting, sniffing network traffic, code injection, cross-site scripting, Metasploit, John the Ripper
	  ○ Maintaining access tools: Netcat, netbus, rootkits
	
	• Python Programming: Installation, Python IDEs, variables, user input, strings, numbers, file I/O, lists, tuples and dictionaries
	
	• Vulnerability assessments/hacking with Python
	  ○ Passive Forensics, Active Surveillance, The Windows Registry, Logging Keyboard Input, Taking Screenshots, Local Systems, Receiving Commands, Exfiltration and Deploying Updates, Packet Sniffing, Packet Interception, ARP poisoning
	
	• Hardware, Software and Web Application Vulnerability Assessments
	  ○ Mobile devices, Office, DVWA, ZAP, WebGoat

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Content	➢ **Autumn Semester:** • Reconnaissance and Information Gathering • Scanning and Discovery • Vulnerability Exploitation ➢ **Spring Semester:** • Maintaining Access and Covering Tracks • Review and Reporting
Teaching	Lectures and workshops
Assessment	Study Option **1:** • portfolio of vulnerability assessment tasks coursework (30%) • Practical test (30%) • Coursework: analysis of Android Apps Python scripting (40%)
	Study Option **2**: • portfolio of vulnerability assessment tasks coursework (50%) • Practical test (50%)
	Study Option **3**: • Coursework: analysis of Android Apps Python scripting (100%)
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Module Code	**CI5250**
Module Title	**Computing Systems**
Level	5
Suitability	Study Options 1 or 2 or 3
Credits	• Full year: 8 (US) 15 (ECTS) • Single semester: 4 (US) 7.5 (ECTS)

Study Option 1 = Whole Year
Study Option 2 = Autumn
Study Option 3 = Spring

Pre-requisites	Successful completion of introductory university-level computer science.
Content	The module aims to enhance students' understanding of how modern computer systems are implemented from the perspectives of architecture, networking, operating system, parallel programming and algorithm complexity. Students will explore the essential features and operations of modern computer architectures and acquire both theoretical and practical knowledge of the principles and major functions of modern operating systems. They will also develop knowledge of parallel programming and algorithm complexity so that they will be able to make use of new parallel computer architectures. Physical networks and their associated address schemes will also be explored. ➢ **Autumn Semester: Networking; Operating Systems** ❖ ***Networking*** • Layering principles • Roles of the different layers (application, transport, network and link) • IP Addressing • Network specific threats and attack types ❖ ***Operating Systems*** • Process management, memory management, file management, input/output management • Examples of operating systems, e.g. Linux and Windows • System, process and data security ➢ **Spring Semester: Parallel Programming; Algorithms & Complexity; Computer Architecture** ❖ ***Parallel Programming*** • Amdahl's law, processes, threads, race conditions, synchronisation, mutexlock, semaphores, load balancing • Communication models: shared memory, e.g. OpenMP, and message passing, e.g. MPI

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Content	❖ ***Algorithms and Complexity*** • floating-point operations and fundamental instructions • time and space complexity, limiting behaviour, big O notation, recursive algorithms, optimization ❖ ***Architectures*** • Von Neumann model, Flynn's classification, parallel architectures including multi-core processors, GPUs, games consoles and clouds, instruction set architectures • Pipelining, memory hierarchies, instruction level parallelism
Teaching	Two 2-hour classroom sessions weekly
Assessment	Study Option **1:** • Networking assignment (15%) • Operating Systems Assignment (15%) • Parallel Programming Assignment and Algorithm complexity (15%) • Computer Architectures Assignment (15%) • Final exam (40%)
	Study Option **2**: • Networking assignment (50%) • Operating Systems Assignment (50%)
	Study Option **3**: • Parallel Programming Assignment and Algorithm complexity • Computer Architectures Assignment
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Module Code	**CI5320**
Module Title	**Database Application Development**
Level	5
Suitability	Study Options 1 or 2 or 3
Credits	• Full year: 8 (US) 15 (ECTS) • Single semester: 4 (US) 7.5 (ECTS)
Pre-requisites	• Successful completion of introductory university-level computer science. • In addition, for study option 3, prior study of database design and development
Content	This module seeks to establish the skills required to build full-stack database-driven web applications. Students will learn how to design, build and query databases according to user information needs using logical data models and structured query language (SQL). They will also learn how to design and build scalable interactive applications that are delivered over the web and integrated with a backend database. **Topics:** ➢ **Autumn Semester: Database Design and Development** • the Relational Model • Data Modelling • Logical Database Design • Normalisation • Relational Algebra • Introduction to SQL • DB Security • Transaction Management • Internet Database Environment ➢ **Spring Semester: Web Development** • Introduction and the basics of Object Oriented PHP • Separating your concerns • MySQL and Databases in PHP • Forms, user input and sessions • Bringing it all together

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Computer Science, Networking and Digital Media Modules for Visiting Students 2024/25

Content	➢ **Spring Semester Continued:** • Styling (CSS) and catering for mobile • Javascript and JQuery • AJAX and web services • Accessibility
Teaching	Weekly two-hour lectures and two-hour practical workshops
Assessment	Study Option **1**: • Coursework on database design & implementation (25%) • Web application project (25%) • Exam (50%)
	Study Option **2**: • Coursework on database design & implementation (100%)
	Study Option **3**: • Web application project
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Module Code	**CI5320**
Module Title	**Database Application Development**
Level	5
Suitability	Study Options 1 or 2 or 3
Credits	• Full year: 8 (US) 15 (ECTS) • Single semester: 4 (US) 7.5 (ECTS)
Pre-requisites	• Successful completion of introductory university-level computer science. • In addition, for study option 3, prior study of database design and development

