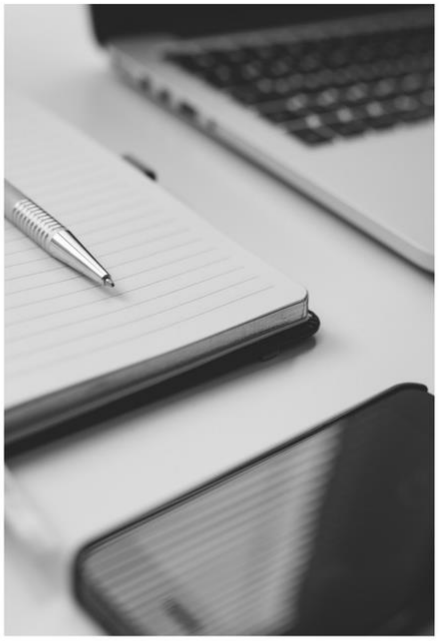

WIT EXCHANGE PROGRAMME

Module Listing

School of Science & Computing
Department of Science
Department of Computing & Mathematics
Academic Year 2018-2019

Waterford Institute *of* Technology
INSTITIÚID TEICNEOLAÍOCHTA PHORT LÁIRGE

CONTENTS

LIST OF ABBREVIATIONS, ACRONYMS AND DEFINITIONS

WIT	**W**aterford **I**nstitute of **T**echnology
(E)	**E**lective module. Please be advised that elective modules are scheduled if there is enough demand. If there is enough demand then the module will be scheduled.
Component Code / Banner Code	The Component Code is a unique identifier code for module. It is the code that identifies the module on your learning agreement and it is also the code that will appear on your Transcript of Records. On the WIT online timetables the Component Code is called the "Banner Code". This is what we call it in WIT. The Component Code/Banner Code is always a combination of four capital letters and four numbers, for example: ABCD 0123
CRN	**C**ourse **R**egistration **N**umber. This is a different unique identifier code for module that WIT use to register you for your module and the exam.
CA	Continuous Assessment
Exam	Exam scheduled during official exam week

Assessment criteria for all modules

- 1st Class Hons (>70%) Demonstrated the learning outcomes showing clear mastery of the topic, analysis, synthesis and reflection and with a high level of written coherence.
- 2nd Class Hons (60% -69%) Demonstrated the learning outcomes with an ability to analyse and synthesise concepts in an integrated manner.
- Pass (40% - 59%) Demonstrate the learning outcomes at threshold level.
- Fail (<40%) Did not demonstrate the learning outcomes at threshold level.

1. DEPARTMENT OF COMPUTING AND MATHEMATICS

Module Listing for Bachelor of Science (HONS) in ENTERTAINMENT SYSTEMS

Programme Code: – WD_KENTS_B

Year 1			
Semester 1 (Autumn) **Code**	**Component**	**Semester 2 (Spring)**	**Component Code**
Year 2			
Semester 3 (Autumn) **Code**	**Component**	**Semester 4 (Spring)**	**Component Code**
Data Structures & Algorithms 1	DATA-0602	Data Structures & Algorithms 2	COMP-0602
Relational Databases	COMP-0638	Statistics & Probability	STAT-0017
Computer Networks	COMP-0637	Applied Cryptography	COMP-0451
Mathematical Methods	MTHS-0016	Software Engineering Practice	COMP-0640
Stream electives		**Stream Electives**	
Professional Communications (E)	COMP-0644	Introduction to 3D Game Development (E)	COMP-0647
Introduction to Game Design (E)	COMP-0643	3D Game Assets (E)	COMP-0645
Narrative Construction (E)	COMP-0246	Audio Visual 2 (E)	COMP-0646
Audio Visual 1 (E)	COMP-0642	User Experience Design (E)	
Year 3			
Semester 5 (Autumn) **Code**	**Component**	**Semester 6 (Spring)**	**Component Code**
Developer Operations	COMP-0559		
NoSQL Databases	COMP-0661		
Web App Development 2	COMP-0611		
Professional Practice	COMP-0599		
Stream Electives			
Introduction to C++ for Games (E)			
Game Development Practicum (E)			
Content Production (E)			
Digital Media Programming (E)			
Year 4			
Semester 7 (Autumn) **Code**	**Component**	**Semester 8 (Spring)**	**Component Code**
Data Mining 1	COMP-0563	Data Mining 2	COMP-0572
Distributed Systems	COMP-0562	Functional Programming	PROG-0094
Mobile App Development 1		Project 2 (Development) (E)	PROJ-0169
Project 1 (Development) (E)	PROJ-0166	Project 2 (Research) (E)	PROJ-0170
Project 1 (Research)(E)	PROJ-0167	Advanced 3D Game Development (E)	GAME-0009
Stream Electives		Emerging Media Technologies (E)	TECH-0049
Game Development in C++ (E)	GAME-0008	Advanced Graphics for Games (E)	GAME-0007
Mobile Game Development (E)	COMP-0671	Artificial Intelligence for Games (E)	GAME-0006
Media Tools & Integration (10 credits) (E)	COMP-0670	Artificial Intelligence (E)	COMP-0215
		Computing Ethics (E)	COMP-0674
		Digital Photography (E)	PHOT-0016
		Formal Specification (E)	COMP-0216
		Management Psychology (E)	PSYC-0099
		Mobile App Development 2 (E)	COMP-0486

Module Descriptors

Data Structures and Algorithms 1	ECTS 5	Banner Code: DATA-0602	CRN: 91819	Level 7	Assessment Methods: CA

Description of Module / Aims
Implement, from first principles, custom and general purpose data structures and algorithms that are efficient, thread safe, and robustly tested and validated.

Indicative Content

- Implementing Data Structures: Abstract Data Types (ADTs); Lists; Sets; Stacks; Queues; Maps
- Implementing Search Algorithms: Linear; Binary; Hashing; Other
- Implementing Sorting Algorithms: Selection; Bubble; Insertion; Other
- Recursive Algorithms
- Multithreading and Concurrency Issues
- Test-Driven Development for Data Structures and Algorithms

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Construct, from first principles, custom and general purpose data structures.
2. Construct suitable and efficient search algorithms for different data structures.
3. Construct efficient sorting algorithms for different data structures.
4. Use recursion in algorithmic implementations.
5. Explain the issues surrounding, and be able to implement solutions for, concurrently accessed data structures.
6. Construct robust data structures and efficient algorithms in a systematic, test-driven fashion.

Supplementary Material(s)

"Khan Academy Computer science alogrithms." https://www.khanacademy.org/computing/computer-science/algorithms
Sedgewick, R. and K. Wayne. *Algorithms*. NY: Addison-Wesley, 2011.

Relational Databases	ECTS 5	Banner Code: COMP-0638	CRN: 91799	Level 8	Assessment Methods: Exam

Description of Module / Aims
This module will introduce the student to the principles and practice of designing and implementing relational database systems. The student will gain competence in Entity Relationship modelling and normalisation techniques. The student will be introduced to the concepts of data persistence, consistency and distribution in the relational database context. They will gain experience in the design and implementation of a practical relational database system.

Indicative Content

- The Relational Model and Relational Database Management System (RDBMS)
- Database Analysis & Design
- Entity Relationship Modelling & Normalisation
- SQL Data definition & manipulation
- Data persistence, ACID transaction management and distributed databases

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Examine a business scenario to design a suitable relational database solution.
2. Construct entity relationship (ER) diagrams from business scenarios and reproduce those diagrams as normalised relations ready for database implementation.
3. Construct a physical database design.

4. Create a relational database in business using SQL Data Definition Language (DDL)
5. Construct queries on a relational database using SQL Data Manipulation Language (DML)
6. Discuss the concepts of data persistence, ACID transaction management and database distribution.

Supplementary Material(s)

Connolly, Thomas M. and E. Carolyn. *Database Systems: A practical approach to design, implementation and management*. 6th ed. NY: Addison-Wesley, 2015.

Computer Networks	**ECTS 5**	**Banner Code: COMP-0637**	**CRN: 91795**	**Level 8**	**Assessment Methods: Exam**

Description of Module / Aims
This module introduces Computer Networking terminology, network protocols and models. Students will use simulation and protocol analysis software to configure network devices and explore various network protocol operations. A detailed examination of TCP/IP, IP addressing and Ethernet is presented. A brief introduction to Routing, Network management and Wireless LANs is also provided. Practical skills are an essential part of this module.

Indicative Content

- Introduction to Computer Networks and Protocols
- OSI and TCP/IP models
- Ethernet and VLANs
- IPv4 Addressing and subnetting
- IPv6
- Routing
- Transport Layer Protocols and Functionality
- Application Layer Protocols and Functionality e.g. HTTP, FTP, DNS, SMTP
- Wireless LANs
- Network Management

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Use network protocol models and tools to explain communications in data networks.
2. Describe in detail the major components, operation and functionality of a computer network and commonly used protocols and services.
3. Construct an IPv4/IPv6 addressing design solution.
4. Build a simple network using routers and switches.
5. Use Cisco command line interface to perform basic router and switch configuration.
6. Implement a basic wireless network.
7. Describe basic computer network management concepts.

Essential Material(s)

"Cisco Network Academy." https://www.netacad.com/

Supplementary Material(s)

Cisco, Networking. *Network Basics, CCNA Routing & Switching Companion Guide*. NY: Cisco Press, 2014.
Tanenbaum, A. and D. Wetherall. *Computer Networks*. 5th Ed. New York: Pearson Education, 2013.

Mathematical Methods	**ECTS 5**	**Banner Code: MTHS-0016**	**CRN 60417**	**Level 8**	**Assessment Methods: Exam**

Description of Module / Aims
This module deals with the framework needed to tackle problems in two and three dimensions.

Indicative Content

1. Matrix algebra: Matrix operations, solution of linear systems using Cramers rule, matrix inversion and numerical methods, eigenvalues and eigenvectors, applications of eigenvalues/eigenvectors.
2. Vector algebra: Dot and cross product, parametric equation of lines and planes, points of intersections of lines and planes, decomposition of vectors using the dot product.
3. Linear transformations: Rotations, reflections, translations, and homogeneous coordinates.
4. Eigenvalues and eigenvectors: Diagonalisation and similar matrices, powers of matrices.
5. Partial differentiation: Critical points, local extrema and saddle points.
6. Vector calculus: Curl, div, volume and surface integrals.

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Manipulate expressions involving vectors and matrices and find the solution set of a system of linear equations using standard methods.
2. Perform standard operations with expressions involving partial derivatives and vector calculus operators.
3. Use partial derivatives to determine stationary points of multivariate functions and apply techniques to appropriate problems.
4. Use vector algebra to solve three-dimensional geometric problems such as finding where a given line cuts a given plane, intersection of polygons, etc.
5. Use existing mathematical software and students own implementations of standard linear algebra methods to represent and solve problems arising in computer science.

Essential Material(s)

"Helping Engineers Learn Mathematics (HELM) @ WIT:." vle.wit.ie/course/view.php?id=3468
"Plus Magazine:." plus.maths.org.uk/index.html
"Project Euler:." http://projecteuler.net/
"Visual Calculus:." archives.math.utk.edu/visual.calculus/
Anton. *Elementary Linear Algebra*. 9th. : Prentice Hall, 2008.
Mc Callum et al. *Calculus*. 4th. : Wiley, 2004.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Professional Communications (E)	**5**	**COMP-0644**	**91771**	**8**	**CA**

Description of Module / Aims

The goal of this module is to enable students to develop key communication and issue exploration skills that are essential to the work-place environment as well as the student's academic career. Such skills include: interpersonal skills, oral presentation skills, ability to participate in meetings, and ability to participate effectively in groups, along with writing skills for both academic and work-related documents and reports.

Indicative Content

- Communication Flows within Industry, within Academia and for Professional Development
- Running Professional Meetings: Managing, Recording and Participation
- Structuring and Writing Academic Papers
- Understanding Audience Expectations
- Structuring and Creating Oral Presentations
- Creation of User Reference Documents
- Creation and Maintenance of Professional Technical Reports

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Record and document meeting action items.
2. Complete a professional presentation.

3. Give a professional presentation.
4. Produce a Technical Review Commentary.
5. Construct a well-structured Technical Report.

Introduction to Game Design (E)	ECTS 5	Banner Code: COMP-0643	CRN: 91767	Level 8	Assessment Methods: CA

Description of Module / Aims
This module is a practical introduction to game design and game design concepts, emphasising the basic tools of game design: paper and digital prototyping, design iteration, and user testing.

Indicative Content

- Vocabulary and formal elements of game design
- Ideation, early design and prototyping
- Mechanics, dynamics, aesthetics and the concept of 'Fun'
- Narratology and story telling
- Character and level design
- Playtesting and balancing
- Pitching an idea

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Classify games using the recognised terminology.
2. Experiment with game ideas through critical investigation and playtesting.
3. Examine a game concept by creating a mechanically sound board game.
4. Construct and present a game pitch and proposal in a commercial style.

Supplementary Material(s)

Blackman, S. and J. Wang. *Unity for Absolute Beginners*. NY: Apress, 2014.

Narrative Construction (E)	ECTS 5	Banner Code: COMP-0246	CRN: 93370	Level 8	Assessment Methods: CA – 100%

Description of Module / Aims
This module will be an introduction to the fundamental principles of narrative construction. It aims to heighten students awareness of the importance of narrative in both linear and interactive storytelling. The student is introduced to the Aristotlean principles of drama from the beginning of the course.

Indicative Content

- This syllabus looks at fundamental principles of drama but also focuses on new and emerging storytelling techniques and how students can use fundamentals of storytelling in order to create interactive narratives.

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Create a short narrative, linear script that contains a solid three act structure
2. Create character through action
3. Employ sound effectively in their stories
4. Understand and use the necessity clause
5. Write effective dialogue for characters
6. Understand the differences between linear and interactive stories.
7. Develop interactive options for linear narratives.

Essential Material(s)

There are no essential reading materials for this course. Rather, the course is taught using excerpts from movie scripts, as well as excerpts from the following books: Aristotle, Poetics (London: Penguin Books Ltd., 1996). Field, Syd. The Definitive Guide to Screenwriting (London: Ebury Press, 2003). McKee, Robert. Story: Substance, Structure Style and the Principles of Screenwriting (London: Methuen Publishing Ltd., 1999)

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Audio Visual 1 (E)	**5**	**COMP-0642**	**91763**	**8**	**CA – 100%**

Description of Module / Aims
This module teaches the fundamentals of sound, music, sound recording and editing using timeline-based tools and introduces the basics of video production.

Indicative Content

- Basic music theory
- Characteristics of sound: amplitude; frequency; timbre
- Sound recording
- Digital Audio Workstations (DAWs)
- Delivery formats
- Basic video production
- Copyright

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Interpret basic sheet music and translate printed sheet music to a digital format.
2. Examine the qualities of sound and musical design as they are applied to digital media productions.
3. Construct a simple but original musical composition, using designated music hardware and software packages.
4. Produce and publish a media asset, which contain sequences of multi-layered audio with some simple visuals.

Learning and Teaching Methods

- This module will be characterised by student participation in both formal theoretical and practical/studio classroom activities in which students learn theoretical concepts and apply them immediately using dedicated hardware and software.
- Studio classes will be delivered in two 2-hour blocks.
- Apple Mac computer lab with relevant hardware & software (kept up to date at least annually e.g. GarageBand, iMovie, Ableton Live).
- Accessible, professional sound proofed recording studios with professional microphones and audio workstations (Vibe FM studios).
- Stock AV Library subscription (e.g. AudioBlocks, VideoBlocks).

Supplementary Material(s)

"Ableton Live Youtube Channel." https://www.youtube.com/user/AbletonInc
"Adobe TV - Adobe Audition." http://tv.adobe.com/product/audition/
"BBC Media Studies Training." http://www.bbc.co.uk/learning/subjects/media_studies.shtml
"GarageBand Help." http://help.apple.com/garageband/mac/10.1/
"MusicTheory.net." http://www.musictheory.net/
"lynda.com." www.lynda.com
Ableton, Inc. *Ableton Live 9 User Manual*. DE: Ableton Inc., 2015.
Kirn, P. *Real World Digital Audio*. CA: Thomson, 2006.
Plummer, M. *Apple Pro Training Series: Garageband*. New York: Pearson Education, 2014.

Scoppettuolo, D. *Apple Pro Training Series: iMovie*. New York: Peachpit Press, 2014.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Data Structures and Algorithms 2	**5**	**COMP-0602**	**91803**	**8**	**CA**

Description of Module / Aims
Implement, from first principles, advanced general purpose and custom data structures and algorithms that employ appropriate strategies for demonstrable efficiency.

Indicative Content

- Implementing Advanced Data Structures: Trees; Graphs; Rings; Other
- Implementing Algorithms for Advanced Data Structures: Traversals; Shortest Path; Union Find; Other
- Algorithmic Strategies: Brute Force; Greedy; Divide and Conquer; Heuristic; Other
- Algorithmic Analysis: Static Analysis; Dynamic Analysis; Profiling Tools
- Test-Driven Development for Advanced Data Structures and Algorithms

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Construct, from first principles, advanced general purpose and custom data structures.
2. Construct suitable and efficient algorithms for utilising advanced data structures.
3. Determine and implement suitable algorithmic strategies for utilising advanced data structures and large data sets.
4. Employ static and dynamic algorithmic analysis.
5. Construct robust advanced data structures and efficient algorithms in a systematic, test-driven fashion.

Supplementary Material(s)

Sedgewick, R. and K. Wayne. Algorithms. 4th ed.. NY: Addison-Wesley, 2011.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Statistics and Probability	**5**	**STAT-0017**	**60507**	**8**	**Exam**

Description of Module / Aims
This module covers topics in introductory statistics including descriptive statistics, probability distributions, point and interval estimation, and statistical inference with applications in computing.

Indicative Content

- 1. Descriptive Statistics: Data types; nominal, ordinal, cardinal. Measures of centre and spread; mean, median, standard deviation, percentiles. Graphs; histograms, bar charts, box plots, pie charts, scatter diagrams.
- 2. Probability theory and applications: Probability types; classical, empirical, subjective. Simple and compound events, conditional probability, Bayes theorem.
- 3. Probability models: Binomial, Poisson, exponential and normal distribution.
- 4. Correlation and regression: Simple linear regression. Introduction to multiple regression. Correlation and coefficient of determination, point estimation of predictions. Interpolation. extrapolation. Variable recoding.
- 5. Inferential statistics: Sampling, confidence intervals about a mean or difference of two means, hypothesis tests on the means of one or two populations, paired tests, chi-squared tests.
- 6. Statistical software: Usage of a statistical software package such as R. Formulating input commands to generate graphs, tables and summary statistics, performing probability model calculations, calculating confidence intervals and performing hypothesis tests for a range of problems in inferential statistics. ANOVA. Multiple regression modelling. Significant coefficients. Indicator variables. Interpreting output from a statistical package. Programming constructs and scripting.
- 7. Applications in computing: Elementary modelling of time to failure of devices. Reliability and application to data backups Password security analysis. Queuing theory and application to process scheduling.
- Practical Programme:

- Extensive use of computers will be employed to: Perform statistical calculations and create graphics necessary for analysing data. Conduct simulations to approximate long-run behaviour of random phenomena. Use scripts to facilitate batch processing of a data set.

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Apply standard descriptive statistics procedures to summarise univariate data.
2. Compute probabilities using counting principles and probability models such as the binomial, Poisson, exponential and normal and apply probability concepts to applications in computer science.
3. Construct a simple linear regression model and use it to make predictions.
4. Construct confidence intervals for a population mean or difference of two means.
5. Use a statistical software computer package to script input for data analyses and interpret output.
6. Communicate the results of statistical analyses correctly and effectively.

Essential Material(s)

"The R Project for Statistical Computing." http://www.r-project.org/
Anderson D R et al. *Introduction to Statistics: Concepts and Applications*. 3rd. : West Pub. Comp., 1994.
Crawley. *Statistics an introduction using R*. : Wiley, 2005.
Lipschutz, & Schiller. *Schaum's Outline of Introduction to Probability and Statistics*. : McGraw-Hill, 1998.
Reilly. *Understanding Statistics: And Its Applications on Business, Science and Engineering*. : Folens, 1997.

Applied Cryptography	**ECTS 5**	**Banner Code: COMP-0451**	**CRN: 83315**	**Level 7**	**Assessment Methods: Exam**

Description of Module / Aims

This module provides students with a detailed introduction to cryptography, including both the fundamentals and leading techniques as applied to the security of systems, applications and communications.

Indicative Content

- Security context: threats & attacks; security standards, services & mechanisms
- Introduction to cryptography: terminology; block and stream ciphers; cryptanalysis; limitations of cryptography
- Symmetric encryption: classical schemes; modern algorithms; deployment modes
- Random numbers: entropy concept; pseudo random generation
- Public-key cryptography: number theory background; requirements; techniques – RSA, Diffie-Hellmann, elliptic curve cryptography; performance issues
- Authentication functions: principles; hash functions; collisions; MACs, digital signatures
- Key management: symmetric key distribution protocols; public key authentication; digital certificates & PKIs; trust models
- Practical applications & deployment issues: placement of encryption function; key storage; application case studies

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Recognise the role (and limitations) of cryptography in securing systems, communications, and applications.
2. Describe leading cryptographic models and algorithms (symmetric ciphers, public-key schemes and hash functions) and explain their mathematical basis in outline terms.
3. Recognise the significance of random numbers in the context of cryptography.
4. Compare the computational performance of leading cryptographic algorithms.
5. Discuss the storage, exchange and management of keys in both symmetric and public-key systems.
6. Describe a selection of practical applications of cryptography.
7. Make effective use of a cryptographic software application or library.

Essential Material(s)

"GNU Privacy Guard." https://www.gnupg.org/
"The OpenSSL project." https://www.openssl.org/

Supplementary Material(s)

Ferguson, N., B. Schneier and T. Kohno. *Cryptography Engineering*. Indianapolis: Wiley, 2010.
Gollmann, D. *Computer Security*. 3rd ed. Chichester: Wiley, 2011.
Stallings, W. *Computer Security: Principles and Practice*. 3rd ed. Harlow: Pearson, 2014.
Stallings, W. *Cryptography and Network Security*. 6th ed. Boston: Pearson, 2014.

Software Engineering Practice	ECTS 5	Banner Code: COMP-0640	CRN: 91807	Level 8	Assessment Methods: CA

Description of Module / Aims
The objective of this module is to provide students with the understanding of techniques and methods used to develop reliable quality software. Students will also research, experiment and utilize various tools in order to explore the typical activities of modern software engineering practices. These tools will also be used to deliver a small software application.

Indicative Content

- Project Management
- Software Processes
- Requirements Elicitation & Modelling
- Automated Project Build and Testing
- Continuous Integration & Deployment
- Project Scaffolding Tools

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Compare different software processes and select a suitable process for the design of a particular software system.
2. Explain the importance of project planning and create a project workflow using appropriate tools.
3. Describe software requirements and illustrate the processes involved in discovering these requirements.
4. Demonstrate an understanding of the different models and activities in the object oriented design process.
5. Design and automate an appropriate test driven strategy for a software development project.
6. Operate a Continuous Integration (CI) practice in collaborative software projects.
7. Illustrate the advantages of Continuous Delivery (CD).

Supplementary Material(s)

"Continuous Delivery." https://www.thoughtworks.com/continuous-delivery.
https://www.thoughtworks.com/continuous-delivery
Pressman, R. and B.R. Maxim. *Software Engineering: A Practitioner's Approach*. 8th. New York: McGraw-Hill Higher Education, 2014.
Sommerville, I. *Software Engineering*. 10th. Boston: Pearson, 2015.

Introduction to 3D Game Development (E)	ECTS 5	Banner Code: COMP-0647	CRN: 91783	Level 8	Assessment Methods: CA

Description of Module / Aims
This module will provide the students with the necessary skill set to develop a 3D game using the Unity Game Engine. It focuses on a high-level approach and the use of 3D game engines to create video games that implement some of the basic features found in commercial video games (e.g., collision detection, 3D navigation, 3D views, and basic artificial intelligence).

Indicative Content

- Collision detection
- Navigation
- Environment creation
- Javascript coding
- Object instantiation
- Artificial intelligence
- Rigid bodies
- Assets creation and management
- 3D animation
- User interface

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Create a 3-Dimensional game with the Unity engine with a corresponding GUI.
2. Code the game mechanics using Javascript.
3. Import and manage both bespoke assets (audio, textures, 3D objects), and built-in assets (audio, textures, 3D objects), and create indoors and outdoors environments.
4. Implement and use navigation (first- and third-person controllers, and collision detection) and cameras (e.g., view ports, multiple cameras, layers, etc.).
5. Use rigid-bodies, particles effects, and manage 3D animations for improved realism.
6. Add and manage NPCs (e.g, AI, Finite-State Machines and navigation).

Supplementary Material(s)

Blackman, S. and J. Wang. *Unity for Absolute Beginners*. NY: Apress, 2014.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
3D Game Assets (E)	**5**	**COMP-0645**	**91775**	**8**	**CA**

Description of Module / Aims

This module serves as an introduction to 3D modelling for game asset designers and comprises an emphasis on the modelling pipeline, from concept to model creation to rigging and skinning, and techniques used for the exporting of 3D models to be used in a game engine.

Indicative Content

- Components of an industry-standard 3D modelling platform
- Polygon, subdivision, and NURB modelling
- Rigging and skinning
- Texture unwrapping and baking
- Techniques for exporting models, textures and collisions

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Identify and navigate the main components and features of an industry standard 3D modelling production platform.
2. Compare various modelling approaches, i.e, polygon, sub-division and NURB-based modelling.
3. Describe the fundamentals of the 3D modelling workflow, from concept to a rigged and skinned model.
4. Construct a textured and rigged game asset in a format ready to be used by a game engine.

Supplementary Material(s)

Lanier, L. *Advanced Maya Texturing and Lighting*. 3rd ed. New York: Sybex, 2015.
Palamar, T. *Mastering Autodesk Maya*. New York: Sybex, 2016.

Audio Visual 2 (E)	**ECTS 5**	**Banner Code: COMP - 0646**	**CRN: 91779**	**Level 8**	**Assessment Methods: CA**

Description of Module / Aims
This module focuses on visual media. Students develop design skills further in composition, graphic design, advertising, typeface, layout and audio synchronisation. Photography skills are developed and then applied to video capture. All elements are combined in the creation, editing and publishing of a short video.

Indicative Content

- Visual image principles
- Design Principles
- Camera Settings
- Video recording, editing and rendering
- Audio synchronisation
- Titles, transitions and simple motion graphics

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Compare and contrast artwork using design principles.
2. Demonstrate practical use of image composition.
3. Produce digital video based on a prescribed script/storyboard.
4. Combine audio and visual media to create a multi-layered asset.

Supplementary Material(s)

"Adobe TV." http://tv.adobe.com/
"BBC Media Studies Training." http://www.bbc.co.uk/learning/subjects/media_studies.shtml
"lynda.com." www.lynda.com
Mantoani, T. *Through The Eyes of a Pro: Canon, Vol.1*. DVD. 2007.
Mantoani, T. *Through The Eyes of a Pro: Canon, Vol.2*. DVD. 2007.
Plummer, M. *Apple Pro Training Series: Garageband*. New York: Pearson Education, 2014.
Scoppettuolo, D. *Apple Pro Training Series: iMovie*. New York: Peachpit Press, 2014.

User Experience Design (E)	ECTS **5**	Banner Code:	CRN:	Level **6**	Assessment Methods: **CA**

Description of Module / Aims
User Experience (UX) is a concept that has many dimensions, and it includes a variety of different disciplines such as interaction design, visual design, usability, and human-computer interaction. This module will introduce the student to elements and tools that are essential for enhancing user satisfaction by improving motivation, usability and accessibility provided in the interaction between the user and the product in both web and non-web based interfaces. The student will engage in the various stages of the UX Design process, utilizing a variety of supportive tools to assist in the completion of the varied tasks of the UX Designer.

Indicative Content

- Visual Design
- Interaction Design
- Usability and Accessibility
- Human Computer Interaction (HCI) & User Centred Design (UCD)
- Guidelines and Standards
- Evaluation and Testing

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Demonstrate an understanding of the underlying issues and principles of UX.
2. Demonstrate, at a fundamental level through written and practical work, the links between UX and Human Factors.
3. Apply the principles of UCD, to the capture of user requirements providing a basis for design that is fit for purpose.
4. Construct appropriate user interfaces for specific applications and specific users using low and high fidelity prototyping.
5. Explain the usability and accessibility of an interface with respect to different user populations.

Essential Material(s)

"Color in Motion." http://www.mariaclaudiacortes.com/colors/Colors.html
"Interaction Design." http://www.id-book.com/index.php
"UXMatters." Fundamental Principles of UX Design.
http://www.uxmatters.com/mt/archives/2014/11/fundamental-principles-of-great-ux-design-how-to-deliver-great-ux-design.php
Preece, J. and Rogers, Y. and Sharp, H. *Interaction Design: Beyond Human Computer Interaction*. 4th Edition. West Sussex: John Wiley and Sons, 2015.

Supplementary Material(s)

Benyon, D. and Turner, P. and Turner, S. *Designing Interactive Systems: People, Activities, Contexts, Technologies*. Essex, UK: Addison-Wesley, 2005.
Garrett, J.J. *The Elements of User Experience: User Centred Design for the Web*. 2nd Edition. New York: New Riders, 2010.
Johnson, J. *Designing with the Mind in Mind*. 2nd Edition. Waltham, MA: Morgan Kaufman, 2014.
McManus, S. *Web Design: make your website a success!*. 6th Edition. Warwickshire, England: In Easy Steps, 2014.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Developer Operations	**5**	**COMP- 0559**	**89869**	**8**	**CA**

Description of Module / Aims
This is a practical module that requires the student to build, configure and manage the operating systems and network infrastructure required for a typical cloud application environment.

Indicative Content

- Cloud Computing Architectures and Services
- Public Cloud Services: Storage; Compute; Networking
- Configuration of Multi-tier Application Infrastructure Services
- Cloud APIs – Python or similar
- Virtual Private Clouds
- Web Application Architecture – Performance, Scaling, Load Balancing and Security
- Automation and scripting – using for example bash (advanced), Python, PowerShell, Chef, Ansible
- Developer Operations (DevOps) tools and configuration
- Network and Application Management and Monitoring

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Build, configure and manage essential network infrastructure and application services.
2. Deploy a network monitoring solution.

3. Develop scripts to assist in the management and automation of modern network services.
4. Analyse application performance, scalability, load balancing and security.
5. Compare and contrast the main technologies required to develop and manage Cloud based Application Infrastructure.

Supplementary Material(s)

"The Python Wiki." https://wiki.python.org/
"boto: Python interface to Amazon Web Services." http://boto.readthedocs.org/en/latest/
Amazon, Amazon. *Getting started with AWS (eBook)*. NY: Amazon Web Services, 2014.
Garnaat, M. *Python and AWS Cookbook*. 1st Ed. NY: O'Reilly, 2012.
Kim, G., K. Behr and G. Spafford. *The Phoenix Project: A Novel about IT, DevOps, and Helping Your Business Win*. New York: IT Revolution Press, 2013.
Loukides, M. *What is DevOps? (ebook)*. NY: O'Reilly, 2012.
Morris, K. *Infrastructure as Code: Managing Servers in the Cloud*. 1st. New York: O'Reilly Media, 2016.

NoSQL Databases	ECTS 5	Banner Code: Comp - 0661	CRN: 92090	Level 8	Assessment Methods: Exam

Description of Module / Aims
This module will introduce the student to the principles and practice of designing database solutions for large volumes of either structured or unstructured data. The student will gain competence in determining the suitability of a schemaless database or a data warehouse. The student will be introduced to the concepts of data persistence, consistency and distribution in the NoSQL database context. They will gain experience in the design and implementation of a NoSQL database system for unstructured data. The module will also introduce them to the use of data warehouses for storage of large volumes of structured data.

Indicative Content

- Introduction to storing large volumes of structured or unstructured data
- Emergence of NoSQL databases
- Aggregate data models
- Key-value databases, document databases, column family databases and graph databases
- Data persistence, database consistency (CAP theorem, version stamps) and distribution of data storage
- Fundamentals involved in the storage of large volumes of structured data in a data warehouse

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Analyse a business scenario to determine a suitable big data database solution.
2. Create at least one type of NoSQL database.
3. Assess the growth and use of NoSQL in business.
4. Appraise the distribution of data on clusters.
5. Examine the issue of consistency in relation to NoSQL databases.
6. Summarise the characteristics, design and implementation of data warehouses for structured data.

Supplementary Material(s)

"TDWI research in the business intelligence and data warehousing industry." http://tdwi.org
"comprehensive resource on NoSQL database solutions." http://nosql-database.org
Connolly, T. and E. Begg Connolly. *Database Systems: A practical approach to design, implementation and management*. NY: Addison-Wesley, 2015.
Sadalage, J. and M. Fowler. *NoSQL Distilled A brief guide to the emerging world of polygot persistence*. New Jersey: Pearson, 2013.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Web Application Development 2	**5**	**COMP-0611**	**91997**	**8**	**Exam**

Description of Module / Aims
This module introduces the student to advanced Web Application Development techniques and standards, with the emphasis on building server side components with Database Integration. Building on the fundamentals learnt in the Server-Side Scripting module, the student will enhance their existing skills and learn how to create and deploy complex web-based applications. Additionally, students will be introduced to Web Services and Service Orientated Architecture (SOA) in web development.

Indicative Content

- This syllabus focuses modern web based technologies and tools used to create web applications.
- 1. Web Application Development Frameworks
- 2. Application Server Administration.
- 3. Extensible Markup Language (XML)
- 4. Data Sources and Database Connectivity.
- 5. Server Configuration and Application Deployment.
- 6. Web Services, Service Composition and Integration.

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Describe the client and server components of complex Web applications including their integration with data sources and session tracking.
2. Design and implement Server Side Web Components using the appropriate technologies for Database Connectivity.
3. Explain the roles and responsibilities of clients and servers in the context of multi-tiered Internet Applications.
4. Understand architectures and design patterns applicable to modern web applications.
5. Deploy, configure and administer a Web Server for the purposes of Web Application Deployment.

Essential Material(s)

"http://java.sun.com/products/servlet/." http://java.sun.com/products/servlet/
"http://www.w3schools.com." http://www.w3schools.com
1. Robert W. Sebesta, Programming the World Wide Web, Addison-Wesley, 4/e, 2008.

	ECTS	**Banner Code:**	**CRN:**	**Level**	**Assessment Methods:**
Professional Practice	**5**	**COMP- 0599**	**93742**	**7**	**CA**

Description of Module / Aims
The aim of this module is to prepare and encourage students to capitalize on the learning potential of their flexible semester experience and enhance their industry awareness. The module will focus on developing students' transferable skills and encouraging professional awareness and practice.

Indicative Content

- Workplace ethics for the computing industry
- Potential for learning during placement and the strategies commonly used
- Identification of transferable skills for integration and progression in the workplace
- Career Preparation: CV preparation and interview skills, career planning, e-portfolio development
- Workplace and placement awareness: Managing equality and diversity, group dynamics and teamwork, understanding organisational culture
- Work-based impression management including the impact of social media as a professional presentation tool for personal and corporate identity

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Examine ethical conduct in the workplace.
2. Develop transferable skills for integration and progression in the workplace.
3. Construct an appropriate personal career development plan and professional profile, to include a skills-needs analysis and CV.
4. Demonstrate professional skills through group and individual presentations.
5. Employ personal autonomy and take responsibility for their personal and academic well-being.
6. Demonstrate the principles and practice of reflective learning.

Essential Material(s)

"Ethics Resource Centre." http://www.ethics.org/
"Transferrable Skills Project." http://www.skillsproject.ie/
"gradireland." https://gradireland.com/

Supplementary Material(s)

Billett, S. *Learning in the Workplace: Strategies for Effective Practice*. Australia: Allen & Unwin, 2001.
Robbins, S.P. and P.L. Hunsaker. *Training in Interpersonal Skills*. 6th ed. USA: Pearson Education, 2012.

5.e **Introduction to C++ for Games (E)**	ECTS **5**	Banner Code:	CRN:	Level **7**	Assessment Methods: **CA**

Descriptor Reference: A10745

Description of Module / Aims

This module will introduce the student to the fundamentals of programming for games using C++ and the Standard Template Library. Using procedural and object-oriented techniques the student will gain confidence in designing and developing small video games.

Indicative Content

- Types, variables and standard I/O
- Control statements
- The Standard Template Library (STL)
- Functions
- Pointers and references
- Objected oriented programming in C++
- Memory allocation
- Introduction to Cocos2d-x

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Develop small games using standard C++ sequence, conditional and iterative control structures.
2. Create game objects and define the ways that they interact with each other through object-oriented programming.
3. Employ the STL to utilise frequently used classes and functions in the development of game programs.
4. Use pointers and memory allocation techniques to address, acquire and free memory as game programs require.

Supplementary Material(s)

Dawson, M. *Beginning C++ Through Game Programming*. New York: Cengage Learning PTR, 2014.
Engelbert, R. *Cocos2d-x by Example: Beginner's Guide*. Birmingham, England: Packt Publishing, 2015.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Game Development Practicum (E)	**5**			**7**	**CA**

Description of Module / Aims
This module will introduce the student to game-related project management skills. The student will build a game or game artifact based on multiple modules across the programme. This module will act as an opportunity for the student to contextualise and link cross-module concepts.

Indicative Content

- Manage a small to medium sized game project.
- Design a small to medium sized game or game artifact
- Develop a small to medium sized game or game artifact
- Communication and presentation of ideas in correct, clear and modern format

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Combine knowledge, skills or practices from (at least) two game development modules to develop a multi-featured game.
2. Construct and present a working game or game artefact.
3. Construct a game design document and present this work in a clear and accessible way.
4. Research and implement an agile software development methodology and present this work in a clear and accessible way.

Learning and Teaching Methods

- Lectures and practicals will be used to introduce new concepts and to consider the concepts' implications for module deliverables.
- Self-directed learning activities will require students to reflect upon the module materials, diagnose their learning needs and conduct research to satisfy these needs.
- Peer learning – students will be encouraged to work in small collaborative groups to jointly consider and analyse in-class materials and to devise solutions to problems posed by the lecturer.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Content Production (E)	**5**			**7**	**CA**

Descriptor Reference: A13888

Description of Module / Aims
Participants create high-quality media assets for simulated clients or events. This is a highly-practical module which challenges the students' communication, team-building and audio/visual development skills.

Indicative Content

- Group communication
- Regulatory environments and bodies
- Audiovisual media conception, creation and evaluation
- Arts informed computing

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Assess several issues raised by collaborative software.
2. Organise themselves within a team environment.

3. Apply a variety of design methods to a given problem.
4. Compose, adapt and/or develop assets to a set of specifications.
5. Review their performance based on appropriate metrics.

Supplementary Material(s)

"BBC Media Studies Training." http://www.bbc.co.uk/learning/subjects/media_studies.shtml
"Broadcasting Authority of Ireland." www.bai.ie
"Create Digital Music." http://www.createdigitalmusic.com
"Project MApping Central." http://projection-mapping.org/
Boykin, B. *Final Cut Pro X*. New York: Peachpit Press, 2015.
Nahmani, D. *Logic Pro X*. New York: Peachpit Press, 2015.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Digital Media Programming (E)	**5**			**7**	**CA**

Description of Module / Aims
This module builds on strengths already gained in programming, digital media, and user experience. Students will build platform appropriate/independent UIs to develop software which uses or interacts with digital media by using relevant tools, software libraries, software frameworks, and environments.

Indicative Content

- Interaction design patterns: visual hierarchy; navigational distance
- Choosing interaction styles and interaction techniques
- Presenting information: navigation; representation; manipulation
- Modern UI libraries and frameworks
- Social and digital media APIs & frameworks
- Programmatic drawing; geometry; animation
- Programmatic image processing
- Programmatic sound & video processing
- Cross platform development
- Optimization for resource-constrained devices

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Differentiate User Interfaces across multiple platforms. (Remembering).
2. Design user interface consistent with digital media programming concepts (Understanding).
3. Build a simple application with a modern graphical user interface (Creating).
4. Build an interactive application utilising digital media libraries and frameworks. (Creating).

Supplementary Material(s)

"Adobe TV." http://tv.adobe.com
"lynda.com." www.lynda.com

	ECTS	**Banner Code:**	**CRN:**	**Level**	**Assessment Methods:**
Data Mining 1	**5**	**COMP-0563**	**89898**	**8**	**Exam**

Description of Module / Aims
The purpose of this module is to introduce the student to the fundamental concepts and techniques of Data Mining. The student will become familiar with Data Mining approaches (such as prediction, classification, clustering) and their typical solution techniques (methods and algorithms) to datasets that support business intelligence applications. The practical part

of the module will present a suite of Data Mining exercises that the student will solve. During each exercise, the student will apply an appropriate Data Mining method and learn to evaluate and interpret the results.

Indicative Content

- Introduction to Data Mining: frameworks, inputs, outputs
- Exploratory Data Mining: relationships, clustering and network analysis using appropriate algorithms and methods
- Predicting outcomes: classification, regression and time-series analysis

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Categorise typical fundamental Data Mining problems.
2. Appraise the concepts and fundamentals of Classification, Prediction and Clustering and their solution techniques.
3. Evaluate the use of typical Data Mining methods and their appropriate implementation.
4. Solve Data Mining problems using the Data Mining methods learnt.
5. Assemble and interpret results of the Data Mining methods learnt.

Supplementary Material(s)

Han, Jiawei, Micheline Kamber and Jian Pei. ...*Data Mining, Third Edition: Concepts and Techniques*. NY: Jian Pe, 2011.
James, G., D. Witten, T. Hastie and R. Tibshirani. *An Introduction to Statistical Learning, with Applications in R*. NY: Springer, 2013.
Pang-Ning, Tan, Michael Steinbach and Vipin Kumar. *Introduction to Data Mining*. NY: Addison-Wesley, 2006.
Witten, I., E. Frank and M. Hall. *Practical Machine Learning Tools and Techniques*. NY: Elsevier, 2011.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Distributed Systems	**5**	**COMP-0562**	**89894**	**8**	**CA**

Description of Module / Aims
This module will equip the student with the knowledge required to comprehend the architecture of a modern, distributed, service-oriented application and the skills to develop same for a constrained set of requirements. The non-functional requirements of a cloud-native application, namely, resilience, fault tolerance and responsiveness will be considered using a mixture of patterns, libraries and middleware technology. The student will gain experience in deploying to a lightweight container-based cloud platform and have the skills to configure an appropriate load balancing strategy.
Indicative Content

- Fundamentals: Interprocess communication; Promises; Non-blocking I/O, Thread pooling
- Application architecture: Layered; Microservice
- Middleware services: Messaging; Caching
- Application Resilience: Availability; Stability patterns
- Failure isolation and recovery
- Containerization
- Reactive communication first principles

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Design, develop and deploy a scalable, distributed application for a constrained requirements set.
2. Choose appropriate middle-ware technology to improve responsiveness.
3. Maximize an application's resilience and fault tolerance utilizing core patterns and practices.
4. Evaluate and configure an appropriate load balance strategy.
5. Choose and configure an appropriate workflow automation tool suite.

Supplementary Material(s)

Newman, S. *Building Microservices - Designing Fine-Grained Systems*. O'Reilly Media: O'Reilly Media, 2014.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Mobile App Development 1	**5**			**8**	**CA**

Description of Module / Aims
Design, build and deploy a multi-screen mobile application incorporating an intuitive and efficient navigation mechanism. Structure the implementation using accepted best-practice with respect to patterns, frameworks and tools. Incorporate localised persistence models + simple access to remote services. Introduce context services such as location/camera and/or other sensor access.

Indicative Content

- Application Structure: Components; Resources; Security; General Assets
- User Experience: UX Principles, Navigation, Imagery, Fonts
- Simple User Interaction Patterns
- Essential Application Structure Patterns: Appropriate Variations on Model/View/Controller (MVVM, MVP etc…)
- Resource access and management; Clean separation of concerns
- Application Life-cycle: Startup/shutdown; Foreground/background
- UI State Preservation and Restoration; Concurrency

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Decompose an application into its constituent parts, including but not limited to: core application components, user experience resources, packaging.
2. Design a coherent User Experience - using appropriate tools, practices and guidelines - for a moderately sized application.
3. Produce medium sized application, based on a limited set of design patterns.
4. Manage the application lifecycle.
5. Structure persistent storage on a device and reliably save and restore application state.

Essential Material(s)

"Android Developer Resources." http://developer.android.com
"Apple Developer Resources." http://developer.apple.com/ios
"Cordova Developer Resources." https://cordova.apache.org

Supplementary Material(s)

Camden, R. *Apache Cordova in Action*. New York: Manning, 2015.
Neuburg, M. *iOS 9 Programming Fundamentals with Swift: Swift, Xcode, and Cocoa Basics*. New York: O'Rielly, 2015.
Phillips, B. *Android Programming: The Big Nerd Ranch Guide*. New York: Pearson, 2015.

	ECTS	**Banner Code:**	**CRN:**	**Level**	**Assessment Methods:**
Project 1 (Development) (E)	**5**	**PROJ-0166**	**92001**	**8**	**CA**

Description of Module / Aims
This module extends the student's knowledge of software engineering with a view to equipping them for their project work in this current year (year IV) of the programme. In addition it requires the student to prepare a consolidated report on the first stage of their fourth year project in conjunction with a learning contract established between student and supervisor.

Indicative Content

- Consolidate knowledge of software development processes, particularly those that are based on an iterative strategy and early risk mitigation
- To enhance the student's ability to analyse a problem through scenarios that will subsequently provide a plan for construction and testing
- Where appropriate to define the user requirements of an intended system through use case descriptions
- Use of UML and other textual/diagramming techniques essential for discussing final year projects at a conceptual level
- To revise and consolidate the students' abilities to write referenced reports
- Using appropriate techniques, tentatively plan a project in detail breaking it into sub-tasks; rigorously identify deliverables and critical dependencies

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Explain, in words and diagrammatically, to their peers, the work of their project.
2. Interact with their supervisor in discussing how their project might proceed and the risks and interact options associated with their work.
3. Complete a technological prototype of their project showing that all their hardware and software components work together.
4. Prepare a test strategy for their project and have a detailed tentative plan for building a draft design.

Supplementary Material(s)

Lacey, M. *The Scrum Field Guide: Practical advice for the first year*. New York: Addison Wesley, 2012.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Project 1 (Research (E)	**5**	**PROJ-0167**	**92005**	**8**	**CA**

Description of Module / Aims
This is the capstone module for Semester one; it should bring together the student?s knowledge on all aspects of IT and utilise many facets of their previous learning, with a view to identifying a suitable research problem that is to be investigated. This module requires the student to identify a research area of interest, conduct a preliminary investigation, identify suitable research question(s), conduct a literature review and critique and select a suitable methodology to enable them to gather and analyse data. In addition, it requires the student to prepare a report on the first stage of their fourth year project in conjunction with a learning contract established between student and supervisor.

Indicative Content

- Write succinct and referenced, well-structured reports
- Introduction
- Analysis of research questions
- Literature review
- Research methodology

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Appraise a research area.
2. Create appropriate research questions.
3. Complete a literature review.
4. Select an appropriate research methodology and data gathering technique.

Essential Material(s)

Cresswell, J.S. *Research Methods: Qualitative, Quantitative and Mixed Methods Approaches*. New York: Sage, 2002.

Game Development in C++ (E)	ECTS 5	Banner Code: GAME-0008	CRN: 94055	Level 8	Assessment Methods: CA

Description of Module / Aims
This module deepens the students' knowledge of game development techniques in C++ and an appropriate game framework and third party libraries to incorporate features such as networking, artificial intelligence, multiplayer modes, and game physics.

Pre-Requisite(s): Introduction to C++ for Games

Indicative Content

- Data structures and algorithms: tile sets and maps, decision trees, influence map, dependency graphs, path finding, path following, hierarchical finite state machines, design patterns
- Data-driven game engines: entity systems, component-based design and relevant design patterns
- Memory and resource management: memory allocation and garbage collection; storing, loading and caching strategies
- Networked games: networked game architectures and protocols, threads, critical sections, latency
- Game libraries for AI, networking, physics, and audio

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Develop a prototype of a non-trivial game containing features such as AI, multiplayer modes, network- ing, or physics.
2. Design and implement bespoke tools for managing game assets.
3. Evaluate multiple programming paradigms appropriate to the game being developed such Data Driven Development.
4. Create a suitable game framework and integrate additional libraries necessary for physics, networking, AI and sound as required.
5. Evaluate and implement custom memory managers.
6. Evaluate and implement techniques for managing game resources which exceed available memory.