Study Option 1 = Whole Year
Study Option 2 = Autumn
Study Option 3 = Spring

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Content	This module seeks to establish the skills required to build full-stack database-driven web applications. Students will learn how to design, build and query databases according to user information needs using logical data models and structured query language (SQL). They will also learn how to design and build scalable interactive applications that are delivered over the web and integrated with a backend database. **Topics:** ➢ **Autumn Semester: Database Design and Development** • the Relational Model • Data Modelling • Logical Database Design • Normalisation • Relational Algebra • Introduction to SQL • DB Security • Transaction Management • Internet Database Environment ➢ **Spring Semester: Web Development** • Introduction and the basics of Object Oriented PHP • Separating your concerns • MySQL and Databases in PHP • Forms, user input and sessions • Bringing it all together • Styling (CSS) and catering for mobile • Javascript and JQuery • AJAX and web services • Accessibility
Teaching	Weekly two-hour lectures and two-hour practical workshops
Assessment	Study Option **1**: • Coursework on database design & implementation (25%) • Web application project (25%) • Exam (50%)

	Study Option **2**: • Coursework on database design & implementation (100%)
	Study Option **3**: • Web application project
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Module Code	**CI5330**
Module Title	**User Centred Design**
Level	5
Suitability	Study Options 1 or 2 or 3
Credits	• Full year: 8 (US) 15 (ECTS) • Single semester: 4 (US) 7.5 (ECTS)
Pre-requisites	Successful completion of introductory university-level computer science.

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Computer Science, Networking and Digital Media Modules for Visiting Students 2024/25

Content	HCI is the core academic discipline that examines the relationship and interface between human and computer. It informs and provides the theoretical and methodological foundation for User Experience, the professional discipline which is practically applied. Students will explore major themes in HCI from both a theoretical and a practical perspective. The module will establish an understanding of key concepts within HCI theory and methods, and examines techniques for HCI design and evaluation. It offers students a practical domain in which to apply knowledge and skills, including those from other modules, to the design, implementation and analysis of interfaces between people and computer systems. Students will undertake practical exercises in which they evaluate real-world problems to identify user experience issues. They will utilise the synthesis of data from methods which explore user needs and requirements and also users' cognitive models to build a suite of artefacts e.g. personas, user journeys, empathy maps etc which will inform a prototyping phase. This process involves interatively building on low, medium and high fidelity prototypes of increasing complexity and levels of interation. Thus students synthesise theory and empirical data to build their prorototypes of a redesign solution to usability issues. These artefacts will iteratively and incrementally inform a user centered redesign. The curriculum is designed around the user centred design process: • **evaluating** a digital product • **understanding** the users' behaviour, practices and needs • (re)**designing** to both meet users' needs and comply with best practices • Iterating through a number of **prototype** fidelities, incrementing each time until a sufficient level of complexity has been reached that facilitates implementation ➢ **Autumn Semester:** • Definition of User Centred Design • Understanding the concepts of human computer interaction • User Markets and Domains • Responsive Web Design • Evaluation of the design and the prototype • Demonstration of designs, prototypes and walkthroughs ➢ **Spring Semester:** • Navigation structures • Examples of web sites with contemporary user interface designs • Information Architecture • User Interface Design Step-by-Step • Using Wireframes and Mock-ups to Express the User Interface Design • Approaches to Developing Prototypes • Evaluation and Inspection of the Designed User Interface

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Teaching	Lectures/workshops
Assessment	Study Option **1**: • Evaluation coursework (45%) • Design coursework (45%) • Oral presentation (10%)
	Study Option **2**: • Evaluation coursework (100%)
	Study Option **3:** • Design coursework (100%)
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Module Code	**CI5450**
Module Title	**Professional Environments 2**
Level	5
Suitability	Study Options 1 or 2
Credits	• Full year: 8 (US) 15 (ECTS) • Single semester: 4 (US) 7.5 (ECTS)
Pre-requisites	Successful completion of CI4450 or equivalent

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Computer Science, Networking and Digital Media Modules for Visiting Students 2024/25

Content:	Following a project-based pedagogic approach, students will undertake a major inter-disciplinary team-work project drawn from a list of authentic industrial problems. Achieving the goals of the project will require students, firstly, to apply the various development methodologies they have acquired on their course and, secondly, to develop professional skills in project management and team working. While the bulk of the taught programme focuses primarily on the learning of domain knowledge, the goal of the Professional Environments 2 module is to prepare students for professional practice in their respective domains. They will develop the necessary project management and team-working skills, and, by working as a team on an authentic industrial project, they will gain a high degree of familiarity with the typical requirements capture, design, and development methodologies relevant to their discipline. With the focus on making real-world artefacts, the students will integrate their work into an employment focused portfolio. Being a professional practitioner also mean critically assessing both goals and solutions from legal, ethical and societal perspectives as well as addressing security and safety concerns. Students are also encouraged to consider their continuing professional development needs and to engage with their professional bodies. To encourage career management skills and promote employability after graduation, students are expected to integrate the artefacts they produce and reflective practice narratives into their employability portfolios and personal development plans. **Topics:** ➢ ***Project Management:*** • Review of general management principles. Introduction to project planning, project control and project life cycle. Project control documentation. • Agile principles and motivation, roles, structure, prioritization of requirements and management of risk. Introduction to a popular Agile methodology eg. Scrum, Kanban • Project analysis, definition, ideation, planning, estimation, monitoring, acceptance criteria, critical path analysis, and the relevant types of technologies and terminologies for these activities. • Preparation for Agile accreditation