Supplementary Material(s)

Rollings, A. and D. Morris. *Games Architecture and Design: A New edition*. Boston: New Riders Publishing, 2004.
"Cocos 2D-x." http://www.cocos2d-x.org
"Gamasutra: The Art and Science of Making Games." http://www.gamasutra.com/
"GameDev.ent." http://www.gamedev.net/
"Microsoft DreamSpark." https://www.dreamspark.com/default.aspx

Mobile Game Development (E)	ECTS 5	Banner Code: COMP-0671	CRN: 94067	Level 8	Assessment Methods: CA

Description of Module / Aims
The aim of the module is to provide students with an understanding of the main concepts and issues in the design and development of mobile games. Students are given the opportunity to acquire practical experience of the tools, technologies and platforms employed in the development of mobile games.

Indicative Content

- Overview of mobile gaming devices: mobile gaming platforms and development environments, cross platforms game engines and native game development
- Developing mobiles games: UI considerations, asset management and rendering for mobile devices, implementing gameplay mechanics, deploying games on mobile devices

- Mobile gaming markets: mobile game market analysis, revenue generation and publishing games

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Select and apply appropriate methodologies and techniques for the development of games for mobile devices, taking in consideration the limitations of mobile devices.
2. Manage the publication of a mobile game application.
3. Develop non-trivial game prototypes for selected mobile platform using industry standard tools and technologies.
4. Evaluate the effectiveness and the quality of the games developed.

Supplementary Material(s)

Brothaler, K. *OpenGL ES 2 for Android: A Quick-Start Guide (Pragmatic Programmers)*. 1. NY: Pragmatic Bookshelf, 2013.
Oehlke, A. *Learning Libgdx Game Development*. 2. NY: Packt Publishing, 2015.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Media Tools and Integration (E)	**10**	**COMP-0670**	**94063**	**8**	**CA**

Description of Module / Aims

This module builds on the student's existing knowledge of audio/visual recording and editing and concentrates on software tool-specific features. The module also looks at bringing together content from multiple sources and integrating it in media-rich digital artefacts.

Indicative Content

- Working with professional-grade audio-visual software tools and hardware
- Arranging, mixing and bouncing complex audio works
- Sound Design and synchronisation for video
- Production of audio-visual media for live performance and/or installation
- Troubleshooting and optimisation
- Lighting
- Projection
- Sample Project: Conceptualise, plan, create and deploy a digital mixed media installation. e.g. live music performance with video projection & lighting; A digital media mashup

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Propose and defend a concept for live performance or installation (Evaluation).
2. Assemble audio and visual media from multiple sources to create improved artefacts (Creating).
3. Plan and develop an audio/visual live performance or installation that contains an algorithmic element (Creating).
4. Solve simulated and real integration problems as they occur (Creating).

Supplementary Material(s)

"Create Digital Music." http://createdigitalmusic.com/
"DJ Tech Tools." http://www.djtechtools.com
"lynda.com." www.lynda.com
Claiborne, V. *Media Servers for Lighting Programmers*. Oxford: Focal Press, 2014.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Data Mining 2	**5**	**COMP-0572**	**89941**	**8**	**CA**

Description of Module / Aims
It is assumed the student is familiar with the fundamental concepts and techniques of Data Mining. The purpose of this module is to apply the theory of Data Mining. The student will learn about the data mining process and experience the steps involved; including data pre-processing, modelling and optimisation and result interpretation and validation. For each step in the data mining process the student will learn and apply an appropriate methodology, tool or technology.

Indicative Content

- Introduction to the Data Mining Process
- Pre-processing: data gathering, wrangling, and transformation
- Model building, optimization and evaluation
- Result analysis, validation, deployment
- Use of data mining tools

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Summarise the Data Mining process and have a clear understanding of its stages.
2. Evaluate the fundamental concepts behind each stage of the Data Mining process.
3. Justify the use of appropriate tools and techniques for each stage of the Data Mining process.
4. Evaluate, interpret and utilize results obtained at each step of the Data Mining process.
5. Create a solution for a set of Data Mining problems.

Supplementary Material(s)

Han, J., M. Kamber and Jian Pei. *Data Mining Concepts and Techniques*. NY: Jian Pe, 2015.
Leskovec, J., A. Rajaraman and J. Ulman. *Mining of Massive Datasets*. NY: Cambridge University Press, 2014.
Witten, I., E. Frank and M. Hall. *Data Mining, Practical Machine Learning Tools and Techniques*. NY: Elsevier, 2011.

Functional Programming	**ECTS 5**	**Banner Code: PROG-0094**	**CRN: 94080**	**Level 8**	**Assessment Methods: Exam**

Description of Module / Aims
This module will introduce the student to the functional programming paradigm. The student will learn the mathematical basis underlying functional programming and then one of the popular languages (e.g. Haskell) and see how it can be applied to a variety of domains. The student will be able to apply functional techniques in non-functional paradigms when it is helpful to do so and is able to judge when this is the case.

Indicative Content

- Introduction to functional programming – why and when should this paradigm be used
- Types and classes, functions
- Lambda expressions - untyped and typed
- Recursive functions, higher-order functions
- Use of a functional language (e.g Haskell)
- Effect-free programming
- Processing structured data (e.g. trees) via functions
- Use of functional programming techniques in other, non-functional programming languages (e.g. Java)
- Current trends in functional programming

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Construct simple and more complex programs in a functional programming language (e.g. Haskell).

2. Construct basic constructs of a functional programming language using untyped lambda calculus.
3. Construct programs using typed lambda calculus.
4. Compare and contrast the procedural/functional approach and the object-oriented approach.
5. Evaluate and reason about variables and lexical scope in a program using function closures.
6. Construct basic algorithms that avoid assigning to mutable state or considering reference equality.
7. Construct and use iterators and other operations on aggregates, including operations that take functions as arguments, in multiple programming languages, selecting the most natural idioms for each language.
8. Write functional code in non-functional languages (e.g. Java)

Supplementary Material(s)

"Java Software." https://www.oracle.com/java/index.html. https://www.oracle.com/java/index.html
Hutton, G. *Programming in Haskell*. 1. England: Cambridge University Press, 2007.
Khan, A. *Grokking Functional Programming*. 1. America: Manning Publications, 2016.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Project 2 (Development) (E)	**10**	**PROJ-0169**	**92025**	**8**	**CA**

Description of Module / Aims
This module gives the student experience in developing a computing-related project by creating a product or a good prototype for a product. The student will present their work at the end of the module by submitting a final report, in addition to a poster, a short video, and a demonstration.

Indicative Content

- Incorporate feedback from project supervisors/examiners, relating to the work done in Semester 1, namely high level analysis and design and the construction of prototypes and/or early iterations.
- Develop further and document a testing strategy to ensure the quality of each software module, each production-quality iteration and of the final product.
- Further develop the student's ability to write referenced academic and technical reports, principally a required final report, not less than 2000 words and not more than 8000 words, accompanied by a poster and a video.
- To provide the student with the opportunity (and requirement) to meet with a supervisor week by week and to complete the work according to the initial or a revised plan.
- To enable the student to apply their problem-solving and their technical skills to address implementation issues as they arise.

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Integrate feedback from Project 1.
2. Implement a fully tested, working system based on a specification and chosen development methodology.
3. Appraise the limitations and potential of the chosen methodology and resulting solution.
4. Validate the final system, with accompanying report, video and poster and competently discuss the problem area.

Supplementary Material(s)

Beck, K. *Test-driven development: by example*. Boston: Addison-Wesley, 2003.
Fowler, M. and K. Scott. *UML distilled: a brief guide to the standard object modelling language*. Boston: Addison-Wesley, 2004.
Lacey, M. *The Scrum field guide practical advice for your first year*. Harlow: Addison-Wesley, 2012.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Project 2 (Research) (E)	**10**	**PROJ-0170**	**92029**	**8**	**CA**

Description of Module / Aims

This module gives the student experience in developing a computing-related project by undertaking research, based on the work the student has completed in Project 1, semester 7. The student will present their work at the end of the module by submitting a dissertation, in addition to a poster, a short video, and a presentation.

Indicative Content

- Incorporate feedback from project supervisors/examiners, relating to the work done in Semester 1, that work being a literature review and consequent formulation of research question(s), and initial investigative work on appropriate research methodologies, including data gathering strategies.
- Complete the consideration of the research methodologies to be used, and design of the data collection instruments.
- Complete the development of any customised software tools to be used in investigation or data gathering and analysis.
- Further develop the student's ability to write referenced academic and technical reports, principally a required final dissertation, not less than 6000 words and not more than 12000 words, accompanied by a poster and a video.
- To provide the student with the opportunity (and requirement) to meet with a supervisor week by week and to complete the work according to the initial or a revised plan.
- To enable the student to apply investigative, problem-solving and technical knowledge to address issues as they arise.

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Integrate feedback from Project 1.
2. Complete the process of devising/designing a research methodology.
3. Create the research question(s), using the appropriate tools and methodologies.
4. Reflect on limitations and potential of the chosen methodology and resulting discoveries.
5. Validate the final dissertation, with accompanying video and poster and competently discuss the research area, showing competence in research methods.

Supplementary Material(s)

Bell, J. and C. Opie. *Learning from research: getting more from your data*. Buckingham: Open University Press, 2002.
Bell, J. and S. Waters. *Doing your research project: A Guide for first time researchers*. Buckingham: Open University Press, McGraw-Hill, 2014.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Advanced 3D Game Development (E)	**5**	**GAME-0009**	**94084**	**8**	**CA**

Description of Module / Aims

This module provides students with theoretical and practical concepts for the development of 3D games. This module will provide the students with advanced skills related to the development of 3D games using the Unity Game Engine (or similar software).

Indicative Content

- Texture mapping
- Artificial intelligence
- Design patterns
- Lighting and shaders
- Object-Oriented Programming in C#

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Implement game mechanics using C# (or similar language) and understand how object oriented programming can improve and optimize their game.
2. Manage advanced texturing (bump- or normal mapping), lighting (e.g., global illumination), animations (blend-tree) or AI (ray-casting or group movement) techniques.
3. Compare and apply common design patterns for game development.
4. Integrate a version control system into the development cycle.
5. Develop networked games using built-in networking capabilities.

Supplementary Material(s)

Nystrom, R. *Game Programming Patterns*. NY: Genever Benning, 2014.
Okita, A. *Learning C# Programming with Unity 3D*. NY: CRC Press, 2014.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Emerging Media Technologies (E)	**5**	**TECH-0049**	**94104**	**8**	**CA**

Description of Module / Aims
The module explores new trends, tools and technologies in the broad digital media domain. Students will build on their existing skills and knowledge from previous modules in the Media Development stream to track emergent technology. This module can cover any aspect(s) of media development. For example, sound, stereoscopic display, haptic feedback, physical simulation, projection mapping, lighting.

Indicative Content

- Interaction styles and interaction techniques
- Representing information to users
- Approaches to design, implementation and evaluation of non-mouse interaction

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Generalise the interaction possibilities beyond mouse-and-pointer interfaces. (Understanding).
2. Critique emerging media trends based upon a set of discovered criteria (Evaluating).
3. Construct a system that demonstrates user action synchronization and data consistency using emerging media tools/technologies (Applying).

Supplementary Material(s)

"Broadcasting Authority of Ireland." www.bai.ie
"Digital Media Awards." www.digitalmedia.ie
"Game Audio Network Guild (GANG)." http://www.audiogang.org
"lynda.com." www.lynda.com

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Advanced Graphics for Games (E)	**5**	**GAME-0007**	**94088**	**8**	**CA**

Description of Module / Aims
Design and construct realistic scenes/effects requiring advanced graphics rendering techniques using OpenGL and the OpenGL Shading Language (GLSL).

Indicative Content

- Constructive solid geometry (CSG): constructing objects using primitives and boolean operations, ray tracing CSG models
- Surface modelling: parametric curves and surfaces, Beziers and NURBS, subdivision surfaces, implicit surfaces and Voronoi diagrams

- Illumination: ray tracing, global illumination, reflection and refraction rays, optimisation methods for ray tracing, Monte Carlo ray tracing and soft shadows, photon mapping
- Textures: texture mapping, procedural textures, Perlin noise, normal mapping
- OpenGL and Shaders: Review of the OpenGL pipeline, programming GPUs, the basics of the OpenGL shader language GLSL, vertex and fragment shaders, memory management and optimisation concerns

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Construct realistic scenes using core technologies of constructive solid geometry, implicit surfaces, illumination technologies and texture mapping.
2. Assess a given geometry to determine properties such as normals, curvature, convex hull, bounding box, etc..
3. Design and implement multi-pass rendering sequences on the GPU.
4. Evaluate the computational cost of a GPU implementation.

Supplementary Material(s)

Angel, E. and D. Shreiner. *Interactive Computer Graphics: A Top-Down Approach with Shader-Based OpenGL*. 6. USA: Pearson, 2011.
Hearn, D. *Computer Graphics with OpenGL*. NY: Pearson, 2004.
Shreiner, D., G. Sellers, J. Kessenich and B. Licea-Kane. *OpenGL Programming Guide: The Official Guide to Learning OpenGL*. 8. USA: Addison-Wesley Professional, 2013.

Artificial Intelligence for Games (E)	**ECTS 5**	**Banner Code: GAME-0006**	**CRN: 94092**	**Level 8**	**Assessment Methods: CA**

Description of Module / Aims
This module provides students with theoretical and practical concepts for the implementation and development of artificial intelligence in video games.

Indicative Content

- Static and dynamic path finding
- Behaviour trees
- Obstacle avoidance
- Machine learning
- Finite state machines

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Develop artificial intelligence for a 2D or 3D game using C# (or equivalent) and demonstrate how it can improve the game play.
2. Design and implement path finding and obstacle avoidance techniques.
3. Construct and implement a finite state machine.
4. Design and implement behaviour trees and machine learning.
5. Implement and assess common AI principles and algorithms for video games.

Supplementary Material(s)

Buckland, M. *Programming Game AI by example*. Burlington, MA, USA: Jones & Bartlett Learning, 2010.
Millington, I. and J. Fudge. *Artificial Intelligence for Games*. Boca Raton: CRC Press, 2009.

Artificial Intelligence (E)	**ECTS 5**	**Banner Code: COMP-0215**	**CRN: 94117**	**Level 8**	**Assessment Methods: Exam**

Description of Module / Aims

The purpose of this module is to introduce the student to the fundamental concepts of Artificial Intelligence. The student will be introduced to symbolic A.I., knowledge representation, search techniques and an A.I. programming paradigm.

Indicative Content

- This module will concentrate on providing an overview on the key topic areas of Artificial Intelligence.
- History of A.I:
- Introduction to problem characteristics, historical and contemporary applications.
- Knowledge representation techniques:
- Trees, productions, frames, semantic networks, predicate calculus and theorem proving; A.I. problem characteristics and examples.
- Search:
- Un-informed, bi-directional, heuristic, constraint based, application domains.
- A.I. architectures:
- Planning and case based reasoning, production systems, rule based systems, agent, reactive and blackboard systems, non-monotonic systems, neural networks, natural language systems.
- Practical Programme:
- The student will exposed to A.I. problems in practical sessions using an A.I language such as Prolog.

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Demonstrate an understanding of the use of various knowledge representation techniques
2. Apply the rules of logic as applied in predicate calculus
3. Demonstrate an understanding of different heuristic search techniques and their applications
4. Programme in an Artificial Intelligence based language

Essential Material(s)

Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig,2nd Ed, Prentice Hall
Artificial Intelligence: Structures and Strategies for Complex Problem Solving, 6th Ed, George Luger, Addison-Wesley
Michael Negnevitsky, Artificial Intelligence A Guide to Intelligent Systems, Addison Wesley, 2/e, 2005.

Computing Ethics (E)	**ECTS 5**	**Banner Code: COMP-0674**	**CRN: 94096**	**Level 8**	**Assessment Methods: Exam**

Description of Module / Aims

The rate of ICT development has outpaced society's ability to regulate responsible usage of such technologies. Technology has a profound effect on many aspects of work, living systems, the environment and society in general. The computing professional has unique responsibilities as the creator, developer, implementer and manager of these systems. This module will provide students with a critical awareness of ethical issues in modern society in relation to computing technologies and the systems they impact. It offers an introduction to the controversies, questions and strategies for ethical computing. It also inculcates an awareness of the key ways in which computing professionals can act ethically, including the role of important standards and professional communities.

Indicative Content

- Introduction to Ethics: Ethical Concepts, Ethical Theories and Moral Systems, Ethical Frameworks for discussing Computer-related issues
- Introduction to Cyberethics: Tools for Evaluating Cyberethics issues
- Ethics in the Information Society/Ethical and Regulatory Issues in the Online World - Social Web (Web 2.0), Web of Things (Web 3.0), Intelligent Web (Web 4.0), emerging technologies, Cybercrime, Cyberterrorism, Social Engineering, The Digital Divide, technology and disability, developing world and IT policy, gender issues, transformation of work and quality of life
- Ethics, Privacy and e-Privacy

- Ethical aspects of Cybersecurity
- IS Development and Governance: Risk, Intellectual Property, systems failure, victims/beneficiaries, user/analyst relations, stakeholders, IS deployment, other issues
- Professional Practice and Moral Responsibility: Whistle-blowing, Peer-Support, Codes of Practice, Frameworks, support communities for computing and systems engineering practitioners (ACM, IEEE, IFAC, AIS)
- Computing Standards in relation to Ethical issues (HCS development, e-privacy, energy-efficiency, other standards)

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Critique ethical issues posed by computing technologies.
2. Appraise the practical implications of ethical dilemmas in computing.
3. Demonstrate the ability to take and exercise personal responsibility in professional practice as a computing professional.
4. Critique what is meant by ethical computing and cyberethics and their practical implications.

Supplementary Material(s)

Baase, S. *A Gift of Fire: Social, Legal and Ethical Issues for Computers and the Internet*. 2nd ed.. NJ: Prentice Hall, 2013.
Hersh, M.A. *Ethical Engineering for International Development and Environmental Stability*. 1st ed.. London: Springer-Verlag, 2015.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Digital Photography (E)	**5**	**PHOT-0016**	**85929**	**8**	**CA**

Description of Module / Aims
The aim of the module is to advance the student's knowledge and skill in practical digital photography. The module addresses both the technical and creative aspects of image creation.

Indicative Content

- Camera Controls and operations
- Composition principles
- Practical image making
- Practical editing techniques
- Lighting Techniques – studio and available light
- Presentation of images

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Manage the technical aspects of image capture.
2. Integrate key visual principals underlying digital image capture and editing.
3. Compose images through editing.
4. Assess correct camera controls and settings for a subject.
5. Develop and realise photographic projects.

Essential Material(s)

"Cambridge in Colour." www.cambridgeincolour.com
"Creative Live." www.creativelive.com
"Digital Photography Review." www.dpreview.com
"Magnum Photo Agency." www.magnumphotos.com
Supplementary Material(s)

Freeman, M. *The Photographer's Eye*. NY: Ilex, 2007.
duChemin, D. *The Photographer's Eye*. NY: Peachpit/New Riders, 2010.
duChemin, D. *Within The Frame*. NY: Peachpit/New Riders, 2009.

Formal Specification (E)	ECTS 5	Banner Code: COMP-0216	CRN: 94119	Level 8	Assessment Methods: Exam

Description of Module / Aims
Having examined the software development process in detail, the student is now introduced to a more formal way to treat systems. Using mathematics, the student learns how to precisely specify computer systems. This exposes the student to rigorous and critical thinking skills. This module will also help the student to prioritise needs in systems, e.g. correctness, usability so that appropriate methodologies are chosen. An overview of the formal life cycle is presented.

Indicative Content

- 1. Introduction to Formal Methods
- 2. Mathematics of formal specification
- 3. Formal Specification notation (state based e.g. Z, B Notation)
- 4. Modelling using notation, writing operations using notation

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Chose when formal methods are applicable in software development.
2. Read and write formal specifications and explain them clearly using informal means.
3. Apply the mathematics underlying the formal specification language in this context.
4. Write consistent specifications, and be able to explain why they are consistent.
5. Examine a complex system, distil an understanding of it into an abstracted view, and model this view using appropriate abstract data models and mathematical description.
6. Formally specify part of a real world system (e.g. substantial student project) with appropriate narrative text.

Essential Material(s)

"http://formalmethods.wikia.com/wiki/Z." http://formalmethods.wikia.com/wiki/Z
Ed Currie, The Essence of Z, Prentice Hall, 1999, ISBN 013749839X.
The Z Notation: a reference manual Copyright J. M. Spivey, 1988, 1992, 2001. (Available on-line).
Various conference proceedings, e.g. ZB, ZUM, ZBZ, B and Z, (Springer Verlag) 200 2009.

Management Psychology (E)	ECTS 5	Banner Code: PSYC-0099	CRN: 72542	Level 8	Assessment Methods: Exam

Description of Module / Aims
This module will introduce the student to the workplace from the point of view of the psychology of managing both a group and oneself in a work situation.

Indicative Content

- Introduction: Introduction and overview to the academic discipline of management psychology.
  Organisational structure and systems: Organisational structure and culture, organisational commitment, organisational power and politics, new technology and job design.
  Group dynamics within the organisation: Group formation and structure, leadership and management, social influence in organisations, stress in the workplace, the employment relationship.
  The individual within the organisation: Individual differences, unemployment and mental health, motivation, job satisfaction causes and consequences, learning and Training.

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Describe the complexities that can arise in a workplace and detail factors relevant to their management.
2. Demonstrate a practical knowledge about oneself and about organisations and their dynamics.
3. Utilise the principles of psychology as an objective means of studying human behaviour in the workplace.

Essential Material(s)

Anderson, O., Sinangil and Viswesvaran. (2001) Handbook of Industrial, Work and Organisational Psychology (Vols. 1 and 2). SAGE, USA. Landy, F. J., Conte, J. M. (2010) Work in the 21st Century. 3rd. Edition. Wiley, USA. Current articles from newspapers and journals will be used throughout the year.
Arnold, C. and Robertson. (2005) Work Psychology. 4th. Edition. Pitman Publishing. Robbins, S. (2007) Organizational Behaviour: Concepts, Controversies, and Applications. Seventh Edition. Prentice Hall, United Kingdom. Reece, B., Brandt, R. (2007) Effective Human Relations in Organizations. Third Edition. Houghton Mifflin. Myers, D.G. (2002) Social Psychology. Seventh Edition. McGraw Hill. Warr, P. (2002) Psychology of Work. Fifth Edition. Penguin Publishing.

Mobile Game Development 2 (E)	**ECTS 10**	**Banner Code: COMP-0486**	**CRN: 91702**	**Level 8**	**Assessment Methods: CA**

Description of Module / Aims
Evolve a multi-screen mobile application in a networked, message driven, context aware application. Incorporate in the application two-way access to remote REST (Representational State Transfer) and Messaging services. Integrate on-device context including camera, location, motion, climate and other sensors to deliver a rich user experience. Incorporate 3rd party components to deliver personalized mapping, media and general information services.

Indicative Content

- Advanced application architectural patterns
- The build, test & deploy lifecycle
- Accessing Platform Services: Persistence; Sensors / Subsystems (e.g. Location, camera, movement etc.)
- Accessing External Services: Access Patterns (e.g. REST); Third Party Applications & Components
- Build Processes: Dependency Management; Build Scripts (e.g. Gradle)
- Wireless Subsystem APIs (Application Programming Interfaces)
- App Store interaction, including key management

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Select the appropriate design patterns and tools in the development of complex mobile apps.
2. Comment on the chosen mobile app framework and the underlying hardware components.
3. Design and develop complex multi-screen mobile apps from concept through to completion using best practices and guidelines.
4. Set up the interaction of an application with internal sensors and physical subsystems.
5. Integrate a remote service API within an application, perhaps based on REST principles, to deliver aspects of its core features set. For example: Maps/GIS (Geographic Information Systems), Media Sharing, Social Networking.