	➢ ***Team Working:*** • Introduction to team-working, different types of team player, group dynamics including an understanding of motivation issues. • Team building, task management, team roles including leadership, as well as conflict and conflict resolution • Collaborative tools supporting team work including virtual teams ➢ ***Product Development:*** • Use of agile project management principles to create user stories, wireframes, prototypes, minimum viable products and other artefacts that usefully demonstrate a team's response to a real-world challenge. • Creation and integration of contributions from team members possibly from a multiplicity of disciplines eg. computer science, games, digital media, creative industries, mathematics, cybersecurity, data science etc. Development activities consistent with students' course priorities, eg. contribution of mathematical, modelling, software, data or media components. • Presentation and critical review of the artefacts created by the team members • Wireframes and prototyping tools eg. Axure, Invision, Balsamiq. ➢ ***Professional Development:*** • Engage with professional body such as British Computer Society, Institute for Mathematics and its Applications, Royal Statistical society - attend local meetings, CPD events, and relate to personal development plan • Identify and embark on a suitable professionally accredited course such as Python programming, Agile Project Management, IBM SPSS, etc
Teaching	lectures, workshops, studios, practical classes, and lab support
Assessment	Study Option **1**: • Profession Skills Test (20%) • Team Assessment Portfolio (40%) • Employment-Portfolio (40%)
	Study Option **2:** • Part of Study Option 1 assessment
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Module Code	**CI5515**
Module Title	**Professional Game Development Environments**
Level	5
Suitability	Study Options 1 or 2
Credits	• Full year: 8 (US) 15 (ECTS) • Single semester: 4 (US) 7.5 (ECTS)
Pre-requisites	Successful completion of CI4500/CI4515 or equivalent
Content	This module teaches games programming with an emphasis on engines and middleware. It covers the components needed to implement computer games using the techniques which would be used in industry. The module stresses the importance of portfolio building to aid employability, and also the requirement to develop software in a rigorous ,professional way. The module links with the games inKUbator where students have the opportunity to work together to create games, emulating the industry environment. **Topics:** • *Elements of a 3D computer game:* GUIs, scenenodes, character control, animated meshes, shadows, skyboxes, cameras, terrains • *Game AI:* steering, route solving, decision making, NPC behaviour, finite state machines • *Game engines and middleware:* e.g. UDK, Unity, CryTek, Valve, PhyreEngine, XNA and Irrlicht; Physics engines, e.g. Bullet, PhysX, Havok; Scripting for game engines, e.g. LUA, Javascript • *Professionalism:* game industry coding standards, version control, agile development and team working, employability skills, project management, responding to a brief, requirements analysis, testing and quality control, professional presence and portfolio.

Content:	• *Games Architecture:* UML, object orientation, reusability, game components, design patterns. • *Effective coding:* standard template library, advanced memory management, lists, vectors, trees, maps and graphs and their implementation, data type sizes, awareness of time/memory resources used by algorithms.
Teaching	Lectures/workshops
Assessment	Study Option **1**: • Individual game typically comprising game artefact, report and video (40%) • Team game typically comprising game artefact, report and video (40%) • Comprising short time-limited practical test(s) eg. using a game engine (20%)
	Study Option **2:** • Part of Study Option 1 assessment
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Module Code	**CI5525**
Module Title	**3D Graphics Programming and Artificial Intelligence**
Level	5
Suitability	Study Options 1 or 2 or 3
Credits	• Full year: 8 (US) 15 (ECTS) • Single semester: 4 (US) 7.5 (ECTS)
Pre-requisites	• Successful completion of CI4510 • For study option 3, requires basic skills in C++ programming and basic experience with a 3D graphics/games programming such as Unity

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Content	This module provides students with core knowledge of the computer graphics methods of geometric modelling, projection, rendering and shading and prepare students for writing their own computer graphics applications using industry-standard specialised software. It explores lower level games programming with an emphasis on C++, 3D graphics libraries and the mathematical concepts underpinning them. ➢ **Autumn Semester: Artificial Intelligence; 3D Graphics** ❖ ***Artificial Intelligence*** • Artificial Intelligence for games • Decision making: state machines and decision trees • Autonomous agents, behaviour patterns and flocking • Path finding ❖ ***3D Graphics*** • Representation of 3D object and your first OGL project • Working with transformations and matrices • Writing and Optimising Programs in OpenGL • Working with shaders ➢ **Spring Semester: 3D Shaders; Portfolio Building** ❖ ***3D Shaders*** • Adding some light to the scene • Fragment shader techniques. Outdoor scenes • Terrain, textures, skyboxes... • Building your portfolio: multi-stage rendering and cube maps Building your portfolio: water rendering & particle systems ❖ ***Portfolio Building*** • shadow maps; post-processing; mirrors • rigged character animation • 3D graphics for the web: WebGL and three.js • 3D graphics for Unity: Shader graphs • Advanced 3D Topics
Teaching	Lectures and practical classes

Assessment	Study Option **1**: • Individual game typically comprising game artefact, report and video (40%) • Team game typically comprising game artefact, report and video (40%) • Comprising short time-limited practical test(s) eg. using a game engine (20%)
	Study Options **2/3:** • Portfolio of coursework (100%)
Last updated	07/04/24 PJW

LEVEL 6 – ADVANCED

Module Code	**CI6001**
Module Title	**Visual Effects**
Level	6
Suitability	Study Option 1 only
Credits	• Full year: 8 (US) 15 (ECTS) • Single semester: 4 (US) 7.5 (ECTS)
Pre-requisites	Prior study of digital media technology such as CI5001 or similar.