Essential Material(s)

"Android Developer site." http://developer.android.com
"Apache Cordova site." https://cordova.apache.org
"iOS Developer site." http://developer.apple.com/ios

Supplementary Material(s)

Camden, R. *Apache Cordova in Action*. New York: Manning, 2015.

Neuburg, M. *iOS 9 Programming Fundamentals with Swift: Swift, Xcode, and Cocoa Basics*. New York: O'Rielly, 2015.
Phillips et al, B. *Android Programming: The Big Nerd Ranch Guide*. New York: Pearson, 2015.

Module Listing for Bachelor of Science in SOFTWARE SYSTEM DEVELOPMENT

Programme Code: – WD_KCOMC_D

Year 1			
Semester 1 (Autumn)	**Component Code**	**Semester 2 (Spring)**	**Component Code**
Year 2			
Semester 3 (Autumn)	**Component Code**	**Semester 4 (Spring)**	**Component Code**
Data Structures & Algorithms 1	COMP-0602	Mobile Application Development 1	COMP-0630
Database Fundamentals	COMP-0185	Database Systems	COMP-0174
Enterprise Applications	COMP-0603	Web App Development 1	COMP-0597
Computer Networks	COMP-0606	Professional Practice	COMP-0599
		Introduction to Computer Security	COMP-0607
Electives*		Electives*	
User Experience Design (E)		Integrated Marketing (E)	MARK-0193
Creative Problem Solving (E)	COMP-0605		
Year 3			
Semester 5 (Autumn)	**Component Code**	**Semester 6 (Spring)**	**Component Code**
		NoSQL Databases	COMP-0661
		Automated Cloud Services	COMP-0967
		Digital Transformation of Information Systems	COMP-0968
		Further Statistics	STAT-0054
		Mobile App Development 2	COMP-0486
		Elective*	
		Technology Entrepreneurship (E)	TECH-0047

Data Structures and Algorithms 1	ECTS 5	Banner Code: COMP-0602	CRN: 91819	Level 7	Assessment Methods: CA

Description of Module / Aims
Implement, from first principles, custom and general purpose data structures and algorithms that are efficient, thread safe, and robustly tested and validated.

Indicative Content

- Implementing Data Structures: Abstract Data Types (ADTs); Lists; Sets; Stacks; Queues; Maps
- Implementing Search Algorithms: Linear; Binary; Hashing; Other
- Implementing Sorting Algorithms: Selection; Bubble; Insertion; Other
- Recursive Algorithms
- Multithreading and Concurrency Issues
- Test-Driven Development for Data Structures and Algorithms

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Construct, from first principles, custom and general purpose data structures.
2. Construct suitable and efficient search algorithms for different data structures.
3. Construct efficient sorting algorithms for different data structures.
4. Use recursion in algorithmic implementations.
5. Explain the issues surrounding, and be able to implement solutions for, concurrently accessed data structures.
6. Construct robust data structures and efficient algorithms in a systematic, test-driven fashion.

Supplementary Material(s)

"Khan Academy Computer science alogrithms." https://www.khanacademy.org/computing/computer-science/algorithms
Sedgewick, R. and K. Wayne. *Algorithms*. NY: Addison-Wesley, 2011.

Database Fundamentals	ECTS 5	Banner Code: COMP-0185	CRN: 69523	Level 7	Assessment Methods: Exam

Description of Module / Aims
This module will introduce the student to the principles and practice of relational database systems including the Database Management Systems aspects. The student will gain competence in Entity Relationship modeling and normalisation techniques involved in the analysis and design phases of the software development lifecycle. They will gain experience in the design and implementation of a practical database system.

Indicative Content

- Database Environment.
- Physical Database Design: Translate the logical data model, File organisation and indexes.
- Database Implementation.
- Database Analysis and Design: Conceptual and Logical Database Design, Relational Model, Normalisation.

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Discuss the role of a DB and DBMS, the components of the DBMS, and the differing roles in the DB environment.
2. Draw Entity Relationship (ER) diagram from an application problem and reproduce this diagram into a set of relations, which are ready for database implementation.
3. Convert unnormalised relations into a set of normalised relations through the rules of normalisation which adhere to relational data model principles

4. Design and implement a database application.
5. Gain an understanding of the physical database design process, its objectives and deliverables.

Essential Material(s)

Connolly, T; and Begg, C Database Systems A Practical Approach to Design Implementation and Management. Ed. 5th (2009) Addison Wesley Hoffer, J; Prescott, M; and Topi, H Modern Database Management. Ed. 9th (2008) Pearson Prentice Hall Connolly, T; and Begg, C Database Solutions: A step-by-step guide to building databases. Ed. 2nd. (2005) Addison Wesley Lejk, M; and Deeks, D An Introduction to Systems Analysis Techniques. Ed. 2nd (2002) Addison Wesley

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Enterprise Applications	**5**	**COMP-0603**	**91823**	**8**	**Exam**

Description of Module / Aims
This module will address Enterprise Applications that a business would use for interacting with multiple parts of an enterprise. Students will learn about different types of Enterprise Application systems and how they are designed to solve the problems encountered by different size enterprises. Emphasis is placed on how these applications provide productivity and efficiency to an enterprise's internal and supply chain processes.

Indicative Content

- Introduction to common types of Enterprise Applications
- Strategies for selecting Enterprise Applications for different types of organisations
- Integration and middleware solutions
- Enterprise Resource Planning (ERP) systems – functions, capabilities to support internal processes and flexibility for supply chain requirements
- Customer Relationship Management (CRM) systems for understanding and engaging with customers
- Supply chain business processes, activities, planning
- Supply Chain Management (SCM) solutions and technologies

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Appraise different types of Enterprise Applications.
2. Justify Enterprise Applications and integration tools for different size organisations.
3. Assess Enterprise Systems within an organisation, focusing on ERP, CRM and SCM.
4. Evaluate supply chain business processes, activities and planning.
5. Assess solutions and technologies for improving supply chain performance.
6. Demonstrate proficiency in the use of an Enterprise Application.

Supplementary Material(s)

"InsideCRM." www.insidecrm.com
"Toolbox for IT - Inside ERP." it.toolbox.com
Laudon, K. and J. Laudon. *Management Information Systems: Managing the Digital Firm*. 14th ed.. New York: Pearson, 2016.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Computer Networks 1	**5**	COMP-0606	**91815**	**7**	**EXAM**

Description of Module / Aims
This module introduces Computer Networking terminology, network protocols and models. Students will use simulation and protocol analysis software to configure network devices and explore various network protocol operations. A detailed examination of TCP/IP, IP addressing and Ethernet is presented. A brief introduction to Routing, Network management and Wireless LANs is also provided. Practical skills are an essential part of this module.

Indicative Content

Introduction to Computer Networks and Protocols
- OSI and TCP/IP models

Ethernet and VLANs
IPv4 Addressing and subnetting
IPv6
Routing
Transport Layer Protocols and Functionality
Application Layer Protocols and Functionality e.g. HTTP, FTP, DNS, SMTP
Wireless LANs
Network Management

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Describe in detail the major components, operation and functionality of a computer network and commonly used protocols and servic

Construct an IPv4/IPv6 addressing design solution.
Build a simple network using routers and switches.
Use Cisco command line interface to perform basic router and switch configuration.
Implement a basic wireless network.
Describe basic computer network management concepts.

Essential Material(s)

"Cisco Network Academy." https://www.netacad.com/

Supplementary Material(s)

Cisco, Networking. *Network Basics, CCNA Routing & Switching Companion Guide*. NY: Cisco Press, 2014.
Tanenbaum, A. and D. Wetherall. *Computer Networks*. 5th Ed. New York: Pearson Education, 2013.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
User Experience Design (E)	**5**			**6**	**CA**

Description of Module / Aims

User Experience (UX) is a concept that has many dimensions, and it includes a variety of different disciplines such as interaction design, visual design, usability, and human-computer interaction. This module will introduce the student to elements and tools that are essential for enhancing user satisfaction by improving motivation, usability and accessibility provided in the interaction between the user and the product in both web and non-web based interfaces. The student will engage in the various stages of the UX Design process, utilizing a variety of supportive tools to assist in the completion of the varied tasks of the UX Designer.

Indicative Content

- Visual Design
- Interaction Design
- Usability and Accessibility
- Human Computer Interaction (HCI) & User Centred Design (UCD)
- Guidelines and Standards
- Evaluation and Testing

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Demonstrate an understanding of the underlying issues and principles of UX.
2. Demonstrate, at a fundamental level through written and practical work, the links between UX and Human Factors.
3. Apply the principles of UCD, to the capture of user requirements providing a basis for design that is fit for purpose.

4. Construct appropriate user interfaces for specific applications and specific users using low and high fidelity prototyping.
5. Explain the usability and accessibility of an interface with respect to different user populations.

Essential Material(s)

"Color in Motion." http://www.mariaclaudiacortes.com/colors/Colors.html
"Interaction Design." http://www.id-book.com/index.php
"UXMatters." Fundamental Principles of UX Design.
http://www.uxmatters.com/mt/archives/2014/11/fundamental-principles-of-great-ux-design-how-to-deliver-great-ux-design.php
Preece, J. and Rogers, Y. and Sharp, H. *Interaction Design: Beyond Human Computer Interaction*. 4th Edition. West Sussex: John Wiley and Sons, 2015.

Supplementary Material(s)

Benyon, D. and Turner, P. and Turner, S. *Designing Interactive Systems: People, Activities,Contexts, Technologies*. Essex, UK: Addison-Wesley, 2005.
Garrett, J.J. *The Elements of User Experience: User Centred Design for the Web*. 2nd Edition. New York: New Riders, 2010.
Johnson, J. *Designing with the Mind in Mind*. 2nd Edition. Waltham, MA: Morgan Kaufman, 2014.
McManus, S. *Web Design: make your website a success!*. 6th Edition. Warwickshire, England: In Easy Steps, 2014.

Creative Problem Solving (E)	ECTS 5	Banner Code: COMP--0605	CRN: 93330	Level 7	Assessment Methods: CA

Description of Module / Aims
This module aims to help the learner understand the role of creativity, innovation, and problem solving in high technology industries. It will encourage the student to recognise the importance of diverse ideas, and to convey that recognition to others. It will cover methods for generating new ideas and ways to increase creative and problem solving abilities through independent research, assessment and discussion.

Indicative Content

- Divergent and Convergent Thinking
- Creative Models and Methods
- Creativity and Observation
- Decision Making Methods
- Implementing Decisions
- Argument Analysis

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Examine the role of creativity and innovation in high tech industries.
2. Apply systematic methods and logical reasoning to problems and decisions.
3. Employ creative models and methods to design, implement and evaluate solutions.
4. Construct and analyse arguments.
5. Complete research activities on their own initiative.

Supplementary Material(s)

"Technology, Entertainment and Design." www.ted.com
Brockman, J. *Thinking: The New Science of Decision-Making, Problem-Solving, and Prediction*. New York: Harper Perennial, 2016.

Mobile App Development 1	ECTS 5	Banner Code: COMP-0630	CRN: 94043	Level 8	Assessment Methods: CA

Description of Module / Aims
Design, build and deploy a multi-screen mobile application incorporating an intuitive and efficient navigation mechanism. Structure the implementation using accepted best-practice with respect to patterns, frameworks and tools. Incorporate localised persistence models + simple access to remote services. Introduce context services such as location/camera and/or other sensor access.

Indicative Content

- Application Structure: Components; Resources; Security; General Assets
- User Experience: UX Principles, Navigation, Imagery, Fonts
- Simple User Interaction Patterns
- Essential Application Structure Patterns: Appropriate Variations on Model/View/Controller (MVVM, MVP etc…)
- Resource access and management; Clean separation of concerns
- Application Life-cycle: Startup/shutdown; Foreground/background
- UI State Preservation and Restoration; Concurrency

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Decompose an application into its constituent parts, including but not limited to: core application components, user experience resources, packaging.
2. Design a coherent User Experience - using appropriate tools, practices and guidelines - for a moderately sized application.
3. Produce medium sized application, based on a limited set of design patterns.
4. Manage the application lifecycle.
5. Structure persistent storage on a device and reliably save and restore application state.

Essential Material(s)

"Android Developer Resources." http://developer.android.com
"Apple Developer Resources." http://developer.apple.com/ios
"Cordova Developer Resources." https://cordova.apache.org

Supplementary Material(s)

Camden, R. *Apache Cordova in Action*. New York: Manning, 2015.
Neuburg, M. *iOS 9 Programming Fundamentals with Swift: Swift, Xcode, and Cocoa Basics*. New York: O'Rielly, 2015.
Phillips, B. *Android Programming: The Big Nerd Ranch Guide*. New York: Pearson, 2015.

Database Systems	ECTS 5	Banner Code: COMP-0174	CRN: 69821	Level 7	Assessment Methods: Exam

Description of Module / Aims
In this module, the student builds on the knowledge gained in Database Fundamentals. The student is exposed to advanced data modelling techniques. They will be provided with the knowledge and know how to administer and manage a commercial database. The student will also gain competence in SQL.

Indicative Content

- Advanced Data Modelling. Data and Database Administration: Concurrency Control, Transaction Management, Backup and Recovery, Functions of the Database Administrator. Introduction to Distributed
- Databases. Database Security. Oracle Architecture. Structured Query Language (SQL).

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Demonstrate the ability to model more complex applications using advanced data modelling concepts.
2. Understand the fundamentals of distributed databases.
3. Identify and assess the various vulnerabilities a database may be subjected to.
4. Construct SQL statements, which would allow for the creation of a relational database tables and manipulation of the data within those tables.
5. Recognise and explain the important issues when administering an enterprise level database and suggest standard techniques to handle those issues.

Essential Material(s)

Connolly, T; and Begg, C, (2009), Database Systems A Practical Approach to Design Implementation and Management, 5/e Edition, Addison Wesley Hoffer, J; Prescott, M; and Topi, H, (2008), Modern Database Management, 9/e Edition, Pearson Prentice Hall, England

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Web App Development 1	**5**	**Comp-0597**	**91981**	**7**	**CA**

Description of Module / Aims
Introduce the the student to the software development lifecycle via the implementation of a simple but functional web application. In doing this, analyse & model a constrained set of user requirements. Then design, build and deploy a simple web application. Incorporate basic database, session support & server side rendering.

Indicative Content

- User Stories & Agile context
- Introduction to Modelling
- Hypertext Transfer Protocol (HTTP) Request/Response Life Cycle
- Introductory Web Application Frameworks
- Simple Object Relational Mapping tools
- Test Driven Development

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Identify the key components of a server rendered web application and incorporate them into a running application.
2. Use Model View Controller & related patterns in the implementation of a web project.
3. Relate the request/response lifecycle, routing & session management in the context of a modern application framework.
4. Convert a set of requirements into a set of discrete stories and translate these stories into a simple project plan with associated timeline and testing strategy.
5. Model the user requirements and realize the model in a simple database.

Supplementary Material(s)

Henderson, M. *Instant CakePHP Starter*. New York: Packt Publishing, 2013.
Richard-Foy, J. *Play Framework Essentials*. New York: Packt Publishing, 2014.
Syed, B. *Beginning Node.js*. New York: Apress, 2014.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Professional Practice	**5**	**COMP-0599**	**91973**	**7**	**CA**

Description of Module / Aims

The aim of this module is to prepare and encourage students to capitalize on the learning potential of their flexible semester experience and enhance their industry awareness. The module will focus on developing students? transferable skills and encouraging professional awareness and practice.

Indicative Content

- Workplace ethics for the computing industry
- Potential for learning during placement and the strategies commonly used
- Identification of transferable skills for integration and progression in the workplace
- Career Preparation: CV preparation and interview skills, career planning, e-portfolio development
- Workplace and placement awareness: Managing equality and diversity, group dynamics and teamwork, understanding organisational culture
- Work-based impression management including the impact of social media as a professional presentation tool for personal and corporate identity

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Examine ethical conduct in the workplace.
2. Develop transferable skills for integration and progression in the workplace.
3. Construct an appropriate personal career development plan and professional profile, to include a skills-needs analysis and CV.
4. Demonstrate professional skills through group and individual presentations.
5. Employ personal autonomy and take responsibility for their personal and academic well-being.
6. Demonstrate the principles and practice of reflective learning.

Essential Material(s)

"Ethics Resource Centre." http://www.ethics.org/
"Transferrable Skills Project." http://www.skillsproject.ie/
"gradireland." https://gradireland.com/

Supplementary Material(s)

Billett, S. *Learning in the Workplace: Strategies for Effective Practice*. Australia: Allen & Unwin, 2001.
Robbins, S.P. and P.L. Hunsaker. *Training in Interpersonal Skills*. 6th ed. USA: Pearson Education, 2012.

Introduction to Computer Security	**ECTS 5**	**Banner Code: COMP-0607**	**CRN: 91833**	**Level 6**	**Assessment Methods: CA**

Description of Module / Aims

This module aims to provide students with an introduction to Computer Security. The module focuses on providing a general awareness of security by highlighting threats and ways to counteract them.

Indicative Content

- 1. What is security?
- 2. Security Threats
- 2.1 Threats to PCs
- 2.2 Threats to data
- 2.3 Threats to networks
- 3. Malware
- 3.1 Viruses
- 3.2 Worms
- 3.3 Key Loggers
- 3.4 Trojans

- 4. Securing a PC
- 4.1 Security policies
- 4.2 Encryption
- 4.3 Anti-malware software
- 4.4 Network Defence
- 4.5 Patching and updating

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Understand threats to the security of data and PCs
2. Differentiate between various forms of malware
3. Summarise the steps involved in a securing a PC
4. Discuss the security cycle
5. Understand the issues surrounding basic computer security principles, including passwords and encryption
6. Write documentation associated with a security policy

Essential Material(s)

" www.gsec.co.uk." www.gsec.co.uk
"Computer Forensic Analysis." http://www.porcupine.org/forensics/
"Computer Forensic World." http://www.computerforensicsworld.com/
"E-evidence Information Center." http://www.e-evidence.info/
"Forensic Focus." http://www.forensicfocus.com/
"SANS." www.sans.org
"www.secure.it." www.secure.it
Conklin, White, Cothren, Williams, Davis. *Principles of Computer Security, Security+ and Beyond*. : McGraw-Hill, 2004.
Eric Maiwald. *Fundamentals of Network Security*. : McGraw-Hill, 2004.
Michael G. Solomon, Diane Barrett, Neil Broom. *Computer Forensics Jump Start, Computer Forensics*. : Sybex, 2005.
Rick Lehitnen, Deborah Russell & G.T., Gangemi Sr. *Computer Security Basics*. 2nd edition. : O'Reilly, 2006.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Integrated Marketing (E)	**5**	**MARK-0193**	**91837**	**7**	**CA**

Description of Module / Aims
The aim of this module is to demonstrate how companies apply marketing concepts and strategy in high technology industries.

Indicative Content

- The Marketing Process
- The High Technology Marketing Environment
- The High Technology Marketing Mix
- Developing Market Information in High Technology Industries
- Digital Promotional Campaigns

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Examine the role of marketing in software and hardware development.
2. Apply marketing research methods used by high tech companies.
3. Apply digital marketing tools to develop an online promotional campaign.
4. Examine market dynamics in high technology marketing industries.
5. Analyse the marketing strategy of high technology companies.

Supplementary Material(s)

Arthur, C. *Digital Wars: Apple, Google, Microsoft and the Battle for the Internet*. London: Kogan Page, 2012.
Brynjolfsson, E. and A. McAffee. *The Second Machine Age - Work, Progress, and Prosperity in a Time of Brilliant Technologies*. New York: W. W. Norton & Company, 2016.
Chaffey, D and F Ellis-Chadwick. *Digital Marketing*. London: Pearson, 2015.
Yoffie, D. and M. Cusumano. *Strategy Rules: Five Timeless Lessons from Bill Gates, Andy Grove, and Steve Jobs*. New York: HarperBusiness, 2015.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
NoSQL Databases	**5**	**COMP-0661**	**94004**	**8**	**Exam**

Description of Module / Aims
This module will introduce the student to the principles and practice of designing database solutions for large volumes of either structured or unstructured data. The student will gain competence in determining the suitability of a schemaless database or a data warehouse. The student will be introduced to the concepts of data persistence, consistency and distribution in the NoSQL database context. They will gain experience in the design and implementation of a NoSQL database system for unstructured data. The module will also introduce them to the use of data warehouses for storage of large volumes of structured data.

Indicative Content

- Introduction to storing large volumes of structured or unstructured data
- Emergence of NoSQL databases
- Aggregate data models
- Key-value databases, document databases, column family databases and graph databases
- Data persistence, database consistency (CAP theorem, version stamps) and distribution of data storage
- Fundamentals involved in the storage of large volumes of structured data in a data warehouse

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Analyse a business scenario to determine a suitable big data database solution.
2. Create at least one type of NoSQL database.
3. Assess the growth and use of NoSQL in business.
4. Appraise the distribution of data on clusters.
5. Examine the issue of consistency in relation to NoSQL databases.
6. Summarise the characteristics, design and implementation of data warehouses for structured data.

Supplementary Material(s)

"TDWI research in the business intelligence and data warehousing industry." http://tdwi.org
"comprehensive resource on NoSQL database solutions." http://nosql-database.org
Connolly, T. and E. Begg Connolly. *Database Systems: A practical approach to design, implementation and management*. NY: Addison-Wesley, 2015.
Sadalage, J. and M. Fowler. *NoSQL Distilled A brief guide to the emerging world of polygot persistence*. New Jersey: Pearson, 2013.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Automated Cloud Services	**5**	**COMP-0967**	**93993**	**7**	**CA**

Description of Module / Aims
This is a practical module that requires the student to build, configure and manage the operating system and network infrastructure required for a typical cloud application environment.

Indicative Content

- Cloud Computing Architectures and Services
- Public Cloud Services: Storage; Compute; Networking
- Introduction to Python Programming
- Cloud APIs – Python or similar
- Configuration of Multi-tier Application Infrastructure Services
- Virtual Private Clouds
- Web Application Architecture – Performance, Scaling, Load Balancing and Security
- Devops, Automation and scripting – using for example bash (advanced), Python, PowerShell, Chef, Ansible
- Network and Application Management and Monitoring

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Develop, configure and manage essential network infrastructure and application services.
2. Deploy a network monitoring solution.
3. Develop scripts to assist in the management and automation of modern network services.
4. Appraise and apply principles of application performance, scalability, load balancing and security.
5. Compare and contrast the main technologies required to develop and manage Cloud based Application Infrastructure.

Supplementary Material(s)

"The Python Wiki." https://wiki.python.org/
"boto: Python interface to Amazon Web Services." http://boto.readthedocs.org/en/latest/
Amazon, A. *Getting started with AWS (eBook)*. New York: Amazon, 2014.
Morris, K. *Infrastructure as Code: Managing Servers in the Cloud*. 1st. New York: O'Reilly Media, 2016.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Digital Transformation of Information Systems	**5**	**COMP-0968**	**94046**	**7**	**Exam**

Description of Module / Aims
This module will address the transformation of legacy approaches of enterprise applications to new ways of using digital, social and emerging technologies. The emergence of all these new technologies adds new capabilities to businesses and options for the next generation of enterprise applications. Cloud services for enterprise applications are examined in detail where students will integrate their technical knowledge and theory with practice of a cloud service to support a business system. The module will also include current relevant issues on privacy ethics and security.

Indicative Content

- Changes in economics and technology: Digital transformation strategies, disruptive technologies, new business models
- Digital Enterprise Wave: Internet of things (IOT), cloud technologies, artificial intelligence (AI), analytics and mobile for real-time data
- Evolving enterprise applications to support a dynamic digital business - advanced inventory control, sensor and location data from mobile devices for marketing intelligence, cloud based manufacturing and planning
- Cloud-based services for enterprise applications: SaaS, PaaS, IaaS
- Emerging social tools for enterprise application strategies
- Management issues including technology investment, digital innovations, relevant ethics, privacy and security issues

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Examine the role played by digital transformation in different industries.
2. Compare digital technologies in continuous changing business environments.
3. Examine and demonstrate enterprise applications in cloud computing.

4. Interpret ways in which enterprises are enhancing their communication and collaboration with emerging social tools.
5. Examine the appropriate procedures for relevant ethics, privacy and security issues with digital wave technologies.