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Content	This module examines the skills that are required to be implemented in the production of a visual effects shot. Those skills include the acquisition of film and video footage for use in visual effects, the creation of computer generated assets both in 3D and 2D form, and the compositing of those elements into a finished shot. The module builds upon specialist skills learned by students in prior study at levels 4 and 5, develops these further and demonstrates how tasks involved in creating a visual effects shot work together. The module looks at the professional working practices of the film, television, visual effects, post production and computer graphics industries and the various roles taken on by individuals working in these industries. Success in the module depends on both students' individual skills and their abilities to work as part of a team. **Topics:** • Digital compositing • Colour correction • Transferring data from one application to another • Media Asset Management. • Metadata. • Motion Capture. • 3D Scanning. • Match moving, object tracking, camera tracking. • Acquisition of imagery. • Gathering information from a live shoot to be used within a computer graphics project. • Particles, Fluids, Dynamics and other physical simulations. • Previsualisation. • Capturing blue/green screen footage so that it is appropriate for chroma keying. • Costing a visual effects shot.
Teaching	Lectures and practical workshops
Assessment	Study Option **1**: • Client Led Project eg video between 1 to 2 minutes incorporating live action, CGI, compositing, audio • Student Led project
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Module Code	**CI6013**
Module Title	**Modelling and Animation**
Level	6
Suitability	Study Option 1 only
Credits	• Full year: 8 (US) 15 (ECTS) • Single semester: 4 (US) 7.5 (ECTS)
Pre-requisites	Prior completion of an introductory 3D computer-generated imagery (CGI) module is useful
Content:	This module will enable students to strengthen modelling and texturing skills and build a portfolio of 3D computer assets and 3D animation. Students will acquire additional skills, such as the use of 3D sculpting software, and advanced shader, lighting, and rendering techniques. Students will be able to show their modelled work as a turntable animation using different rendering techniques. Students will apply the Principles of Animation and other animation concepts to the creation of believable body mechanics and appealing character performance. This is a practical module where the majority of a student's time is spent working at a computer. Similarly assessment is practically based with quizzes to demonstrate basic and advanced theoretical techniques. Topics: ➢ **Autumn Semester:** • Pipeline, Modelling Concepts 1 • Modelling Concepts 2 (Topology and Edge Flow) • Modelling Concepts 3 (Hardsurface Topology) • UV Mapping (Advanced) • Digital Sculpting • Retopology, Baking Detail • Lighting and Rendering • Arnold Shaders, Texturing • Final Looks: Turntables and Compositing

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Content	➢ **Spring Semester:** • Rigging 1 - Creating the Skeleton, Joint Orient, Rotate Order • Rigging 2 - Rig Controllers, IK/FK setup, Set-Driven Keys • Rigging 3 - Blendshapes, Skinning, Painting Skin Weights • Intro to 12 Principles of Animation, Anim. Tools, i.e Motion Trail, tweenMachine • 12 Principles of Animation, Cont.'d, Maya Animation, Graph Editor, Animation Workspace and Tips • Animation Concepts - Twinning, Moving Holds, Smears, Multiples, Appeal • Animation Concepts - Previs and Reference Analysis • Body Mechanics - Walk/Run Cycle, Blocking, Functional Breakdowns, In-Betweens, Studio Library • Advanced Body Mechanics - Constraints, Force and Impact, Weight, Visual Rhythm, FCM Hider • Polishing an Animation - Graph Editor Clean-Up, Motion Trails, Ghosting, Wireframe View • Facial Animation and Lip Sync - Phonemes/Visemes, Phrasing, FACS, Expression/Emotion, Facial Anatomy
Teaching	Lectures/workshops
Assessment	Study Option **1**: • Coursework 1 CGI Modelling: Modelling and Texturing (30%) • Coursework 2 CGI Animation and Rigging (30%) • Coursework 3 CGI Showreel (40%)
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Module Code	**CI6015**
Module Title	**Cryptography and Network Security**
Level	6
Suitability	Study Options 1 or 2

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Credits	• Full year: 8 (US) 15 (ECTS) • Single semester: 4 (US) 7.5 (ECTS)
Pre-requisites	Prior study of cyber crime and digital forensics
Content:	The Cyber Security module explores the major challenges to computer security. It familiarises students with a range of cryptographic algorithms and protocols, firewall and access-control architectures and methods to assess and improve network and application security. This knowledge will allow students to implement and evaluate security controls and develop secure policies for corporate networks. **Overall Topics:** • Terminology and concepts of security in computing: o Security vulnerabilities of networks and networked applications. o Threats and modes of attack (including malware). • Cryptography: o The principles of substitution and transposition. o Symmetric block and stream ciphers (including Feistel networks and one-time pads). o Public key cryptosystems (RSA). o Hash functions (MD5 and SHA).oKey exchange protocols. o Approaches to cryptanalysis. • Network security: o Security protocols. o Cryptographic mechanisms in TCP/IP. o Firewalls and ACLs. o Stateful packet inspection. o DMZs and proxy servers. • Access control and monitoring: o Password and multi-factor authentication.oIntrusion detection and prevention systems. o Security in multi-user operating systems. • Formal methodologies: o Security management and assessment principles. o Analysis of technological and non-technological risks. o Mature frameworks (OCTAVE, STRIDE, ISO). o Development of security policy. • Web-application security: o Buffer overflow attacks. o Cross-site scripting.

Content	○ SQL injection. ○ Phishing. • Experimental assessment of security: ○ Design and configuration of experimental testbeds. ○ Qualitative and quantitative analysis of experimental data. ➢ **Autumn Semester:** ❖ ***Cryptographic Principles and Classical Ciphers*** We introduce the three pillars of security: confidentiality, integrity and availability and the related concepts of risk, vulnerability and control. We discuss historic symmetric cryptosystems, and how they are vulnerable to relatively simple methods of cryptanalysis. ❖ ***Modern Digital Cryptosystems*** We show how historic ciphers have given way to stronger computer-based techniques such as DES and AES. We introduce asymmetric (public key) cryptography and show how it provides authentication as well as confidentiality. We illustrate this with the RSA cipher algorithmbased on the "prime factorization" problem. ❖ ***Cryptography and Security in the Internet*** We show how public key cryptography is made secure by means of the Public Key Infrastructure (PKI) and Certificate Authorities (CAs) and cryptographic architectures like TLS and IPSec. We show how network perimeters can also be secured using firewalls and proxy servers. ➢ **Spring Semester:** ❖ ***Internet and World Wide Web Vulnerabilities and Protection*** expansion on the topics of the autumn discussing how network and web vulnerabilities can be detected and eliminated. We look at different kinds of malware attack, and how antivirus scanning works. ❖ ***Cryptographic Algorithms based on the Discrete Logarithm Problem*** We introduce another family of public key algorithms, where the "discrete logarithm problem" takes the place of the prime factorization problem used in RSA. These include Elgamal, Diffie Hellman and the Digital Signature Algorithm (DSA). ❖ ***Additional Topics*** Here we look at steganography (securing information by hiding it without encryption), the BB84 Quantum Key Distribution (QKD) algorithm, the assessment of security using OCTAVE and STRIDE, and finally the concept of a Blockchain.
Teaching	Lectures/workshops

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Assessment	Study Option **1**: • Coursework: 2000-word experimental report (25%) • 2,000-word coursework report (25%) • Exam (50%)
	Study Option **2**: • Coursework: 2000-word experimental report (25%) • Mock exam (50%)
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Module Code	**CI6115**
Module Title	**Programming III – Patterns and Algorithms**
Level	6
Suitability	Study Option 1 only
Credits	• Full year: 8 (US) 15 (ECTS)
Pre-requisites	Successful completion of intermediate-level programming such as CI5105 or similar.

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Content:	Programming is a central activity of software development, which encompasses a wide range of languages, environments and specialisms. This module will offer students the opportunity to aquire a useful competence across this range. The first semester will cover aspects of language, algorithms, tools, test-driven methodologies, and a range of user interface technologies. The second semester will apply these themes across a range of technologies and application environments, focusing on web and mobile in particular. ➢ **Autumn Semester: Unified Modelling Language (UML) & Patterns, Software Testing** ❖ ***Unified Modelling Language (UML) & Patterns*** • UML, Class Diagram • Class Diagram, Sequence and Collaboration Diagrams, UML in Agile Unified Process, UML and Java • Design Patterns: GRASP Patterns, GoF Patterns • Model View Controller Pattern; Refactoring • Code Smells, Anti-Patterns and Refactoring ❖ ***Principles of Software Testing, Testing in Java with JUnit*** • Java recap, Functional Interfaces, Lambda Expressions and Java Streams • Software (code) Testing, Introduction to JUnit Testing • Test Driven Development (TDD) • Performance Testing • Test automation ➢ **Spring Semester: Machine Learning with Python; DYOPL** ❖ ***Do Your Own Programming Language:*** • explaining basic terminology. • create a new language, identify its use cases and suggest its syntax. • testing the Case Study new language
Teaching	Lectures/workshops

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Assessment	Study Option **1**: • Coursework: UML and software design patterns (25%) • Coursework: Software testing (25%) • Coursework: Machine Learning w/ Python (25%) • Coursework: Do your own Programming Language (25%)
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Module Code	**CI6125**
Module Title	**Software Development Practice**
Level	6
Suitability	Study Options 1 or 2
Credits	• Full year: 8 (US) 15 (ECTS) • Single semester: 4 (US) 7.5 (ECTS)
Pre-requisites	Prior study of computer software/programming