Supplementary Material(s)

Bounfour, A. *Digital Futures, Digital Transformation*. Switzerland: Springer International Publishing, 2016.
Laudon, K. and J. Laudon. *Management Information Systems: Managing the Digital Firm*. 14th ed.. New York: Pearson, 2016.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Further Statistics	**5**	**STAT-0054**	**94035**	**7**	**Exam**

Description of Module / Aims
The module is designed to consolidate understanding of fundamental statistical concepts and extend knowledge and skills to probability, advanced regression techniques and inferential statistics. The student will see how these tools can be applied in an industry setting. Statistical software will be used as a modelling tool.

Indicative Content

- Probability: Basic probability and nature of statistical investigations; Discrete and continuous distributions; Quality control charts
- Inferential statistics: Sampling distributions; Hypothesis testing using p values and confidence intervals on one or more samples
- Advanced regression: Non-linear regression; Multiple regression; Goodness of fit testing

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Apply probability principles and data distributions to evaluate quality control procedures.
2. Distinguish between descriptive and inferential statistical quantities in data analytics.
3. Apply a broad range of analytical statistical techniques and interpret these appropriately.
4. Analyse patterns from intricate data sets.
5. Assemble data sets for subsequent analysis and conclude suitable inferences from them.
6. Use appropriate statistical software tools to analyse and interpret data.

Supplementary Material(s)

"Further Statistics moodle page." https://moodle.wit.ie
Crawley, M.J. *Statistics: An Introduction using R*. 2nd ed. New Jersey: Wiley, 2014.
Rice, J.A. *Mathematical Statistics and Data Analysis*. 3rd ed. New York: Duxbury Press, 2010.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Mobile App Development 2	**5**	**COMP-0486**	**91702**	**8**	**CA**

Description of Module / Aims
Evolve a multi-screen mobile application in a networked, message driven, context aware application. Incorporate in the application two-way access to remote REST (Representational State Transfer) and Messaging services. Integrate on-device context including camera, location, motion, climate and other sensors to deliver a rich user experience. Incorporate 3rd party components to deliver personalized mapping, media and general information services.

Indicative Content

- Advanced application architectural patterns
- The build, test & deploy lifecycle
- Accessing Platform Services: Persistence; Sensors / Subsystems (e.g. Location, camera, movement etc.)

- Accessing External Services: Access Patterns (e.g. REST); Third Party Applications & Components
- Build Processes: Dependency Management; Build Scripts (e.g. Gradle)
- Wireless Subsystem APIs (Application Programming Interfaces)
- App Store interaction, including key management

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Select the appropriate design patterns and tools in the development of complex mobile apps.
2. Comment on the chosen mobile app framework and the underlying hardware components.
3. Design and develop complex multi-screen mobile apps from concept through to completion using best practices and guidelines.
4. Set up the interaction of an application with internal sensors and physical subsystems.
5. Integrate a remote service API within an application, perhaps based on REST principles, to deliver aspects of its core features set. For example: Maps/GIS (Geographic Information Systems), Media Sharing, Social Networking.

Essential Material(s)

"Android Developer site." http://developer.android.com
"Apache Cordova site." https://cordova.apache.org
"iOS Developer site." http://developer.apple.com/ios

Supplementary Material(s)

Camden, R. *Apache Cordova in Action*. New York: Manning, 2015.
Neuburg, M. *iOS 9 Programming Fundamentals with Swift: Swift, Xcode, and Cocoa Basics*. New York: O'Rielly, 2015.
Phillips et al, B. *Android Programming: The Big Nerd Ranch Guide*. New York: Pearson, 2015.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Technology Entrepreneurship (E)	**5**	**TECH-0047**	**94040**	**7**	**CA**

Description of Module / Aims
This module is designed to develop knowledge, skills and capabilities for the formulation and initiation of technology enterprises. The module will emphasize lean principles and analytics to enable the student to understand the process of building, testing and iterating to achieve product-market fit.The identification and design of business models and revenue models appropriate to technology enterprises will also form part of the module.

Indicative Content

- Lean start-up principles
- Lean analytics and metrics
- Minimal viable product(MVP) design and testing
- Defining and developing value propositions
- Business model design
- Revenue model design
- Pitching to investors and customers

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Describe the principles and practices of lean start-up.
2. Demonstrate the technology start-up process using lean principles.
3. Design business models and revenue models appropriate to different technology enterprises and their contexts.
4. Develop lean analytics and metrics to support decision making in the technology enterprise.
5. Demonstrate the process and usage of minimal viable product (MVP) design.

6. Articulate their technology enterprise concept in a business context.

Essential Material(s)

Ries, E. *The Lean Start-up.*. UK: Penguin, 2011.

Supplementary Material(s)

Croll, A. and B. Yoskovitz. *Lean Analytics: Use data to build a better start-up faster*. USA: O'Reilly Media Inc., 2013.
Osterwalder, A. and Y. Pigneur. *Business Model Generation*. New Jersey. USA: John Wiley and Sons Inc., 2010.
Scarborough, N. and J. Cornwall. *Essentials of Entrepreneurship and Small Business Management*. 8th ed.. USA: Pearson, 2015.

Module Listing for Bachelor of Science (Hons) in SOFTWARE SYSTEM DEVELOPMENT

- Progression to Honours degree from BSc in Software System Development

Programme Code: – **WD_KCSDV_B**

Year 4			
Semester 1 (Autumn) Code	**Component**	**Semester 8 (Spring)**	**Component Code**
Agile Software Practice	COMP-0608	Application Security	COMP-0612
Business Analytics 1	COMP-0609	Business Analytics 2	COMP-0613
Enterprise Systems Architecture	COMP-0610	Distributed Systems	COMP-0614
Web App Development2	COMP-0611	Project 2 (Development) (E)	PROJ-0169
Project 1 (Development) (E)	PROJ-0111	Project 2 (Research) (E)	PROJ-0170
Project 1 (Research) (E)	PROJ-0167	Technology Commercialism (E)	COMP-0615
Project Management (E)	PROJ-0168	Management Psychology (E)	PSYC-0099

Agile Software Development	ECTS 5	Banner Code: COMP-0608	CRN: 91985	Level 8	Assessment Methods: Exam

Description of Module / Aims
This module will address a subset of the tools and technologies required to support the development of reliable, efficient and scalable software services, and some techniques aimed at improving their maintainability. The focus is on the use of Agile development methods, requiring test-driven development and regular automated system builds. The aim is to assemble a toolkit of modern tools that enable the setup of a software development process where this process is automated by the tools.

Indicative Content

- Agile Development methodologies - Values, Principles and strategies
- Agile Development support tools - Testing, System Build, Version Control.

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Demonstrate knowledge and understanding of modern software development methods, such as eXtreme Programming Demonstrate an understanding of a range of tools that support agile development processes, in particular version control, build and testing, all operating within an IDE. Use agile methods to improve the effectiveness of their own software development processes. Be able to make appropriate choices regarding the
2. application of refactoring techniques to software design.

Essential Material(s)

Hightower,R & Lesiecki, J Java tools for Agile Development2002 Wiley

Business Analytics 1	ECTS 5	Banner Code: COMP-0609	CRN: 91989	Level 8	Assessment Methods: Exam

Description of Module / Aims
The student is introduced to the use of analytics to support the decision making process in the business context. The student will experience the identification, description, cleaning, transforming and storage of structured data in an appropriate environment. Data mining techniques appropriate for the business analytics' context such as up-selling, cross-selling, customer classification and pattern discovery will be investigated. The student will conduct appropriate statistical analysis, rule generation and modelling in order to discover patterns and create new insights. The student will present and evaluate that analysis using visualisation tools.

Indicative Content

- Introduction to Business Analytics
- The Data Mining process; Data Identification, Data description, Data cleaning, Data transformation
- Data modelling: Statistical modelling; decision trees; rudimentary rules
- Deployment, evaluation and maintenance
- The application of business analytics: CRM; Sales; Marketing etc
- Business Analyst job role

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Appraise the use of analytics in the business context to support decision making.
2. Prepare results from an introductory analytics project using an appropriate Data Mining process.
3. Organise a set of data in preparation for business analytics.
4. Develop, implement and evaluate the results of data models on a data set.
5. Assess the use of a data mining process in the context of business analytics.

6. Evaluate and determine appropriate introductory data mining techniques.

Supplementary Material(s)

Evans, J. *Statistics, Data Analysis, and Decision Modelling*. NY: Pearson, 2013.
Jank, Wolfgang. *Use R! Business Analytics for Managers*. NY: Springer, 2011.
Stubbs, E. *Delivering Business Analytics practical guidelines for best practice*. NY: Wiley, 2013.

Enterprise Systems Architecture	ECTS 5	Banner Code: COMP-0610	CRN: 91993	Level 8	Assessment Methods: Exam

Description of Module / Aims

This module aims to provide the student with an understanding of an architectural approach to development of information systems. The module introduces the constituent parts of architecture and their interrelationship. The student is introduced to the use of architectural frameworks and to the use of architecture approaches for different contexts within the organisation.

Indicative Content

- Architectural Structure, Components, and Interactions
- Architectural Frameworks
- Enterprise Architectures
- Data Architectures
- Information System Architectures
- Technology Architecture
- Enterprise Modelling
- Enterprise Application Architectures and Integration
- Process Management and Service Architectures
- Model Driven Architectures
- Architecture Development Methods and Capabilities

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Determine the role of architectures in the development of enterprise systems.
2. Construct architectures for business, data, technology, and enterprise applications.
3. Design a service architecture to support a set of business processes.
4. Evaluate the role of model driven architectures in enterprise application development.
5. Compare architecture development method.

Essential Material(s)

Desfray, P. and G. Raymond. *Modelling Enterprise Architecture with TOGAF: A Practical Guide using UML and BPMN*. Waltham, MA, USA: Morgan Kaufmann/OMG Press, 2014.

Supplementary Material(s)

Bass, L. and P. Clements. *Software Architecture in Practice*. 3rd.. Upper Saddle River, NJ, USA: Pearson, 2013.
Bernard, S.A. *An Introduction to Enterprise Architecture*. Bloomington, IN, USA: AuthorHouse, 2012.
Fowler, M. *Patterns of Enterprise Application Architecture*. Upper Saddle River, NJ, USA: Pearson, 2002.
Newman, S. *Building Microservices: Designing Fine Grained Systems*. Sebastapol, CA, USA.: O'Reilly, 2015.
Rosenfeld, L., P. Morville and J. Arango. *Information Architecture: For the Web and Beyond*. Sebastapol, CA, USA: O'Reilly, 2015.
Russell-Rose, T. and T. Tate. *Designing the Search Experience: The Information Architecture of Discovery*. Waltham, MA, USA: Morgan-Kaufmann, 2013.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Web App Development 2	**5**	**COMP-0611**	**91997**	**8**	**CA**

Description of Module / Aims
This module approaches web application development from an apps and services perspective, as opposed to the monolithic, server-side rendering model. Services will be formulated as REST APIs (Representational State Transfer Application Program Interface), while multiple service consumer forms will be considered, including Single Page Apps (SPA) and other services. The principles and patterns underpinning the design of both components (SPA and REST API) will be examined as well as the fine-grained aspects of the underlying communication protocol. There will be an emphasis on development, including the use of application frameworks, workflow automation tools and cloud deployment platforms. The module's scope will also encompass the technical aspects of both realtime API communication and isomorphic web apps.

Indicative Content

- Fundamentals: Architecture patterns; HTTP (Hypertext Transfer Protocol) protocol; advanced Javascript
- API Design patterns and principles: REST; CQRS (Command Query Responsibility Separation); versioning; vecurity; hypermedia; realtime
- SPA design patterns and principles: MV* (Model View *); Flux; caching; data synchronisation
- Application Frameworks: Web API; Single Page App; Isomorphic app
- Developer tool suite: API modelling; DSL(Domain Specific Language); scaffolding; workflow automation
- Deployment environments: API gatways; containers

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Apply best practice principles and patterns to the design and documentation of a web API.
2. Apply best practice principles and patterns to the design of a medium-sized Single Page Web App.
3. Design an end-to-end web app that supports session management and persistence for a constrained functional requirement set.
4. Utilise and configure related workflow automation tools.
5. Manage a cloud deployed web API using a Gateway intermediary service.

Supplementary Material(s)

"ReactJS." https://facebook.github.io/react/. https://facebook.github.io/react/
Richardson, L. and M. Amundsen. *RESTful Web APIs*. O'Reilly Media: O'Reilly Media, 2009.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Project 1 (Development (E)	**5**	**PROJ-0111**	**92001**	**8**	**CA**

Description of Module / Aims
This module extends the student's knowledge of software engineering with a view to equipping them for their project work in this current year (year IV) of the programme. In addition it requires the student to prepare a consolidated report on the first stage of their fourth year project in conjunction with a learning contract established between student and supervisor.

Indicative Content

- Consolidate knowledge of software development processes, particularly those that are based on an iterative strategy and early risk mitigation
- To enhance the student's ability to analyse a problem through scenarios that will subsequently provide a plan for construction and testing
- Where appropriate to define the user requirements of an intended system through use case descriptions
- Use of UML and other textual/diagramming techniques essential for discussing final year projects at a conceptual level
- To revise and consolidate the students' abilities to write referenced reports

- Using appropriate techniques, tentatively plan a project in detail breaking it into sub-tasks; rigorously identify deliverables and critical dependencies

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Explain, in words and diagrammatically, to their peers, the work of their project.
2. Interact with their supervisor in discussing how their project might proceed and the risks and interact options associated with their work.
3. Complete a technological prototype of their project showing that all their hardware and software components work together.
4. Prepare a test strategy for their project and have a detailed tentative plan for building a draft design.

Supplementary Material(s)

Lacey, M. *The Scrum Field Guide: Practical advice for the first year*. New York: Addison Wesley, 2012.

Project 1 (Research) (E)	**ECTS 5**	**Banner Code: PROJ-0167**	**CRN: 92005**	**Level 8**	**Assessment Methods: CA**

Description of Module / Aims
This is the capstone module for Semester one; it should bring together the student's knowledge on all aspects of IT and utilise many facets of their previous learning, with a view to identifying a suitable research problem that is to be investigated. This module requires the student to identify a research area of interest, conduct a preliminary investigation, identify suitable research question(s), conduct a literature review and critique and select a suitable methodology to enable them to gather and analyse data. In addition, it requires the student to prepare a report on the first stage of their fourth year project in conjunction with a learning contract established between student and supervisor.

Indicative Content

- Write succinct and referenced, well-structured reports
- Introduction
- Analysis of research questions
- Literature review
- Research methodology

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Appraise a research area.
2. Create appropriate research questions.
3. Complete a literature review.
4. Select an appropriate research methodology and data gathering technique.

Essential Material(s)

Cresswell, J.S. *Research Methods:Qualitative, Quantitaive and Mixed Methods Approaches*. New York: Sage, 2002.

Project Management (E)	**ECTS 5**	**Banner Code: PROJ-0168**	**CRN: 92009**	**Level 8**	**Assessment Methods: Exam**

Description of Module / Aims
This module aims to provide the student with the ability to initiate, plan, execute, control and close-out the work of a team in order to achieve specific project goals and meet specific success criteria as set out by the project sponsor and organisation.

Indicative Content

- Project Management Life Cycle Model (PMLC)
- Managing Project Scope
- Managing Project Resources
- Managing Project Quality
- Managing Project Risk
- Managing Project Execution
- Managing Project Implementation and Closure

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Appraise principles of project management.
2. Evaluate contemporary issues that may affect the project management process.
3. Estimate project duration and costings using a variety of tools and models.
4. Produce a project plan based on a business context.
5. Plan, control and monitor project schedules using project management software.

Supplementary Material(s)

Cadle, J. and D. Yeates. *Project Management for Information Systems*. 5th ed.. London, UK: Pearson, 2008.
Marchewka, J.T. *Information Technology Project Management: Providing Measurable Organisational Value*. 5th ed.. MA, USA: Wiley, 2015.

Application Security	**ECTS 5**	**Banner Code: COMP-0612**	**CRN: 92013**	**Level 8**	**Assessment Methods: Exam**

Description of Module / Aims
This module equips the student with knowledge of security vulnerabilities of application software taking into account both web and native applications. Methods used to solve these vulnerabilities are investigated. Intrusion Detection/Prevention Systems and Malicious Software are also presented. Students will be given a grounding in the area of Secure Software Development. This module also explores issues pertinent to Incident Response and Recovery.

Indicative Content

- Web application security
- Native application security (mobile apps, desktops apps etc.)
- Intrusion detection/prevention systems
- Malicious software
- Secure software engineering
- Incident response and recovery

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Assess a variety of security issues, vulnerabilities and fixes that arise in applications and categorise them by using information from CERT, OWASP and other trusted services.
2. Compare the capabilities and limitations of intrusion detection systems and intrusion prevention systems.
3. Appraise different threats posed by various categories of malware and explain different techniques to defend against them.
4. Justify the need for appropriate incident response and recovery measures.
5. Assess how security can be integrated into the software development process.
6. Formulate a variety of security attacks in a simulated environment.

Supplementary Material(s)

"Computer Emergency Response Team, CERT." http://www.cert.org

"Security Focus." http://www.securityfocus.com/
"The SANS Institute." http://www.sans.org
Stallings, W. *Cryptography and Network Security, Principles and Practice*. 6th ed. England: Pearson, 2014.
Stallings, W. *Network Security Essentials*. England: Pearson, 2014.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Business Analytics 2	**5**	**COMP-0613**	**92017**	**8**	**CA**

Description of Module / Aims
The purpose is to advance the students skills in conducting business analytics on structured data and to introduce the student to the analysis conducted on unstructured data. Students will investigate data mining techniques such as predicting customer behaviour, performance management, simulation and optimisation of business processes. The student will conduct analysis to discover patterns and to predict future events or outcomes. The student will be introduced to the analysis of unstructured data such as text and web mining.

Indicative Content

- Theory of advanced data mining methods
- Use of advanced data mining methods in the context of business analytics
- Data mining algorithms: Association Rules; Classification; Clustering;
- Implementation, evaluation and interpretation of results using advanced data mining techniques
- Fundamental of the analysis of unstructured data
- Introduction to Text and Web mining techniques

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Prepare results from an advanced analytics project using an appropriate Data Mining process.
2. Choose and apply appropriate data mining methods to a data set.
3. Evaluate results from data mining conducted on a data set.
4. Evaluate and determine appropriate advanced data mining techniques.
5. Appraise the use of analytics on unstructured data in relation to text and web mining.

Supplementary Material(s)

Delen, D. *Real-World Data Mining: Applied Business Analytics and Decision Making - See more at: http://www.pearsonhighered.com/educator/product/RealWorld Data Mining Applied Business Analytics and Decision Making*. NY: Pearson, 2015.
Jank, Wolfgang. *Use R! Business Analytics for Managers*. NY: Springer, 2011.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Distributed Systems	**5**	**COMP-0614**	**92021**	**8**	**CA**

Description of Module / Aims
This module will equip the student with the knowledge required to comprehend the architecture of a modern, distributed, service-oriented application and the skills to develop same for a constrained set of requirements. The non-functional requirements of a cloud-native application, namely, resilience, fault tolerance and responsiveness will be considered using a mixture of patterns, libraries and middleware technology. The student will gain experience in deploying to a lightweight container-based cloud platform and have the skills to configure an appropriate load balancing strategy.

Indicative Content

- Fundamentals: Inter process communication; Promises; Non-blocking I/O, Thread pooling
- Application architecture: Layered; Microservice
- Middleware services: Messaging; Caching

- Application Resilience: Availability; Stability patterns
- Failure isolation and recovery
- Containerization
- Reactive communication first principles

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Design, develop and deploy a scalable, distributed application for a constrained requirements set.
2. Choose appropriate middle-ware technology to improve responsiveness.
3. Maximize an application's resilience and fault tolerance utilizing core patterns and practices.
4. Evaluate and configure an appropriate load balance strategy.
5. Choose and configure an appropriate workflow automation tool suite.

Supplementary Material(s)

Newman, S. *Building Microservices - Designing Fine-Grained Systems*. O'Reilly Media: O'Reilly Media, 2014.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Project 2 (Development) (E)	**10**	**PROJ-0169**	**92025**	**8**	**CA**

Description of Module / Aims
This module gives the student experience in developing a computing-related project by creating a product or a good prototpye for a product. The student will present their work at the end of the module by submitting a final report, in addition to a poster, a short video, and a demonstration.

Indicative Content

- Incorporate feedback from project supervisors/examiners, relating to the work done in Semester 1, namely high level analysis and design and the construction of prototypes and/or early iterations.
- Develop further and document a testing strategy to ensure the quality of each software module, each production-quality iteration and of the final product.
- Further develop the student's ability to write referenced academic and technical reports, principally a required final report, not less than 2000 words and not more than 8000 words, accompanied by a poster and a video.
- To provide the student with the opportunity (and requirement) to meet with a supervisor week by week and to complete the work according to the initial or a revised plan.
- To enable the student to apply their problem-solving and their technical skills to address implementation issues as they arise.

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Integrate feedback from Project 1.
2. Implement a fully tested, working system based on a specification and chosen development methodology.
3. Appraise the limitations and potential of the chosen methodology and resulting solution.
4. Validate the final system, with accompanying report, video and poster and competently discuss the problem area.

Supplementary Material(s)

Beck, K. *Test-driven development: by example*. Boston: Addison-Wesley, 2003.
Fowler, M. and K. Scott. *UML distilled: a brief guide to the standard object modelling language*. Boston: Addison-Wesley, 2004.
Lacey, M. *The Scrum field guide practical advice for your first year*. Harlow: Addison-Wesley, 2012.

Project 2 (Research) (E)	ECTS 10	Banner Code: PROJ-0170	CRN: 92029	Level 8	Assessment Methods: CA

Description of Module / Aims
This module gives the student experience in developing a computing-related project by undertaking research, based on the work the student has completed in Project 1, semester 7. The student will present their work at the end of the module by submitting a dissertation, in addition to a poster, a short video, and a presentation.

Indicative Content

- Incorporate feedback from project supervisors/examiners, relating to the work done in Semester 1, that work being a literature review and consequent formulation of research question(s), and initial investigative work on appropriate research methodologies, including data gathering strategies.
- Complete the consideration of the research methodologies to be used, and design of the data collection instruments.
- Complete the development of any customised software tools to be used in investigation or data gathering and analysis.
- Further develop the student's ability to write referenced academic and technical reports, principally a required final dissertation, not less than 6000 words and not more than 12000 words, accompanied by a poster and a video.
- To provide the student with the opportunity (and requirement) to meet with a supervisor week by week and to complete the work according to the initial or a revised plan.
- To enable the student to apply investigative, problem-solving and technical knowledge to address issues as they arise.

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Integrate feedback from Project 1.
2. Complete the process of devising/designing a research methodology.
3. Create the research question(s), using the appropriate tools and methodologies.
4. Reflect on limitations and potential of the chosen methodology and resulting discoveries.
5. Validate the final dissertation, with accompanying video and poster and competently discuss the research area, showing competence in research methods.

Supplementary Material(s)

Bell, J. and C. Opie. *Learning from research: getting more from your data*. Buckingham: Open University Press, 2002.
Bell, J. and S. Waters. *Doing your research project: A Guide for first time researchers*. Buckingham: Open University Press, McGraw-Hill, 2014.

Technology Commercialisation	ECTS 5	Banner Code: COMP-0615	CRN: 92033	Level 8	Assessment Methods: CA

Description of Module / Aims
This module will offer the student a process and tools to access the business visibility of a technical idea, and to develop the best business approach for commercialisation. This will be a 'hands on' class in which students will exercise commercialisation concepts on patents and develop technology commercialisation plan with real world business application.

Indicative Content

- Technology Commercialisation Process
- Technology/Product Analysis
- Business Modelling
- Market Needs Assessment & Customer Profiling
- Market Landscape & Trend Analysis

- Value Chain Analysis
- Risk and Challenges
- Resource Requirements Identification

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Understand the use of screening tools to identify attributes of a marketable technical concept.
2. Understand steps in a technology commercialisation process to develop a viable commercialisation proposal.
3. Understand the elements of a successful business proposal and presentation for commercialising a technical concept.
4. Be able to skillfully use screening tools and the technology commercialisation process to develop a business proposal for a selected innovation.
5. Be able to make an effective presentation of a business proposal for a selected innovation.
6. Be able to work effectively in a multidisciplinary team to develop and present your commercialisation plan.
7. Be able to listen to the ideas of others and appropriately incorporate them into your thinking.