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Content:	This module aims to provide a strong theoretical and practical background necessary for students to build high quality scalable software and to operate effectively as an industry professional. It examines software quality concepts necessary to build high quality software architecture. The module introduces students to the concept of software architecture and architectural patterns as part of software design and reuse which can be viewed as components and interfaces. At a lower level, programming models and paradigms are explored, as well as design patterns and anti-patterns. Testing strategies and other software quality principles will also be covered, and students will explore these principles in the context of practical projects which expose them to industry tools, practices and management methodologies. Topics: • Ethical, legal and social issues associated with software engineering • Design Patterns and Architectural Frameworks, Application Architectures, Design Decisions and Issues • Agile Software Development, methods and project management • Technical and Socio-technical systems, system modelling: context, interaction, structural, behavioural models and model driven engineering • Requirements engineering: specification, engineering processes, elicitation, analysis, validation, management, emergent properties • Security: risk management, security specification and design, system survivability, defensive programming • Software testing, process assurance, process improvement and configuration management • Component based software engineering, Service oriented architecture, distributed software engineering, • Software reuse: reuse landscape, application frameworks, software product lines and Software estimation • Quality management: software quality, standards, inspections and reviews, software measurement and metrics • Process improvement: measurement and analysis, the CMMI process improvement framework • Programming languages and frameworks to implement design patterns and architectural patterns. • Tools for building, testing, management and deployment of software artefacts • Emerging trends in software engineering: Soft trends, Open- world software, process trends, model driven development, test driven development

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Content	❖ **Autumn Semester:** • System faults and dependability • Sociotechnical Systems • Dependability Measures • Requirements Specification for Quality • Software Testing & Security Specification • Software Testing and Assurance • Assurance and Turvil Software Depend. • Components and Services • Cloud Computing • Software architecture ❖ **Spring Semester:** • TDD and DevOps • Software reuse • Features, Scenarios & Stories • XP intro • Configuration Management • Refactoring • Software architecture 2 and microservices • Software Evolution • DevOps2
Teaching	Weekly tutorials/Problem-based learning
Assessment	Study Option **1:** • XP style system development project (30%) • e-portfolio: 6 items (Systems, Unix, Powershell, Cloud Computing, Software testing) (30%) • Final written exam (40%)
	Study Option **2:** • Part of study option 1 assessment
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Module Code	**CI6250**
Module Title	**Internet Services and Protocols**
Level	6
Suitability	Study Options 1 or 2
Credits	• Full year: 8 (US) 15 (ECTS) • Single semester: 4 (US) 7.5 (ECTS)
Pre-requisites	Successful completion of CI5220 or similar
	This module will develop your understanding of how the Internet protocol suite achieves the interconnection of separated "things"(computers, phones, sensors) over networks of arbitrary topology and technology. Introduction to the main principles, attributes and characteristics of the modern wireless technologies such as 4G (LTE), 5Gand Wi-Fi. This knowledge will underpin the skills required to design such networks including identifying the physical components required and designing appropriate IP addressing/ routing schemes. Principles of wireless systems. Focus on QoS and QoE for different applications and network architectures. Introduction to principles of encoding and transmission of multimedia content over the Internet. ➢ **Autumn Semester: Internet Protocols and Networks** ❖ ***Introduction to Internet Services and Protocols*** • IP suite of protocols for wireless transmission, including new trends (5G). • Introduction to Internet Services and multimedia content delivery. ❖ ***Networks and Transport*** • Fundamental processes of the network layer; emphasis will be given on the IPv4 addressing, sub-netting, routing and its use in the wireless systems. • Fundamental principles of IPv6 for modern and future networks (focus on wireless). • Key reliability mechanisms in transport protocols including ports, segmentation, PAR and connection-oriented vs. connection-less delivery. Understanding congestion issues and the TCP congestion control algorithms. ➢ **Spring Semester: Wireless Systems and Multimedia over Internet; QoS and QoE for Internet Services**

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Content:	❖ ***Introduction to Wireless Technologies*** • Principles of propagation of EM waves, design and measurements on wireless networks. • Main principles, attributes and characteristics of the modern wireless technologies such as LTE/-A and Wi-Fi. ❖ ***Multimedia over the Internet, QoS/ QoE*** • Principles of encoding and transmission of multimedia content over the Internet. Voice over IP. Protocols and technologies for video streaming over the Internet. • Quality of Service concepts in Internet and QoS provisioning for different applications and network architectures. • Difference between QoS and QoE for different Internet services. Basic concepts of QoE measurement and models for current and emerging Internet applications.
Teaching	Weekly two-hour lectures and two-hour workshops
Assessment	Study Option **1**: • Coursework 1: Physical Design Coursework (25%) • Coursework 2: Network Measurements Coursework (25%) • Final exam (50%)
	Study Option **2:** • One practical component (100%)
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Module Code	**CI6280**
Module Title	**Threat Hunting, Analysis and Mitigation**
Level	6
Suitability	Study Option 1
Credits	• Full year: 8 (US) 15 (ECTS)