Essential Material(s)

Overholt, S. *Mastering Technology Commercialization: Inventions; Patents; Markets; Money*. USA: Overholt, 2013.
Touhill, J., G. Touhill and T. Riordan. *Commercialization of Innovative Technologies: Bringing Good Ideas to the Marketplace*. USA: Wiley, 2008.

Supplementary Material(s)

"Nebrask business Development Centre." http://nbdc.unomaha.edu/. http://nbdc.unomaha.edu/technology-commercialization/techventure/home

Management Psychology (E)	ECTS 5	Banner Code: PSYC-0099	CRN: 72542	Level 8	Assessment Methods: Exam

Description of Module / Aims
This module will introduce the student to the workplace from the point of view of the psychology of managing both a group and oneself in a work situation.

Indicative Content

- Introduction and overview to the academic discipline of management psychology
- Organisational structure: systems, culture, commitment, organisational power and politics, recruitment
- Group dynamics within the organisation: group formation and structure, leadership and management, teams
- The individual within the organisation: individual differences, unemployment and mental health, motivation, job satisfaction
- Learning and Training
- New technology and job design

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Describe the complexities that can arise in a workplace and detail factors relevant to their management.
2. Demonstrate a practical knowledge about oneself and about organisations and their dynamics.
3. Evaluate human behaviour in the workplace.

Essential Material(s)

Landy, F.J. and J.M. Conte. *Work in the 21st Century. An Introduction to Industrial and Organizational Psychology*. 4th ed. USA: Wiley, 2013.

Supplementary Material(s)

Anderson,, N.A., H.K. Sinangil and C. Viswesvaran. *Handbook of Industrial, Work and Organisational Psychology (Vols. 1 and 2)*. USA: Sage, 2001.
Arnold, C. and R. Randall. *Work Psychology*. 5th ed. England: Prentice Hall, 2010.
Robbins, S.P. and T.A. Judge. *Organizational Behavior*. 16th ed. USA: Pearson Education, 2015.

Module Listing for Bachelor of Science in INFORMATION TECHNOLOGY

Programme Code: – WD_KINFT_D

Year 1			
Semester 1 (Autumn) **Code**	**Component**	**Semester 2 (Spring)** **Code**	**Component**
Year 2			
Semester 3 (Autumn) **Code**	**Component**	**Semester 4 (Spring)**	**Component Code**
Enterprise Applications	COMP-0603	Professional Practice	COMP-0599
Network Theory Fundamentals	COMP-0658	Web App Development 1	COMP-0597
Database Fundamentals	COMP-0185	Database Systems	COMP-0174
Programming Fundamentals 2	COMP-0378	Introduction to Computer Security	COMP-0607
Introduction to Cloud Computing	COMP-0625	Further Statistics	STAT-0054
Computer Networks	COMP-0637	Networks Infrastructure	
Year 3			
Semester 5 (Autumn) **Code**	**Component**	**Semester 6 (Spring)**	**Component Code**
		NoSQL Databases	COMP-0661
		Automated Cloud Services	COMP-0967
		Digital Transformation of Info Systems	COMP-0968
		Mobile App Development 1	COMP-0630
		Application Security	COMP-0612
		Enterprise Data Exchange and XML	

Enterprise Applications	ECTS 5	Banner Code: COMP-0603	CRN: 91823	Level 7	Assessment Methods: Exam

Description of Module / Aims
This module will address Enterprise Applications that a business would use for interacting with multiple parts of an enterprise. Students will learn about different types of Enterprise Application systems and how they are designed to solve the problems encountered by different size enterprises. Emphasis is placed on how these applications provide productivity and efficiency to an enterprise's internal and supply chain processes.

Indicative Content

- Introduction to common types of Enterprise Applications
- Strategies for selecting Enterprise Applications for different types of organisations
- Integration and middleware solutions
- Enterprise Resource Planning (ERP) systems – functions, capabilities to support internal processes and flexibility for supply chain requirements
- Customer Relationship Management (CRM) systems for understanding and engaging with customers
- Supply chain business processes, activities, planning
- Supply Chain Management (SCM) solutions and technologies

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Appraise different types of Enterprise Applications.
2. Justify Enterprise Applications and integration tools for different size organisations.
3. Assess Enterprise Systems within an organisation, focusing on ERP, CRM and SCM.
4. Evaluate supply chain business processes, activities and planning.
5. Assess solutions and technologies for improving supply chain performance.
6. Demonstrate proficiency in the use of an Enterprise Application.

Supplementary Material(s)

"InsideCRM." www.insidecrm.com
"Toolbox for IT - Inside ERP." it.toolbox.com
Laudon, K. and J. Laudon. *Management Information Systems: Managing the Digital Firm*. 14th ed.. New York: Pearson, 2016.

Network Theory Fundamentals	ECTS 5	Banner Code: COMP-0658	CRN: 91458	Level 7	Assessment Methods: Exam

Description of Module / Aims
This module will introduce students to the principles of graph/network models and information theory. The module will focus on the practical application of the fundamental concepts to problems in computing, such as, resource allocation, planning, optimization problems, and software testing.

Indicative Content

- Graph and Network Models: Network algorithms for applied problems; Minimal spanning tree and shortest route problems; project networks; application of network models
- Information Theory: Information measure and entropy; source coding; Shannon theory and Huffman codes; noisy channel coding theorem; error correcting codes
- Finite-State Machines: Network and matrix representation; equilibrium and absorbing states, applications to software testing; cellular automata models

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Use mathematical software to solve network based optimisation problems and interpret solutions generated.
2. Apply appropriate algortihms to solve graph/network theory problems.
3. Apply fundamental concepts and techniques of information theory.
4. Apply finite-state machine techniques to problems in computing, such as software testing.

Supplementary Material(s)

Johnsonbaugh, R. *Discrete Mathematics*. 7th Edition. New Jersey: Pearson, 2009.
Jones, G. and J. Jones. *Information and Coding Theory*. New York: Springer, 2000.
Narsingh, D. *Graph Theory with Applications to Engineering and Computer Science*. New York: Dover Publications, 2016.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Database Fundamentals	**5**	**COMP-0185**	**69523**	**6**	**Exam**

Description of Module / Aims
This module will introduce the student to the principles and practice of relational database systems including the Database Management Systems aspects. The student will gain competence in Entity Relationship modeling and normalisation techniques involved in the analysis and design phases of the software development lifecycle. They will gain experience in the design and implementation of a practical database system.

Indicative Content

- Database Environment.
- Physical Database Design: Translate the logical data model, File organisation and indexes.
- Database Implementation.
- Database Analysis and Design: Conceptual and Logical Database Design, Relational Model, Normalisation.

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Discuss the role of a DB and DBMS, the components of the DBMS, and the differing roles in the DB environment.
2. Draw Entity Relationship (ER) diagram from an application problem and reproduce this diagram into a set of relations, which are ready for database implementation.
3. Convert unnormalised relations into a set of normalised relations through the rules of normalisation which adhere to relational data model principles
4. Design and implement a database application.
5. Gain an understanding of the physical database design process, its objectives and deliverables.

Essential Material(s)

Connolly, T; and Begg, C Database Systems A Practical Approach to Design Implementation and Management. Ed. 5th (2009) Addison Wesley Hoffer, J; Prescott, M; and Topi, H Modern Database Management. Ed. 9th (2008) Pearson Prentice Hall Connolly, T; and Begg, C Database Solutions: A step-by-step guide to building databases. Ed. 2nd. (2005) Addison Wesley Lejk, M; and Deeks, D An Introduction to Systems Analysis Techniques. Ed. 2nd (2002) Addison Wesley

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Programming Fundamentals 2	**5**	**COMP-0378**	**93609**	**8**	**CA**

Description of Module / Aims
The purpose of this module is to further develop the thought processes, problem solving techniques and programming structures essential for developing larger systems responsible for more complex tasks. The module will focus on developing maintainable, robust, persistent applications that are consistent with user interaction (UI) best practice.

Indicative Content

- Use of complex constructs and data structures associated with the chosen language
- Introduction to UI
- Programming for persistence
- Programming techniques for well-behaved, robust applications
- Use of Test Driven Development (TDD) approaches
- Read, understand and consume the Application Programming Interface (API) specific to the chosen language
- Use of innovative visualisation tools, Integrated Development Environments (IDEs) and frameworks

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Apply problem-solving strategies to various computing problems of increasing complexity.
2. Plan, code, test and document applications using advanced programming constructs and data structures.
3. Construct applications consistent with UI best practice.
4. Construct persistent applications.
5. Apply maintainability and robustness when designing applications.

Essential Material(s)

"Code Academy." http://www.codecademy.com/
"Khan Academy." https://www.khanacademy.org/
"W3 Schools on-line Web Tutorials." www.w3schools.com/

Supplementary Material(s)

"BlueJ." http://www.bluej.org
"Project Euler." https://projecteuler.net/
"Python Tutorials." http://www.introtopython.org/
Kolling, M. and D. Barnes. *Objects first with Java-A Practical Introduction using BlueJ*. 5th ed.. NY: Prentice Hall/Pearson Education, 2012.
Sprankle, M. *Problem Solving and Programming Concepts*. NY: Prentice Hall, 2011.
Venit, S. and E. Drake. *Prelude to Programming: Concepts & Design*. NY: Pearson Higher Education, 2015.
Vickers, P. *How to think like a programer: Problem Solving for the Bewildered*. NY: Cengage, 2008.

Introduction to Cloud Computing	ECTS 5	Banner Code: COMP-0625	CRN: 92130	Level 8	Assessment Methods: Exam

Description of Module / Aims
This module introduces students to the capabilities of cloud computing. Basic concepts of cloud computing are covered and students carry out a series of practical exercises with cloud computing technologies and services.

Indicative Content

- Basic concepts of cloud computing
- Cloud technologies
- Cloud usage scenarios
- Using and integrating cloud services
- Other issues: privacy, security, economics and cost-benefit analysis

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Communicate the evolution of cloud computing.
2. Appraise the main cloud computing service models and deployment models that are in widespread use.
3. Illustrate the operation of a selection of leading cloud technologies.

4. Deploy an application that integrates a selection of cloud services using a popular cloud platform (e.g. IBM Bluemix).
5. Explore cloud computing services and technologies from the perspectives of security, privacy and cost.

Essential Material(s)

"IBM Bluemix." http://www.ibm.com/cloud-computing/bluemix/

Supplementary Material(s)

Rafaels, R. *Cloud Computing: From Beginning to End*. 1st. New York: CreateSpace Independent Publishing Platform, 2015.

Computer Networks	**ECTS 5**	**Banner Code: COMP-0637**	**CRN: 91795**	**Level 8**	**Assessment Methods: Exam**

Description of Module / Aims
This module introduces Computer Networking terminology, network protocols and models. Students will use simulation and protocol analysis software to configure network devices and explore various network protocol operations. A detailed examination of TCP/IP, IP addressing and Ethernet is presented. A brief introduction to Routing, Network management and Wireless LANs is also provided. Practical skills are an essential part of this module.

Indicative Content

- Introduction to Computer Networks and Protocols
- OSI and TCP/IP models
- Ethernet and VLANs
- IPv4 Addressing and subnetting
- IPv6
- Routing
- Transport Layer Protocols and Functionality
- Application Layer Protocols and Functionality e.g. HTTP, FTP, DNS, SMTP
- Wireless LANs
- Network Management

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Use network protocol models and tools to explain communications in data networks.
2. Describe in detail the major components, operation and functionality of a computer network and commonly used protocols and services.
3. Construct an IPv4/IPv6 addressing design solution.
4. Build a simple network using routers and switches.
5. Use Cisco command line interface to perform basic router and switch configuration.
6. Implement a basic wireless network.
7. Describe basic computer network management concepts.

Essential Material(s)

"Cisco Network Academy." https://www.netacad.com/

Supplementary Material(s)

Cisco, Networking. *Network Basics, CCNA Routing & Switching Companion Guide*. NY: Cisco Press, 2014.
Tanenbaum, A. and D. Wetherall. *Computer Networks*. 5th Ed. New York: Pearson Education, 2013.

Professional Practice	ECTS 5	Banner Code: COMP-0599	CRN: 93742	Level 7	Assessment Methods: CA

Description of Module / Aims
The aim of this module is to prepare and encourage students to capitalize on the learning potential of their flexible semester experience and enhance their industry awareness. The module will focus on developing students' transferable skills and encouraging professional awareness and practice.

Indicative Content

- Workplace ethics for the computing industry
- Potential for learning during placement and the strategies commonly used
- Identification of transferable skills for integration and progression in the workplace
- Career Preparation: CV preparation and interview skills, career planning, e-portfolio development
- Workplace and placement awareness: Managing equality and diversity, group dynamics and teamwork, understanding organisational culture
- Work-based impression management including the impact of social media as a professional presentation tool for personal and corporate identity

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Evaluate and discuss ethical conduct in the workplace.
2. Develop transferable skills for integration and progression in the workplace.
3. Construct an appropriate personal career development plan and professional profile, to include a skills-needs analysis and CV.
4. Demonstrate professional skills through group and individual presentations.
5. Exercise personal autonomy and take responsibility for their personal and academic well-being.
6. Demonstrate the principles and practice of reflective learning.

Essential Material(s)

"Ethics Resource Centre." http://www.ethics.org/
"Transferrable Skills Project." http://www.skillsproject.ie/
"gradireland." https://gradireland.com/

Supplementary Material(s)

Billett, S. *Learning in the Workplace: Strategies for Effective Practice*. Australia: Allen & Unwin, 2001.
Robbins, S.P. and P.L. Hunsaker. *Training in Interpersonal Skills*. 6th ed. USA: Pearson Education, 2012.

Web App Development 1	ECTS 5	Banner Code: COMP-0597	CRN: 93744	Level 7	Assessment Methods: CA

Description of Module / Aims
Introduce the the student to the software development lifecycle via the implementation of a simple but functional web application. In doing this, analyse & model a constrained set of user requirements. Then design, build and deploy a simple web application. Incorporate basic database, session support & server side rendering.

Indicative Content

- User Stories & Agile context
- Introduction to Modelling
- Hypertext Transfer Protocol (HTTP) Request/Response Life Cycle
- Introductory Web Application Frameworks
- Simple Object Relational Mapping tools
- Test Driven Development

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Identify the key components of a server rendered web application and incorporate them into a running application.
2. Use Model View Controller & related patterns in the implementation of a web project.
3. Relate the request/response lifecycle, routing & session management in the context of a modern application framework.
4. Convert a set of requirements into a set of discrete stories and translate these stories into a simple project plan with associated timeline and testing strategy.
5. Model the user requirements and realize the model in a simple database.

Supplementary Material(s)

Henderson, M. *Instant CakePHP Starter*. New York: Packt Publishing, 2013.
Richard-Foy, J. *Play Framework Essentials*. New York: Packt Publishing, 2014.
Syed, B. *Beginning Node.js*. New York: Apress, 2014.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Database Systems	**5**	**DATB-0174**	**69821**	**7**	**Exam**

Description of Module / Aims
In this module, the student builds on the knowledge gained in Database Fundamentals. The student is exposed to advanced data modelling techniques. They will be provided with the knowledge and know how to administer and manage a commercial database. The student will also gain competence in SQL.

Indicative Content

- Advanced Data Modelling. Data and Database Administration: Concurrency Control, Transaction Management, Backup and Recovery, Functions of the Database Administrator. Introduction to Distributed
- Databases. Database Security. Oracle Architecture. Structured Query Language (SQL).

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Demonstrate the ability to model more complex applications using advanced data modelling concepts.
2. Understand the fundamentals of distributed databases.
3. Identify and assess the various vulnerabilities a database may be subjected to.
4. Construct SQL statements, which would allow for the creation of a relational database tables and manipulation of the data within those tables.
5. Recognise and explain the important issues when administering an enterprise level database and suggest standard techniques to handle those issues.

Essential Material(s)

Connolly, T; and Begg, C, (2009), Database Systems A Practical Approach to Design Implementation and Management, 5/e Edition,
Addison Wesley Hoffer, J; Prescott, M; and Topi, H, (2008), Modern Database Management, 9/e Edition, Pearson Prentice Hall, England

	ECTS	**Banner Code:**	**CRN:**	**Level**	**Assessment Methods:**
Introduction to Computer Security	**5**	**COMP-0607**	**91833**	**7**	**Exam**

Description of Module / Aims
This module will provide an introduction to computer security. The emphasis is on the fundamentals of security, including the nature of security threats and attack methods. It will also include the services that can be put in place to address these

threats. Cryptographic techniques, that underpin many security mechanisms, are also covered. This module will introduce the student to the foundations of modern cryptography, with a focus on practical applications. The importance of security policy and procedures will also be explained.

Indicative Content

- Vulnerabilities, types of attack, security services
- Overview of encryption and authentication
- Randomness & entropy
- Symmetric block & stream ciphers, public key cryptography
- Authentication and hash functions
- Key management & digital certificates
- Security policy & procedures
- Applications

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Describe and categorise potential computer security threats and attacks and the security services that can be implemented to address them.
2. Explain the role played by both technology and security policy in supporting security services.
3. Describe various cryptographic approaches and techniques for the provision of secrecy, authentication, integrity and non-repudiation.
4. Use commercial encryption software for secrecy of data and authentication purposes.
5. Communicate technical information effectively.

Essential Material(s)

"OpenSSL, Cryptography and SSL/TLS Toolkit." https://www.openssl.org/

Supplementary Material(s)

"Computer Emergency Response Team, CERT." http://www.cert.org/
"Security Focus." http://www.securityfocus.com/
"The SANS Institute." http://www.sans.org
Stallings, W. *Network Security Essentials*. 5th ed. England: Pearson, 2014.
Stalllings, W. *Cryptography and Network Security, Principles and Practice*. 6th ed. England: Pearson, 2013.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Further Statistics	**5**	**STAT-0054**	**94035**	**7**	**Exam**

Description of Module / Aims
The module is designed to consolidate understanding of fundamental statistical concepts and extend knowledge and skills to probability, advanced regression techniques and inferential statistics. The student will see how these tools can be applied in an industry setting. Statistical software will be used as a modelling tool.

Indicative Content

- Probability: Basic probability and nature of statistical investigations; Discrete and continuous distributions; Quality control charts
- Inferential statistics: Sampling distributions; Hypothesis testing using p values and confidence intervals on one or more samples
- Advanced regression: Non-linear regression; Multiple regression; Goodness of fit testing

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Apply probability principles and data distributions to evaluate quality control procedures.
2. Distinguish between descriptive and inferential statistical quantities in data analytics.
3. Apply a broad range of analytical statistical techniques and interpret these appropriately.
4. Analyse patterns from intricate data sets.
5. Assemble data sets for subsequent analysis and conclude suitable inferences from them.
6. Use appropriate statistical software tools to analyse and interpret data.

Supplementary Material(s)

"Further Statistics moodle page." https://moodle.wit.ie
Crawley, M.J. *Statistics: An Introduction using R*. 2nd ed. New Jersey: Wiley, 2014.
Rice, J.A. *Mathematical Statistics and Data Analysis*. 3rd ed. New York: Duxbury Press, 2010.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Networks Infrastructure	**5**				**Exam**

Description of Module / Aims
This module will build on the students' basic Computer Networks knowledge. This module will provide a student with an understanding of Routing and Switching and other essential services in the operation and management of a networking infrastructure. The practical element will cover the configuration and management of these services.

Indicative Content

- Static Routing
- Dynamic Routing: Distance Vector Routing; Links State Routing; OSPF
- Switching: VLANs; Spanning Tree Protocol; Inter-VLAN Routing
- Network Design: Scalability; Redundancy; Load Balancing
- Network Management: SNMP; Monitoring; Performance
- Network Security: Securing Devices; Access Control Lists
- Virtual Networking

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Configure Static Routes and Dynamic Routing Protocols.
2. Troubleshoot Static Routes and Dynamic Routing Protocols.
3. Explain how routing and switching technologies work.
4. Discuss the main concepts in Network Design.
5. Discuss the main concepts in Network Management.
6. Discuss the main concepts in Network Security.
7. Determine, configure and troubleshoot Access Control Lists.
8. Apply best practices in the configuration and management of network infrastructure.

Essential Material(s)

"Cisco Network Academy." https://www.netacad.com/. https://www.netacad.com/

Supplementary Material(s)

Cisco, P. *Routing and Switching Essentials Companion Guide*. 1st. New York: Cisco Press, 2014.
Kurose, J.F. and K.W. Ross. *Computer Networking: A Top-down Approach*. 6th. New York: Pearson, 2012.
Tanenbaum, A.S. and D.J. Wetherall. *Computer Networks*. 5th ed.. New York: Pearson, 2010.

	ECTS	**Banner Code:**	**CRN:**	**Level**	**Assessment Methods:**
NoSQL Databases	**5**	**COMP-0661**	**94004**	**8**	**Exam**

Description of Module / Aims
This module will introduce the student to the principles and practice of designing database solutions for large volumes of either structured or unstructured data. The student will gain competence in determining the suitability of a schemaless database or a data warehouse. The student will be introduced to the concepts of data persistence, consistency and distribution in the NoSQL database context. They will gain experience in the design and implementation of a NoSQL database system for unstructured data. The module will also introduce them to the use of data warehouses for storage of large volumes of structured data.

Indicative Content

- Introduction to storing large volumes of structured or unstructured data
- Emergence of NoSQL databases
- Aggregate data models
- Key-value databases, document databases, column family databases and graph databases
- Data persistence, database consistency (CAP theorem, version stamps) and distribution of data storage
- Fundamentals involved in the storage of large volumes of structured data in a data warehouse

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Analyse a business scenario to determine a suitable big data database solution.
2. Create at least one type of NoSQL database.
3. Assess the growth and use of NoSQL in business.
4. Appraise the distribution of data on clusters.
5. Examine the issue of consistency in relation to NoSQL databases.
6. Summarise the characteristics, design and implementation of data warehouses for structured data.

Supplementary Material(s)

"TDWI research in the business intelligence and data warehousing industry." http://tdwi.org
"comprehensive resource on NoSQL database solutions." http://nosql-database.org
Connolly, T. and E. Begg Connolly. *Database Systems: A practical approach to design, implementation and management*. NY: Addison-Wesley, 2015.
Sadalage, J. and M. Fowler. *NoSQL Distilled A brief guide to the emerging world of polygot persistence*. New Jersey: Pearson, 2013.

Automated Cloud Services	**ECTS 5**	**Banner Code: COMP-0967**	**CRN: 93993**	**Level 7**	**Assessment Methods: CA**

Description of Module / Aims
This is a practical module that requires the student to build, configure and manage the operating system and network infrastructure required for a typical cloud application environment.

Indicative Content

- Cloud Computing Architectures and Services
- Public Cloud Services: Storage; Compute; Networking
- Introduction to Python Programming
- Cloud APIs – Python or similar
- Configuration of Multi-tier Application Infrastructure Services
- Virtual Private Clouds
- Web Application Architecture – Performance, Scaling, Load Balancing and Security
- Devops, Automation and scripting – using for example bash (advanced), Python, PowerShell, Chef, Ansible
- Network and Application Management and Monitoring

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Develop, configure and manage essential network infrastructure and application services.
2. Deploy a network monitoring solution.
3. Develop scripts to assist in the management and automation of modern network services.
4. Appraise and apply principles of application performance, scalability, load balancing and security.
5. Compare and contrast the main technologies required to develop and manage Cloud based Application Infrastructure.

Supplementary Material(s)

"The Python Wiki." https://wiki.python.org/
"boto: Python interface to Amazon Web Services." http://boto.readthedocs.org/en/latest/
Amazon, A. *Getting started with AWS (eBook)*. New York: Amazon, 2014.
Morris, K. *Infrastructure as Code: Managing Servers in the Cloud*. 1st. New York: O'Reilly Media, 2016.

Digital Transformation of Information Systems	ECTS 5	Banner Code: COMP-0968	CRN: 94046	Level 7	Assessment Methods: Exam

Description of Module / Aims
This module will address the transformation of legacy approaches of enterprise applications to new ways of using digital, social and emerging technologies. The emergence of all these new technologies adds new capabilities to businesses and options for the next generation of enterprise applications. Cloud services for enterprise applications are examined in detail where students will integrate their technical knowledge and theory with practice of a cloud service to support a business system. The module will also include current relevant issues on privacy ethics and security.