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Pre-requisites	Successful completion of CI5235 or similar
Content	This module is primarily concerned with defensive (Blue Team) security. Its structure is based on the National Institute of Standards and Technology (NIST) Cyber Security Framework (CSF), which consists of standards, guidelines and best practices to help organisations manage cybersecurity-related risks. It is within this context that you will discover techniques and strategies for undertaking threat hunting, by way of device, network and data forensics. In this module, all the activities are associated with five core functions of NIST CSF, i.e., Identify, Protect, Detect, Respond and Recover. Various tools and techniques are investigated within the scope of the following topics. • Network Scanning and Auditing • Operating Systems Hardening • Log Files Analysis and Threat Intelligence • Risk Mitigation and Management • Vulnerabilities and Threat Analysis • Cyber Attack Recovery and Response Plan . **Topics:** • Live Data Forensics • Introduction, overall process, post-mortem versus live forensics, pros and cons of system shutdown, order of volatility • Live Data Collection • System date and time, current network connections, open TCP or UDP ports, users currently logged on, running processes and services • Live Response Tools • Sysinternals (Pslist, listDLLs, PSLoggedOn), WFT • RAM Acquisition and Analysis Tools (e.g. Volatility) • Network Analysis • Network-related attacks, network traffic, logs (text-based logs, event-logs), firewalls, routers, sniffers, Wireshark, PyFlag • An introduction to mobile security • Investigation methods, practical steps, obstacles and limitations • Security Operation Centres (SOCs) • Network Monitoring, Incident Response, Threat Intelligence, Incident Management, Forensics
Teaching	Weekly 1-hour lectures and 3-hour workshops

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Assessment	Study Option **1**: • Portfolio of 3 security and forensic tasks; (10% each) (30%) • 1 lab exam (20%) • 1 SOC Case study coursework (50%)
	Study Option **2:** • One practical component (100%)
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Module Code	**CI6315**
Module Title	**User Experience Design Thinking**
Level	6
Suitability	Study Option 1
Credits	Full year: 8 (US) 15 (ECTS)
Pre-requisites	Successful completion of intermediate level computer science
Content	This module intended for undergraduate students who are studying computing-related subjects. Previous experience of UX is not assumed. This module will focus upon the skills, methods and tools required in careers such as UX Architect, UX Designer, Service Designer, Information Architect or Digital Product Designer. The curriculum is finely balanced between theory and practice. Students are directly immersed in organisational practices and skills used in industry and will make use of academic theory in this practical context. Students will learn to develop investigative, analytical, technical, communication and advocacy skills to help them shape interactive technologies that augment people's abilities, enhance their creativity, connect them to others and protect their interests. They will also become aware of the impact of levels of digital literacy, availability of and access to technology, economic and business drivers, regulations, and regional/cultural norms. The module will also develop methods and skills required to understand current users, to investigate non-use, and to imagine future users.

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Teaching	Lectures and workshops
Assessment	Study Option **1**: • Coursework 1: Group-based industry-themed problem assignment (50%) • Coursework 2: Individual industry-themed problem assignment (40%) • Oral presentation based on individual problem assignment (10%)
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Module Code	**CI6320**
Module Title	**Advanced Data Modelling**
Level	6
Suitability	Study Options 1 or 2 or 3
Credits	• Full Year: 8 US, 15 ECTS • Single Semester: 4 US, 15 ECTS
Pre-requisites	• Successful completion of CI5320 or similar. • In addition, for study option 3, knowledge of advanced databases design.

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Content	This module will consolidate and build on previously acquired knowledge of databases by analysing and evaluating important issues in the database area. In addition, advanced aspects of data warehousing and data mining will be studied, encompassing the principles and commercial application of the technologies. ➢ **Autumn Semester: Advanced Database Design** • Data Modelling • Enhanced Data Modelling • Normalisation • Physical Database Design • Distributed Databases • Transaction Processing • Query Processing • Object-Oriented databases • Security ➢ **Spring Semester: Big Data & Data Warehousing** • NoSQL • Introduction to Data Warehousing • Data Warehousing Architectures • Multi Dimensional DB and OLAP • Machine Learning and Applications • Deep Learning and Applications • Data Quality
Teaching	Lectures and workshops
Assessment	Study Option **1**: • Database design coursework (25%) • Data Analytics coursework (25%) • Exam – 4 questions out of 6 (50%)
	Study Option **2:** • Database design coursework (100%)

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	Study Option **3:** • Data Analytics coursework (100%)
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Module Code	**CI6415**
Module Title	**Digital Entrepreneurship**
Level	6
Suitability	Study Option 1 only
Credits	• Full year: 8 (US) 15 (ECTS)
Pre-requisites	Prior study of business information systems
Content	This module supports the creation of digital enterprises through the lifecycle of innovation and entrepreneurship, financing and development, business planning, customer development, marketing and retention. There are 3 key parts: 1. Starting up: Innovation and Entrepreneurship, funding and funders, customers and prototyping 2. Digital strategy, management, finance and planning 3. Digital marketing, customer service and retention Digital innovation is a major driving force in creating economic growth and this module illustrates how to work in an entrepreneurial fashion. At the heart of Entrepreneurship is innovation which can come in many forms. Sometimes this can be an incremental but generally gives significant improvement to the customer or alternatively as a new breakthrough or transformational innovation. Ideas are then considered from potential customers' and funders' perspectives to enable realistic aspirations to be made.