Indicative Content

- Changes in economics and technology: Digital transformation strategies, disruptive technologies, new business models
- Digital Enterprise Wave: Internet of things (IOT), cloud technologies, artificial intelligence (AI), analytics and mobile for real-time data
- Evolving enterprise applications to support a dynamic digital business - advanced inventory control, sensor and location data from mobile devices for marketing intelligence, cloud based manufacturing and planning
- Cloud-based services for enterprise applications: SaaS, PaaS, IaaS
- Emerging social tools for enterprise application strategies
- Management issues including technology investment, digital innovations, relevant ethics, privacy and security issues

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Examine the role played by digital transformation in different industries.
2. Compare digital technologies in continuous changing business environments.
3. Examine and demonstrate enterprise applications in cloud computing.
4. Interpret ways in which enterprises are enhancing their communication and collaboration with emerging social tools.
5. Examine the appropriate procedures for relevant ethics, privacy and security issues with digital wave technologies.

Supplementary Material(s)

Bounfour, A. *Digital Futures, Digital Transformation*. Switzerland: Springer International Publishing, 2016.
Laudon, K. and J. Laudon. *Management Information Systems: Managing the Digital Firm*. 14th ed.. New York: Pearson, 2016.

Mobile App Development 1	ECTS 5	Banner Code: COMP-0630	CRN: 94043	Level 8	Assessment Methods: CA

Description of Module / Aims
Design, build and deploy a multi-screen mobile application incorporating an intuitive and efficient navigation mechanism. Structure the implementation using accepted best-practice with respect to patterns, frameworks and tools. Incorporate localised persistence models + simple access to remote services. Introduce context services such as location/camera and/or other sensor access.

Indicative Content

- Application Structure: Components; Resources; Security; General Assets
- User Experience: UX Principles, Navigation, Imagery, Fonts
- Simple User Interaction Patterns
- Essential Application Structure Patterns: Appropriate Variations on Model/View/Controller (MVVM, MVP etc…)
- Resource access and management; Clean separation of concerns
- Application Life-cycle: Startup/shutdown; Foreground/background
- UI State Preservation and Restoration; Concurrency

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Decompose an application into its constituent parts, including but not limited to: core application components, user experience resources, packaging.
2. Design a coherent User Experience - using appropriate tools, practices and guidelines - for a moderately sized application.
3. Produce medium sized application, based on a limited set of design patterns.
4. Manage the application lifecycle.
5. Structure persistent storage on a device and reliably save and restore application state.

Essential Material(s)

"Android Developer Resouces." http://developer.android.com
"Apple Developer Resources." http://developer.apple.com/ios
"Cordova Developer Resources." https://cordova.apache.org

Supplementary Material(s)

Camden, R. *Apache Cordova in Action*. New York: Manning, 2015.
Neuburg, M. *iOS 9 Programming Fundamentals with Swift: Swift, Xcode, and Cocoa Basics*. New York: O'Rielly, 2015.
Phillips, B. *Android Programming: The Big Nerd Ranch Guide*. New York: Pearson, 2015.

Application Security	ECTS 5	Banner Code: COMP-0612	CRN: 92013	Level 8	Assessment Methods: Exam

Description of Module / Aims
This module equips the student with knowledge of security vulnerabilities of application software taking into account both web and native applications. Methods used to solve these vulnerabilities are investigated. Intrusion Detection/Prevention Systems and Malicious Software are also presented. Students will be given a grounding in the area of Secure Software Development. This module also explores issues pertinent to Incident Response and Recovery.

Indicative Content

- Web application security
- Native application security (mobile apps, desktops apps etc.)

- Intrusion detection/prevention systems
- Malicious software
- Secure software engineering
- Incident response and recovery

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Assess a variety of security issues, vulnerabilities and fixes that arise in applications and categorise them by using information from CERT, OWASP and other trusted services.
2. Compare the capabilities and limitations of intrusion detection systems and intrusion prevention systems.
3. Appraise different threats posed by various categories of malware and explain different techniques to defend against them.
4. Justify the need for appropriate incident response and recovery measures.
5. Assess how security can be integrated into the software development process.
6. Formulate a variety of security attacks in a simulated environment.

Essential Material(s)

"Open Web Application Security Project (OWASP)." https://www.owasp.org

Supplementary Material(s)

"Computer Emergency Response Team, CERT." http://www.cert.org
"Security Focus." http://www.securityfocus.com/
"The SANS Institute." http://www.sans.org
Stallings, W. *Cryptography and Network Security, Principles and Practice*. 6th ed. England: Pearson, 2014.
Stallings, W. *Network Security Essentials*. England: Pearson, 2014.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Enterprise Data Exchange and XML	**5**			**7**	**Exam**

Description of Module / Aims

XML is one of the most popular industry formats for business document publishing, web application development and digital content management. It is also a critical part of the web environment and web standard stacks and is the basis for emerging next-generation document, web, and e-business application strategies. This course focuses upon providing the student with an understanding of the XML standard syntax and related standards and how these can be used to build enterprise applications. Important standards associated with XML, including machine-readable business information standards which support, for example, automatic data interchange (for electronic business data sharing in EDI) are also introduced. XML documents support business intelligence and other architectures and infrastructures, as well as a variety of content management systems and processes and the student is introduced to these applications. XML also provides important web data management capabilities to firms which are covered here. Finally, as a data interchange standard on the web XML provides a basis for governance and regulation in the e-business context.

Indicative Content

- XML origins and the W3C including objectives and advantages of XML
- The XML language: XML Syntax elements and components, DTs, markups and stylesheets
- Authoring an XML application: well-formed and valid XML script, XML authoring tools and interfaces, XSL, XSLT, XPath, templates
- XML Schemas: Advantages of using schemas, schema authoring (e.g RELAX NG, SCHEMATRON validator), DTD vs XML schemas, structure of a schema, namespaces, common attributes for schema elements, data types, XML types, schema element declarations, overview of a schema
- Data Exchange Standardization using DTDs, web registries, CSS and related technologies
- XML Applications and Uses: XML and Enterprise Applications Integration and automated information interchange (e.g. EDI) standards
- XML-based system engineering methodologies and design standards

- Content & Communications Management (ATOM etc.)
- Regulation and Governance: e.g XBRL and other data reporting standards
- Limitations of XML: security issues, problems associated with obtaining intelligence (semantic limitations) and supporting decision making and other related issues
- Related Standards for interoperability and automated enterprise information exchange: e.g JavaScript Object Notation, RDF and others
- Case Studies of Enterprise Data Exchange applications and systems

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Evaluate the importance of XML as a solution for enterprise data interchange across web-platforms.
2. Construct basic XML applications.
3. Appraise key ideas of XML applications engineering.
4. Appraise current examples of deployed XML systems and how they can enhance enterprise and related information interchange applications.
5. Appraise the application of XML in the modern information technology systems support environment and its relationship with other standard frameworks.

Supplementary Material(s)

Fawcett, J., D. Ayers and L.R.E. Quin. *Beginning XML*. New York: Wiley, 2012.
Right, C. *XML Programming*. UK: CreateSpace, 2015.
Walmsley, P. *Definitive XML Schema*. NJ: Pearson, 2013.

Module Listing for Bachelor of Science in MULTIMEDIA APPLICATIONS DEVELOPMENT

Programme Code: – WD_KMULA_D

Year 1			
Semester 1 (Autumn) **Code**	**Component**	**Semester 2 (Spring)** **Code**	**Component**
Year 2			
Semester 3 (Autumn) **Code**	**Component**	**Semester 4 (Spring)**	**Component Code**
Audio production	COMP-0592	Professional Practice	COMP-0599
Database Fundamentals	COMP-0185	Database Systems	COMP-0190
2D Animation	COMP-0591	Web App Development 1	COMP-0597
Graphic Design 2	COMP-0593	3D Modelling Fundamentals	COMP-0595
Mathematics for Graphics & Statistics	MTHS-0029	Video Production	COMP-0596
Website Development 2	COMP-0594	Web Design & Production	COMP-0598
Year 3			
Semester 5 (Autumn) **Code**	**Component**	**Semester 6 (Spring)**	**Component Code**
		NoSQL Databases	COMP-0661
		3D Animation Practice	COMP-0965
		Digital Graphic Design	DESG-0056
		Multimedia Networks	COMP-0966
		Web Application Development 2	COMP-0611
		Software Engineering	COMP-0103

Audio Production	ECTS 5	Banner Code: COMP-0592	CRN: 91953	Level 7	Assessment Methods: CA

Description of Module / Aims
This module teaches the fundamentals of sound, sound recording and multi-track sound editing using timeline based tools. A large emphasis is placed on practical work - recording, editing, and mixing. Audio productions are created for use in media applications & trans-coded for delivery on multiple platforms.

Indicative Content

- Sound Theory (25%): Characteristics of sound (amplitude, frequency, timbre); Harmonic series; Basic music theory; Music appreciation
- Voiceover Scripting (15%)
- Digital Audio (50%): Introduction to analogue and digital recording; DAWS; Audio editing; Multi-tracking (including use of MIDI sequences); Loop based composition; Synchronising with visuals; DSP effects; Time stretch and pitch shifting; Beat syncing; Beat grids; Warping; Audio file types & compression (uncompressed v compressed, Lossy v Lossless)
- Publishing Audio (5%)
- Copyright (5%)
- Sample Projects: Commercial advertisement, Infomercial, Podcast, Beat matched music promo, Music mashup
- Essential Materials: Students are required to have studio reference monitor headphones (e.g. Samson SR-850) and professional media web hosting

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Prepare a script, and record, edit, mix, and publish it as a sound production for multi-platform delivery.
2. Create, produce and publish sequences of multi-layered music and sound.
3. Demonstrate a theoretical understanding of the fundamentals of sound and professional sound editing, recording & publishing.

Supplementary Material(s)

"Ableton Live Youtube Channel." https://www.youtube.com/user/AbletonInc
"Adobe TV - Adobe Audition." http://tv.adobe.com/product/audition/
"GarageBand Help." http://help.apple.com/garageband/mac/10.1/
"MusicTheory.net." http://www.musictheory.net/
"lynda.com." www.lynda.com
Ableton, Inc. *Ableton Live 9 User Manual*. DE: Ableton, 2015.
Kirn, P. *Real World Digital Audio*. CA: Thomson, 2006.

Database Fundamentals	ECTS 5	Banner Code: COMP-0185	CRN: 69523	Level 6	Assessment Methods: CA

Description of Module / Aims
This module will introduce the student to the principles and practice of relational database systems including the Database Management Systems aspects. The student will gain competence in Entity Relationship modeling and normalisation techniques involved in the analysis and design phases of the software development lifecycle. They will gain experience in the design and implementation of a practical database system.

Indicative Content

- Database Environment.
- Physical Database Design: Translate the logical data model, File organisation and indexes.
- Database Implementation.
- Database Analysis and Design: Conceptual and Logical Database Design, Relational Model, Normalisation.

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Discuss the role of a DB and DBMS, the components of the DBMS, and the differing roles in the DB environment.
2. Draw Entity Relationship (ER) diagram from an application problem and reproduce this diagram into a set of relations, which are ready for database implementation.
3. Convert unnormalised relations into a set of normalised relations through the rules of normalisation which adhere to relational data model principles
4. Design and implement a database application.
5. Gain an understanding of the physical database design process, its objectives and deliverables.

Essential Material(s)

Connolly, T; and Begg, C Database Systems A Practical Approach to Design Implementation and Management. Ed. 5th (2009) Addison Wesley Hoffer, J; Prescott, M; and Topi, H Modern Database Management. Ed. 9th (2008) Pearson Prentice Hall Connolly, T; and Begg, C Database Solutions: A step-by-step guide to building databases. Ed. 2nd. (2005) Addison Wesley Lejk, M; and Deeks, D An Introduction to Systems Analysis Techniques. Ed. 2nd (2002) Addison Wesley

2D Animation	**ECTS 5**	**Banner Code: COMP-0591**	**CRN: 91949**	**Level 7**	**Assessment Methods: CA**

Description of Module / Aims
The student's drawing skills will be developed, with an awareness of traditional animation techniques, to create 2D objects and characters in a digital environment. The Principles of Animation are introduced. The student will produce the main movements of objects and characters, and the background scenes for these animations.

Indicative Content

- Principles of Animation
- Drawing in a 2D environment
- Symbols and instances
- Tweening: shape, motion, classic, motion guides, onion skinning
- Animation effects: filters, transparencies
- Masking
- Audio in animation

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Construct a background scene in a 2D environment.
2. Construct animated facial expressions of a character to display different emotions.
3. Apply the relevant Principles of Animation in the creation of a bouncing ball.
4. Complete a generic walk cycle.
5. Complete a short animation.

Supplementary Material(s)

"Adobe Animate CC." 30/11/2015. http://blogs.adobe.com/animate/welcome-adobe-animate-cc-a-new-era-for-flash-professional/
"Adobe Animate Learn and Support." https://helpx.adobe.com/animate/how-to/create-2d-animation.html
Chun, A. *Adobe Flash Professional CC Classroom in a Book*. NY: Adobe Press, 2015.
Selby, A. *Animation*. London: Laurence King, 2012.
Williams, R. *The Animator's Survival Kit*. London: Faber and Faber, 2012.

Graphic Design 2	ECTS 5	Banner Code: COMP-0593	CRN: 91957	Level 7	Assessment Methods: Exam

Description of Module / Aims
This module aims to introduce the student to the theories and design elements involved in the creation of content. The student develops an understanding of the colour and its' meaning, art movements, art mediums and concept generation for advertisements. The student will have a number of practical labs to gain understanding and experience in an art medium.

Indicative Content

- Concept design: idea generation through the use of creative filters e.g. Expected Unexpected Bizarre (E.U.B);Visual Dynamic; Advertising and other media outlets
- Colour: colour theory; colour wheel; colour models; light; meaning of colour; colour psychology; mood boards
- Art movements: Impressionism; cubism; modernism etc.
- Art mediums: watercolour; oil; acrylic
- Composition: Visual harmony and disharmony

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Complete a concept design for advertising.
2. Discuss art movements and use an art medium.
3. Apply the techniques used in an art medium.
4. Recognise and apply the fundamental concepts of colour.

Supplementary Material(s)

Gombrich, E.H. *The Story of Art*. 16th ed. NY: Phaidon Press, 2007.
Hockney, D. *Secret Knowledge (New and Expanded Edition): Rediscovering the Lost Techniques of the Old Masters*. Expanded ed. NY: Avery, 2006.

Mathematics for Graphics and Statistics	ECTS 5	Banner Code: MTHS-0029	CRN: 91961	Level 7	Assessment Methods: Exam

Description of Module / Aims
The module applies matrix algebra to 2D and 3D transformations - including translations, scaling, shearing, rotation and perspective. It also introduces the student to descriptive statistics with an emphasis on visually presenting data in an appropriate and informative way using traditional statistical constructs. The practical element of this module applies matrix and vector algebra to computer graphics and also, obtains visual representations of data using software.

Pre-Requisite(s): None
Co-Requisite(s): None

Indicative Content

- Matrix algebra: Multiplication; Transformations - translations, scaling, shearing, rotation and perspective
- Reference frames: Cartesian and homogeneous coordinates; Right handed and left handed 3D reference frames
- 2D and 3D geometric entities: Polygons and polyhedrons
- Vector algebra: Dot product; Cross product; Hidden face problem; Illumination problem
- Introduction to statistics: Types of variables (scale, nominal, ordinal); Descriptive and inferential statistics; Population and sample; Probability and non-probability sampling
- Descriptive statistics: Statistics measuring centre (mean, median, mode) and spread (standard deviation, quantiles); Charts for categorical and scale data – basic (histograms, pie charts etc.) and advanced (clustered/stacked charts etc.)

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Describe a 2D polygon or a 3D polyhedron in terms of its faces and vertices.
2. Determine and apply the transformation matrices which perform translation, shearing, scaling, rotation and perspective in 2D or 3D space.
3. Perform vector algebra calculations and apply Painter's algorithm to the hidden face and illumination problems in 3D rendering.
4. Define the terminology and discuss the concepts of introductory statistics.
5. Implement an animation of a simple 3D object in a suitable software environment.
6. Select and construct statistical charts that convey pertinent information in a dataset.

Supplementary Material(s)

"Statsoft Electronic Statistics Textbook. ." http://www.statsoft.com/Textbook
Tufte, E.R. *The visual display of quantitative information*. 2. Connecticut: Graphics Press, 2001.
Vince, J. *Mathematics for Computer Graphics*. London: Springer, 2014.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Website Development 2	**5**	**COMP-0594**	**93599**	**7**	**CA**

Description of Module / Aims
In this module, the student will develop the core technical skills necessary for a complete understanding of client side web development. This module will examine the concepts involved in front-end user interface design and client side scripting. The module will focus on the development of dynamic interactive client side web applications. The use of client side frameworks, client side libraries and plugins will also be examined.

Indicative Content

- Basic Scripting: Variables; Functions; Conditions; Loops and Repetition; Arrays
- The Document Object Model: Nodes; Manipulation; Scripting; Event Handling
- Storing and transporting data with JavaScript Object Notation (JSON)
- Use of libraries and plugins
- Forms Enhancements and Validation
- Role of Client Web Frameworks & Cascading Style Sheets (CSS) meta languages
- Client side routing
- Dynamic Web: Combining Content; Presentation; and Behaviour

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Plan and construct dynamic websites incorporating client side scripts.
2. Construct dynamic interactive websites that support user interaction, feedback, and validation.
3. Use client side libraries and plugins in the design of dynamic websites.
4. Apply a client web framework in the design of interactive websites.
5. Employ the client side components in a web application.

Supplementary Material(s)

"Tutorialspoint." http://www.tutorialspoint.com
"w3schools." http://www.w3schools.com
McFarland, D. *JavaScript & jQuery:The Missing Manual*. 3rd.. California: O'Reilly Media, 2014.
Pehlivanian, A. and D. Nguyen. *Jump Start JavaScript*. Melbourne: Sitepoint, 2013.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Professional Practice	**5**	**COMP-0599**	**91973**	**7**	**CA**

Description of Module / Aims

The aim of this module is to prepare and encourage students to capitalize on the learning potential of their flexible semester experience and enhance their industry awareness. The module will focus on developing students? transferable skills and encouraging professional awareness and practice.

Indicative Content

- Workplace ethics for the computing industry
- Potential for learning during placement and the strategies commonly used
- Identification of transferable skills for integration and progression in the workplace
- Career Preparation: CV preparation and interview skills, career planning, e-portfolio development
- Workplace and placement awareness: Managing equality and diversity, group dynamics and teamwork, understanding organisational culture
- Work-based impression management including the impact of social media as a professional presentation tool for personal and corporate identity

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Examine ethical conduct in the workplace.
2. Develop transferable skills for integration and progression in the workplace.
3. Construct an appropriate personal career development plan and professional profile, to include a skills-needs analysis and CV.
4. Demonstrate professional skills through group and individual presentations.
5. Employ personal autonomy and take responsibility for their personal and academic well-being.
6. Demonstrate the principles and practice of reflective learning.

Essential Material(s)

"Ethics Resource Centre." http://www.ethics.org/
"Transferrable Skills Project." http://www.skillsproject.ie/
"gradireland." https://gradireland.com/

Supplementary Material(s)

Billett, S. *Learning in the Workplace: Strategies for Effective Practice*. Australia: Allen & Unwin, 2001.
Robbins, S.P. and P.L. Hunsaker. *Training in Interpersonal Skills*. 6th ed. USA: Pearson Education, 2012.

Database Systems	**ECTS 5**	**Banner Code: COMP-0190**	**CRN: 69547**	**Level 7**	**Assessment Methods: Exam**

Description of Module / Aims
In this module, the student builds on the knowledge gained in Database Fundamentals. The student is exposed to advanced data modelling techniques. They will be provided with the knowledge and know how to administer and manage a commercial database. The student will also gain competence in SQL.

Indicative Content

- Advanced Data Modelling. Data and Database Administration: Concurrency Control, Transaction Management, Backup and Recovery, Functions of the Database Administrator. Introduction to Distributed
- Databases. Database Security. Oracle Architecture. Structured Query Language (SQL).

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Demonstrate the ability to model more complex applications using advanced data modelling concepts.
2. Understand the fundamentals of distributed databases.
3. Identify and assess the various vulnerabilities a database may be subjected to.

4. Construct SQL statements, which would allow for the creation of a relational database tables and manipulation of the data within those tables.
5. Recognise and explain the important issues when administering an enterprise level database and suggest standard techniques to handle those issues.

Essential Material(s)

Connolly, T; and Begg, C, (2009), Database Systems A Practical Approach to Design Implementation and Management, 5/e Edition, Addison Wesley Hoffer, J; Prescott, M; and Topi, H, (2008), Modern Database Management, 9/e Edition, Pearson Prentice Hall, England

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Web App Development 1	**5**	**COMP-0597**	**91981**	**7**	**CA**

Description of Module / Aims
Introduce the the student to the software development lifecycle via the implementation of a simple but functional web application. In doing this, analyse & model a constrained set of user requirements. Then design, build and deploy a simple web application. Incorporate basic database, session support & server side rendering.

Indicative Content

- User Stories & Agile context
- Introduction to Modelling
- Hypertext Transfer Protocol (HTTP) Request/Response Life Cycle
- Introductory Web Application Frameworks
- Simple Object Relational Mapping tools
- Test Driven Development

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Identify the key components of a server rendered web application and incorporate them into a running application.
2. Use Model View Controller & related patterns in the implementation of a web project.
3. Relate the request/response lifecycle, routing & session management in the context of a modern application framework.
4. Convert a set of requirements into a set of discrete stories and translate these stories into a simple project plan with associated timeline and testing strategy.
5. Model the user requirements and realize the model in a simple database.

Supplementary Material(s)

Henderson, M. *Instant CakePHP Starter*. New York: Packt Publishing, 2013.
Richard-Foy, J. *Play Framework Essentials*. New York: Packt Publishing, 2014.
Syed, B. *Beginning Node.js*. New York: Apress, 2014.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
3D Modelling Fundamentals	**5**	**COMP-0595**	**91969**	**7**	**CA**

Description of Module / Aims
This module serves as an introduction to 3D modelling and comprises an emphasis on the modelling pipeline, from concept to model creation. Students will acquire a knowledge of the craft of 3D modelling and will gain experience in producing a number of 3D models using a number of essential tools within an industry-led 3D-creation toolset.

Indicative Content

- Introduction to the 3D production pipeline, from concept to mesh creation

- Components of an industry-standard 3D modelling platform
- Polygon, subdivision, and NURB modelling
- Basic camera and viewing techniques
- Introductory shading and rendering

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Describe the fundamentals of the 3D modelling workflow, from concept to a shaded mesh.
2. Identify and effectively navigate the main components and features of an industry standard 3D modelling production platform.
3. Compare various modelling approaches, i.e. polygon, sub-division and NURB-based modelling.
4. Demonstrate the use of appropriate tools for the creation and manipulation of 3D objects and object components.

Supplementary Material(s)

Palamar, T. *Mastering Autodesk Maya 2016*. New York: Sybex, 2015.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Video Production	**5**	**COMP-0596**	**91977**	**7**	**CA**

Description of Module / Aims
This module provides the student with the opportunity to apply his/her knowledge of the production pipeline. The student will learn the skills required to shoot and capture footage. Industry standard video editing software is extensively explored in the assembly, editing and application of effects to video footage and audio. The student gains an introduction to post production software, to edit and enhance a completed video asset.

Indicative Content

- Shoot and capture video assets
- Video editing: Transitions; Effects; Edits ;Motions; Titles; Animations
- Audio: acquire; Edit; Mix; Effects
- Post Production: Colour; Presets; Animation of objects and text
- Toolset for the distortion of objects in post production
- Build and manipulate 3d objects using advanced editing techniques in post production

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Demonstrate an understanding of video principles.
2. Apply sympathetic audio tracks to video.
3. Demonstrate extensive use of industry standard video editing software.
4. Apply animation of objects and text utilizing effects, and pre-sets using post production software.
5. Construct basic post production cinematic effects for the purpose of branding.
6. Complete a short trailer, advert or instructional video for delivery on web, mobile or social media.