Content	From this foundation, the module proceeds to explain how to develop a Digital business strategy not only to satisfy the critical needs that organizations have, but also aims to explore the application and use of improved value chains using the concepts of corporate venturing (spin-out/intrapreneurship) and Entrepreneurship (new venture creation). Further grounding in terms of management, finance (including revenue models/forecasting) and planning is established. The final element is the assurance of customer interest through Digital marketing, customer service and journey models that ensure retention. Digital marketing explores, for example, reputation models of value, search engine optimization and pay per pick. Whilst customer service and journey models emphasize continuing relationships with the business to ensure the validity of current and new products. ➢ **Curriculum Content:** *Develop an innovative Digital product/service idea* • An overview of intellectual capital (IPR); patents, design- & trade-marks and copyright. • How creativity and innovation come about and spread in high-tech environments *Business Planning* • Strategy • Operations management • Finance • Joint ventures and acquiring other companies, M&A, takeovers etc • The next step, from liquidation to initial public offering • Revenue models, and revenue forecasting *Opening and running a new company* • Technical issues associated with creating new vehicles; Companies House, raising capital (Business Angels, venture capital, crowdfunding, government schemes etc) & how tax issues vary with type of company. • Running a company; Due Diligence, shareholder agreements & the legal duties of the Directors and Board. *Marketing* • The basics of marketing • Customer research methods • User profiles and audiences • Online marketing
Teaching	Lectures and workshops

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Assessment	Study Option **1**: • Coursework: digital consultancy (50%) • Coursework: business plan(50%)
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Module Code	**CI6330**
Module Title	**Mobile Application Development**
Level	6
Suitability	Study Option 1 only
Credits	Full year: 8 (US) 15 (ECTS)
Pre-requisites	Prior study of programming and software development principles
Content	This module provides a foundation for careers in mobile application development: mobile is becoming increasingly ubiquitous and the skills taught also have applications in UX, web development and software engineering in general. The module is divided into two phases. ➢ **Autumn Semester: React Native App Development & Android Studio App Development** In the first phase of the module students will be introduced to software development for the two major mobile platforms. This will cover development environments for these platforms, UI conventions, building and deploying simple applications. Students will then be introduced to cross platform development environments for mobile development. Finally, standard frameworks for mobile web development will be introduced. ➢ **Spring Semester: Major App Development Project**

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Content	The second phase of the module is organised around a practical project. Students will choose one of the platforms on which to build a mobile application of their choice. This project students gives students the opportunity to specialise and explore their chosen platform in greater depth, acquiring the knowledge and proficiency to be able to design and build complex mobile apps. Students will be encouraged to publish their apps in one or both (in the case of a cross-platform app) of the two major app stores, thus providing an introduction to mobile application delivery and distribution.
Teaching	Lectures and workshops
Assessment	Study Option **1**: • React Native app assignment (15%) • Android app assignment (15%) • Major app project assignment (50%) • Practical exam / Presentation (20%)
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Module Code	**CI6515**
Module Title	**Multiplayer and Game Console Programming**
Level	6
Suitability	Study Options 1 or 2 or 3
Credits	• Full Year: 8 US, 15 ECTS • Single Semester: 4 US, 15 ECTS
Pre-requisites	• Completion of CI5515 Professional Game Development Environments

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Content	This module covers two important specialisms in computer games programming: low level device programming (such as for game consoles or mobile devices) and programming for networked games. The module is taught as "learning by doing" and comprises both theory taught in class and applied work in the laboratory. Topics (indicative): • Architecture of gaming hardware • Computation models • Network based programming for games • Programming for mobile platforms and windows • GPGPU • Code performance, debugging and profiling • Low-level optimisation techniques. • Introduction to high-level optimisation techniques • Hardware aspects of code optimisation (CPU, memory, GPU) • Selected topics in optimisation of console games • Introduction to Parallel Programming • Concurrency ➢ **Autumn Semester:** • Multiplayer Games • Sony PlayStation 5 Programming • ECS: Entity-Component-System • Optimisation and Profiling with Unity ➢ **Spring Semester:** • Introduction To Advanced C++ • Cellular Automata & Parallel Programming
Teaching	Lectures, workshops, studios, practical classes
Assessment	Study Option **1**: • Software Project 1 (Team project on multiplayer games and plugins) (40%) • Software Project 2 (3D graphics, game performance for consoles) (50%) • Software Project 1 (Presentation) (10%)
	Study Option **2:** • ECS Game or Demo (100%)

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Module Code	**CI6535**
Module Title	**Game and Media Creation Processes**
Level	6
Suitability	Study Option 1 only
Credits	Full year: 8 (US) 15 (ECTS)
Pre-requisites	Successful completion of intermediate-level computer science
Content	This module provides an in-depth real-world simulation of the business of making computer games in teams using industry-standard production management techniques and simulating a professional environment of collaboration to deliver a product on time. Students will be creating two major games, a mobile phone game in the autumn semester and a story based PC/Mac game in the second semester both of which are developed in team work. **The Creative Industry**: Economic relationships; ow the industry works; Identify new areas of growth; Entrepreneurship; The retail market; Online/mobile/ business models; Legal, social and ethical issues; Information security issues; **Roles**: Team roles required for games creation; Responsibilities of a leader and the deputy; The importance of minutes; Collaboration techniques; **Production Process**: The build process; Production management tools; The art of scheduling; Using a Task list; Localisation; Developing prototypes; Designing editors and using scripting to allow rapid change; Coordinating artists, animations and level designers; Completing the game; Testing and Quality assurance; Agile development **Work environment**: Working collaboratively and responsibly; Presenting with confidence; Leadership; Time management; Meeting deadlines; Running meetings; Portfolio and professional presence

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Content	**Case study**:	The organisation of a game/media production team; Job roles in a real company; How individuals facilitate the roles of others
Teaching	Lectures and workshops	
Assessment	Study Option **1**: • Coursework 1: Develop and publish a mobile game in a small team (50%) • Coursework 2: Develop and publish a more technical challenging PC/VR game in a larger team (50%)	
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