Supplementary Material(s)

Fridsma, L. and B. Gyncild. *Adobe After Effects CC Classroom in a Book*. 1st ed. NY: Adobe Press, 2016.
Maxim, J. *Adobe Premiere Pro CC Classroom in a Book*. 1st ed. NY: Adobe Press, 2015.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Web Design and Development	**5**	**COMP-0598**	**91454**	**7**	**CA**

Description of Module / Aims

This module focuses on the Web Design and Development Process, from User Experience (UX), Planning, Responsive Design, to Development and Maintenance. The module will use industry standard website planning, design and web authoring tools. It will include web publishing and cross platform application development.

Indicative Content

- Planning & User Experience
- Design & User Experience
- Development: Content Management Systems, What You See Is What You Get (WYSIWYG) Authoring
- Web Publishing
- Responsive Development / Frameworks (Cross Platform App Development)
- Website Maintenance: Search Engine Optimisation , Testing & Approval, Launch & Transition

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Demonstrate an ability to document and complete the planning stage of a Web Development project.
2. Apply Web UX guidelines to the design of an interactive website.
3. Demonstrate an ability to construct a responsive website using a Content Management System.
4. Demonstrate an ability to develop an interactive website using industry standard web authoring tools.
5. Publish and test an interactive website.

Supplementary Material(s)

"Adobe Dreamweaver CC Tutorials." https://helpx.adobe.com/dreamweaver/tutorials.html
"Learn WordPress." https://learn.wordpress.com
"Stages of Web Design." https://helpx.adobe.com/dreamweaver/how-to/stages-web-design.html
Fielding, J. *Beginning Responsive Web Design with HTML5 and CSS3*. 1st ed.. New York: Apress, 2014.
Maivald, J. *Adobe Dreamweaver CC Classroom in a Book (2015 release)*. 1st ed.. United States of America: Peachpit, 2015.

NoSQL Databases	ECTS 5	Banner Code: COMP-0661	CRN: 94004	Level 7	Assessment Methods: Exam

Description of Module / Aims

This module will introduce the student to the principles and practice of designing database solutions for large volumes of either structured or unstructured data. The student will gain competence in determining the suitability of a schemaless database or a data warehouse. The student will be introduced to the concepts of data persistence, consistency and distribution in the NoSQL database context. They will gain experience in the design and implementation of a NoSQL database system for unstructured data. The module will also introduce them to the use of data warehouses for storage of large volumes of structured data.

Indicative Content

- Introduction to storing large volumes of structured or unstructured data
- Emergence of NoSQL databases
- Aggregate data models
- Key-value databases, document databases, column family databases and graph databases
- Data persistence, database consistency (CAP theorem, version stamps) and distribution of data storage
- Fundamentals involved in the storage of large volumes of structured data in a data warehouse

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Analyse a business scenario to determine a suitable big data database solution.
2. Create at least one type of NoSQL database.

3. Assess the growth and use of NoSQL in business.
4. Appraise the distribution of data on clusters.
5. Examine the issue of consistency in relation to NoSQL databases.
6. Summarise the characteristics, design and implementation of data warehouses for structured data.

Supplementary Material(s)

"TDWI research in the business intelligence and data warehousing industry." http://tdwi.org
"comprehensive resource on NoSQL database solutions." http://nosql-database.org
Connolly, T. and E. Begg Connolly. *Database Systems: A practical approach to design, implementation and management*. NY: Addison-Wesley, 2015.
Sadalage, J. and M. Fowler. *NoSQL Distilled A brief guide to the emerging world of polygot persistence*. New Jersey: Pearson, 2013.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
3D Animation Practice	**5**	**COMP-0965**	**94023**	**8**	**CA**

Description of Module / Aims
The purpose of this module is to give a student the practical knowledge to prepare 3D Model and audio digital assets for use in rendered 3D animated scenes and to be able to appreciate the theory and practice of 3D animation techniques.

Indicative Content

- Rigging and Skinning 3D assets
- Real-time polygon mesh textured rendering
- Inverse Kinematics and motion analysis
- Principles of Animation
- Audio: adding soundtracks to scenes

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Design, manage and produce short key-framed 3D Animations.
2. Apply the key principles of animation to 3D assets and scene.
3. Prepare a computer generated character for animation.
4. Integrate audio assets within a 3D animated scene.
5. Demonstrate the rendering process needed to create a sequence of images.

Essential Material(s)

Naas, P. *Autodesk Maya 2014 Essentials*. UK: Wiley, 2014.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Digital Graphic Design	**5**	**DESG-0056**	**71747**	**7**	**Exam**

Description of Module / Aims
The aim of the subject is to bring the artistic power and vision of each student to a higher level, by further developing the visual creativity of the student. High quality visuals are produced for both screen and print taking into account the limitations of printing methods for various print media.

Indicative Content

- 1. Layout and Composition (20%) - Gestalt Theory, Rule Of Thirds, Structuring other media (posters, flyers stationary, etc.), Single & Multi-page layout software.
- 2. Illustration (20%) - Bzier curves, Tracing & Autotracing, Smartguides, Isometric drawing, Crosshatching, Map Making, Digital Brushes, Exploded drawing, Meshes

- 3. Advanced Composite Development (20%) - Photoshop Filters & Blending Modes, Image Adjustments, Working with Paths, Textures, Patterns and Techniques, Tiling and Effects
- 4. Design For Print (20%) - software, proofing, print process, finishing, Paper Standards (A0 - A5 etc.), Bindings, Costing, Colour management (Pantone)
- 5. Typography (10%) - Fontography, Font Management
- 6. Logography (10%) - Idea development, Semiotics

Learning Outcomes

On successful completion of this module, a student will be able to:

1. L01: Specify, design and cost a print job for a business or event (including business cards, stationary, flyers, posters, T-shirts, vinyl adhesives, etc.)
2. L02: Demonstrate a thorough understanding of the theoretical and practical principles of graphic design.
3. L03: Display a comprehensive knowledge of a range of techniques, to enable them to develop a multimedia portfolio.
4. L04: Compose digital artwork, using a range of techniques and software, for both digital and print media.

Essential Material(s)

Computer Arts Magazine. UK: Future Publishing, .
Computer Arts Project Magazine. UK: Future Publishing, .
Create Magazine. UK: Future Publishing, .
Caplan, S. *The Complete Guide to Digital Illustration*. : Ilex Press Ltd, 2004.
Gordon, B. & Gordan, M. *The Complete Guide to Digital Graphic Design*. : Thames & Hudson, 2004.
Silver, S. *Logo Design That Works*. UK: Rockport Publishers Inc., 2001.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Multimedia Networks	**5**	**COMP-0966**	**94027**	**8**	**Exam**

Description of Module / Aims

This module introduces Computer Networking terminology and concepts, and examines various network protocols and models. Students will use protocol analysis software to explore various network protocol operations. TCP/IP and IP addressing are presented as well as an exploration of real-time Multimedia applications and protocols. Quality of Service (QoS) is also discussed and a brief examination of resource management is also provided. Practical skills are an essential part of this module.

Indicative Content

- Introduction to Computer Networks and Protocols
- OSI and TCP/IP models
- IPv4 Addressing and subnetting
- IPv6
- Transport Layer Protocols and Functionality
- Application Layer Protocols and Functionality
- Multimedia Protocols
- Quality of Service (QoS)
- Resource Management

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Use network protocol models and tools to explain communications in data networks.
2. Examine in detail the major components, operation and functionality of a computer network and commonly used protocols and services.
3. Examine the technologies used for streaming multimedia over the Internet.
4. Design, calculate and apply subnet masks and addresses.

5. Build a simple network using routers and switches.
6. Examine issues related to the configuration and management of resources required in multimedia environments.

Supplementary Material(s)

Cisco, Networking. *Network Basics, CCNA Routing & Switching Companion Guide*. New York: Cisco Press, 2014.
Kurose, J. and K Ross. *Computer Networking: A Top Down Approach*. 6th Ed.. New York: Pearson Education, 2012.
Tanenbaum, A. and D. Wetherall. *Computer Networks*. 5th Ed.. New York: Pearson Education, 2013.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Web App Development 2	**5**	**COMP-0611**	**94020**	**8**	**CA**

Description of Module / Aims
This module approaches web application development from an apps and services perspective, as opposed to the monolithic, server-side rendering model. Services will be formulated as REST APIs (Representational State Transfer Application Program Interface), while multiple service consumer forms will be considered, including Single Page Apps (SPA) and other services. The principles and patterns underpinning the design of both components (SPA and REST API) will be examined as well as the fine-grained aspects of the underlying communication protocol. There will be an emphasis on development, including the use of application frameworks, workflow automation tools and cloud deployment platforms. The module's scope will also encompass the technical aspects of both real-time API communication and isomorphic web apps.

Indicative Content

- Fundamentals: Architecture patterns; HTTP (Hypertext Transfer Protocol) protocol; advanced Javascript
- API Design patterns and principles: REST; CQRS (Command Query Responsibility Separation); versioning; security; hypermedia; realtime
- SPA design patterns and principles: MV* (Model View *); Flux; caching; data synchronisation
- Application Frameworks: Web API; Single Page App; Isomorphic app
- Developer tool suite: API modelling; DSL(Domain Specific Language); scaffolding; workflow automation
- Deployment environments: API gatways; containers

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Apply best practice principles and patterns to the design and documentation of a web API.
2. Apply best practice principles and patterns to the design of a medium-sized Single Page Web App.
3. Design an end-to-end web app that supports session management and persistence for a constrained functional requirement set.
4. Utilise and configure related workflow automation tools.
5. Manage a cloud deployed web API using a Gateway intermediary service.

Supplementary Material(s)

"ReactJS." https://facebook.github.io/react/. https://facebook.github.io/react/
Richardson, L. and M. Amundsen. *RESTful Web APIs*. O'Reilly Media: O'Reilly Media, 2009.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Software Engineering	**5**	**COMP-0103**	**94018**	**7**	**Exam**

Description of Module / Aims
The objective of this module is to provide students with the understanding of techniques and methods used to develop reliable quality software. Students will also research and experiment with various tools in order to gain an insight into how they can be utilised in the software engineering process.

Indicative Content

- Evolution of the Software Engineering Discipline
- Project Management
- Software Processes and Methodologies
- Requirements Engineering
- Object Oriented Modelling
- Software Testing and Software Quality
- Configuration Management
- Software Evolution

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Understand what software engineering is and why it is important and develop an awareness of the role and responsibilities of the professional software engineer.
2. Understand the importance of project planning and create a project workflow using appropriate tools.
3. Differentiate between different software processes and methodologies and be able to select a suitable process or methodology for the design of a particular software system.
4. Describe software requirements and illustrate the processes involved in discovering these requirements.
5. Demonstrate an understanding of the different models and activities in the object oriented design process.
6. Understand the importance of software testing, software quality and configuration management in the development of software systems.
7. Identify the different stages of systems evolution.

Supplementary Material(s)

Pressman, R. and B.R. Maxim. *Software Engineering: A Practitioner's Approach*. 8th ed. New York: McGraw-Hill Higher Education, 2014.
Sommerville, I. *Software Engineering*. 10th ed. Boston: Pearson, 2015.

Module Listing for Bachelor of Science in MULTIMEDIA APPLICATIONS DEVELOPMENT YEAR 4

Programme Code: – WD_KMULA_B

Year 4			
Semester 7 (Autumn) **Code**	**Component**	**Semester 8 (Spring)** **Code**	**Component**
Project Management	PROJ-0168	Integrated Marketing	MARK-0193
Computer Security	COMP-0628	Mobile App Development 2	COMP-0486
Data Visualisation	COMP-0629	Multimedia Databases	COMP-0633
Mobile App Development 1	COMP-0630	Project 2 (Development) (E)	PROJ-0169
Project 1 (Research) (E)	PROJ-0166	Project 2 (Research) (E)	PROJ-0170
Project 1 (Development) (E)	PROJ-0167	3D Animation and Transmedia (E)	COMP-0634
3D Lighting and Rendering (E)	COMP-0631	Advanced Graphic Design (E)	COMP-0635
Advanced Media Productions (E)	COMP-0632	eLearning (E)	DESG-0038
Instructional Design (E)	DESG-0038		

Project Management	ECTS 5	Banner Code: PROJ-0168	CRN: 92009	Level 8	Assessment Methods: Exam

Description of Module / Aims
This module aims to provide the student with the ability to initiate, plan, execute, control and close-out the work of a team in order to achieve specific project goals and meet specific success criteria as set out by the project sponsor and organisation.

Indicative Content

- Project Management Life Cycle Model (PMLC)
- Managing Project Scope
- Managing Project Resources
- Managing Project Quality
- Managing Project Risk
- Managing Project Execution
- Managing Project Implementation and Closure

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Appraise principles of project management.
2. Evaluate contemporary issues that may affect the project management process.
3. Estimate project duration and costings using a variety of tools and models.
4. Produce a project plan based on a business context.
5. Plan, control and monitor project schedules using project management software.

Supplementary Material(s)

Cadle, J. and D. Yeates. *Project Management for Information Systems*. 5th ed.. London, UK: Pearson, 2008.
Marchewka, J.T. *Information Technology Project Management: Providing Measurable Organisational Value*. 5th ed.. MA, USA: Wiley, 2015.

Computer Security	ECTS 5	Banner Code: COMP-0628	CRN: 91727	Level 8	Assessment Methods: CA

Description of Module / Aims
This module provides the essentials of computer security. Topics covered include the various security threats and vulnerabilities and the services available to address these threats. Cryptographic foundations that underpin many security mechanisms are covered. Issues relating to network and application security, including web applications, are also explored. Best practice in secure programming is also covered.

Indicative Content

- Introduction to computer security: security threats; attack methods; common vulnerabilities; security services
- Cryptography: symmetric encryption; modern encryption; block vs stream ciphers; public key cryptography
- Message authentication and integrity: hash functions; collisions; MACs; digital signatures; digital certificates
- Network security: TLS/SSL; wireless security, SSH, firewalls
- Secure Web Application development: SQL Injection; Cross Site Scripting, CSRF
- Security policy and procedures
- Steganography, Digital watermarking and Digital rights management

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Assess the various security threats and attack methods to which an organisation may be susceptible.
2. Appraise the role of cryptography in computer security, including its benefits and limitations.
3. Test and use cryptographic software and set up network and system security.

4. Evaluate the specific security concerns pertinent when developing web applications.
5. Appraise the role of steganography, digital watermarking and digital rights management within multimedia environments.

Essential Material(s)

"Open Web Application Security Project (OWASP)." https://www.owasp.org
"OpenSSL, Cryptography and SSL/TLS Toolkit.." https://www.openssl.org/

Supplementary Material(s)

"Computer Emergency Response Team, CERT." https://www.cert.org
"Security Focus." http://securityfocus.com/
"The SANS Institute." https://www.sans.org
McGraw, G. *Software Security: Building Security In*. NY: Addison-Wesley, 2006.
Stallings, W. *Computer Security: Principles and Practices*. 3rd ed. England: Pearson Higher Education, 2014.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Data Visualisation	**5**	COMP-0629		**8**	**Exam**

Description of Module / Aims

This module will expose the learner to statistical and other methods that will enable them to create a variety of visualisations from different types of data, using both traditional and contemporary methods. Issues pertaining to the collection of data will be presented as will cautions on the potential for statistics to mislead. A basic introduction to the statistical tools used in data analytics is also given.

Indicative Content

- Data: Sourcing; Primary and secondary data; Sampling mechanisms; Validity checks – outlier detection, data cleaning etc; Big data
- Traditional approaches: Review of conventional statistical charts – elementary (histograms, boxplots, pareto, pie charts etc.); Advanced (multiple, clustered, stacked, contour etc.); Selecting suitable charts for a given purpose
- Lies and statistics: Misrepresentation and deception in statistics in general and in statistical charts in particular; Historical case studies
- Contemporary visualisation charts: Static (linear, planar, multidimensional, temporal, tree/hierarchical etc.) and dynamic
- Software: Statistical visualisation and graphics tools – using both industry standard software (e.g SAS visual analytics etc.) and non-commercial software (e.g. GGobi, R etc.)
- Statistical methods: Overview of methods used in data analytics using appropriate software. (E.g. significance testing, multiple regression, cluster analysis etc.)

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Discuss the issues pertaining to the collection and preparation of data.
2. Choose an appropriate, traditional, statistical chart that will successfully convey information contained in a data set.
3. Determine in statistical metrics or charts, potential to accidentally or deliberate misrepresent information in a data set.
4. Select and utilize suitable software that creates data visualisations – both traditional (elementary and advanced) and contemporary (static and dynamic).
5. Select and utilize suitable software that implements statistical methods used in data analytics.

Supplementary Material(s)

"Statsoft Electronic Statistics Textbook." www.statsoft.com
Tufte, E.R. *The visual display of quantitative information*. Connecticut: Graphics Press, 2001.

Mobile App Development 1	ECTS 5	Banner Code: COMP-0630	CRN: 91735	Level 8	Assessment Methods: CA

Description of Module / Aims
Design, build and deploy a multi-screen mobile application incorporating an intuitive and efficient navigation mechanism. Structure the implementation using accepted best-practice with respect to patterns, frameworks and tools. Incorporate localised persistence models + simple access to remote services. Introduce context services such as location/camera and/or other sensor access.

Indicative Content

- Application Structure: Components; Resources; Security; General Assets
- User Experience: UX Principles, Navigation, Imagery, Fonts
- Simple User Interaction Patterns
- Essential Application Structure Patterns: Appropriate Variations on Model/View/Controller (MVVM, MVP etc…)
- Resource access and management; Clean separation of concerns
- Application Life-cycle: Startup/shutdown; Foreground/background
- UI State Preservation and Restoration; Concurrency

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Decompose an application into its constituent parts, including but not limited to: core application components, user experience resources, packaging.
2. Design a coherent User Experience - using appropriate tools, practices and guidelines - for a moderately sized application.
3. Produce medium sized application, based on a limited set of design patterns.
4. Manage the application lifecycle.
5. Structure persistent storage on a device and reliably save and restore application state.

Essential Material(s)

"Android Developer Resouces." http://developer.android.com
"Apple Developer Resources." http://developer.apple.com/ios
"Cordova Developer Resources." https://cordova.apache.org

Supplementary Material(s)

Camden, R. *Apache Cordova in Action*. New York: Manning, 2015.
Neuburg, M. *iOS 9 Programming Fundamentals with Swift: Swift, Xcode, and Cocoa Basics*. New York: O'Rielly, 2015.
Phillips, B. *Android Programming: The Big Nerd Ranch Guide*. New York: Pearson, 2015.

Project 1 (Research) (E)	ECTS 10	Banner Code: PROJ-0166	CRN: 92001	Level 8	Assessment Methods: CA

Description of Module / Aims
This is the capstone module for Semester one; it should bring together the student's knowledge on all aspects of IT and utilise many facets of their previous learning, with a view to identifying a suitable research problem that is to be investigated. This module requires the student to identify a research area of interest, conduct a preliminary investigation, identify suitable research question(s), conduct a literature review and critique and select a suitable methodology to enable them to gather and analyse data. In addition, it requires the student to prepare a report on the first stage of their fourth year project in conjunction with a learning contract established between student and supervisor.

Indicative Content

- Write succinct and referenced, well-structured reports
- Introduction
- Analysis of research questions
- Literature review
- Research methodology

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Appraise a research area.
2. Create appropriate research questions.
3. Complete a literature review.
4. Select an appropriate research methodology and data gathering technique.

Essential Material(s)

Cresswell, J.S. *Research Methods: Qualitative, Quantitative and Mixed Methods Approaches*. New York: Sage, 2002.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Project 1 (Development) (E)	**10**	**PROJ-0167**	**92005**	**8**	**CA**

Description of Module / Aims
This module extends the student's knowledge of software engineering with a view to equipping them for their project work in this current year (year IV) of the programme. In addition it requires the student to prepare a consolidated report on the first stage of their fourth year project in conjunction with a learning contract established between student and supervisor.

Indicative Content

- Consolidate knowledge of software development processes, particularly those that are based on an iterative strategy and early risk mitigation
- To enhance the student's ability to analyse a problem through scenarios that will subsequently provide a plan for construction and testing
- Where appropriate to define the user requirements of an intended system through use case descriptions
- Use of UML and other textual/diagramming techniques essential for discussing final year projects at a conceptual level
- To revise and consolidate the students' abilities to write referenced reports
- Using appropriate techniques, tentatively plan a project in detail breaking it into sub-tasks; rigorously identify deliverables and critical dependencies

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Explain, in words and diagrammatically, to their peers, the work of their project.
2. Interact with their supervisor in discussing how their project might proceed and the risks and interact options associated with their work.
3. Complete a technological prototype of their project showing that all their hardware and software components work together.
4. Prepare a test strategy for their project and have a detailed tentative plan for building a draft design.

Supplementary Material(s)

Lacey, M. *The Scrum Field Guide: Practical advice for the first year*. New York: Addison Wesley, 2012.

3D Lighting and Rendering (E)	ECTS 5	Banner Code: COMP-0631	CRN: 91739	Level 8	Assessment Methods: CA

Description of Module / Aims
This module looks at the lighting and rendering components of the 3D digital animation pipeline. The module will encompass materials editing, lighting and shadows, and rendering using an industry-standard rendering engine. Students will have the opportunity to explore advanced techniques and effects that may be used to light and render complex 3D scenes and, using pre-existing scene assets, and to produce a photo-realistic and production-quality rendered scene.

Indicative Content

- Principles of light and colour
- Materials and Maps
- 3D lighting including standard, photometric, and HDRI lighting
- Shadows
- Rendering including indirect and global illumination
- Effects including lens and camera shaders

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Appraise approaches to managing and creating materials used in 3D rendering.
2. Compare standard, photometric and HDRI lighting assemblies.
3. Evaluate, in terms of optimisation, techniques used to render shadows in 3D animation.
4. Create camera and lens effects in a pre-existing 3D scene.
5. Integrate lighting and rendering techniques to manage the production of a short animated scene.

Essential Material(s)

Lanier, J. *Advanced Maya Texturing and Lighting*. New York: Sybex, 2015.

Supplementary Material(s)

Palamar, T. *Mastering Autodesk Maya*. New York: Sybex, 2016.

Advanced Media Productions (E)	ECTS 5	Banner Code: COMP-0632	CRN: 91743	Level 8	Assessment Methods: CA

Description of Module / Aims
This module provides the student with the opportunity to apply his/her knowledge of the pre-production and production process whilst learning and utilizing the necessary skillset to work in a post-production environment. The student will be required to use an industry standard asset management tool for his/her work during the duration of the module.

Indicative Content

- This module enables the student to apply animation to text, video, 2D and 3D objects
- Perform colour correction and use an adequate toolset for the distortion of objects
- Build multimedia objects and add appropriate features
- Animate layers and masks and work with the 3D camera tracker
- Apply advanced editing techniques
- Use camera techniques
- Create and use lighting setups
- Create set designs
- Use industry standard asset management tools

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Produce animation and utilize effects on various types of objects.
2. Develop a working knowledge of a range of tools available for the adjustment of color and distortion of objects.
3. Produce and edit a short film incorporating text, video, 2D and 3D objects including special effects.
4. Develop proficiency in camera techniques, lighting and set design.
5. Integrate the use of industry standard asset management tools.

Supplementary Material(s)

Faulkner, A. *Adobe After Effects CC Classroom in a Book*. 1st ed. NY: Adobe, 2014.
Figgis, M. *Digital Film-Making*. revised. NY: Faber & Faber, 2014.
Thurlow, C. and M. Thurlow. *Making Short Films: The Complete Guide from Script to Screen*. 3rd ed. NY: Bloomsbury Academic, 2013.

Instructional Design (E)	**ECTS 5**	**Banner Code: DESG-0038**	**CRN: 68363**	**Level 8**	**Assessment Methods: Exam**

Description of Module / Aims
This module aims to provide students with a detailed understanding of empirically-based principles in computer-based training and learning systems which instructional designers can employ to create applications that improve and optimise learning.

Indicative Content

- Introduction to Instructional Design: Designing instructional systems, Basic processes in Learning and Instruction, The outcome of instruction, Instruction of educational goals, Categories of learning outcomes
- The multi-media learning environment: Active learning, Elaborative processing, Use of both verbal and pictorial channels to process information, Use of feedback and learning, E-learning in practice
- Delivery systems for instruction: Group instruction, Individualised instruction.
- Practical Implications of Learning Theories: Learner centred views of Behaviourism, Cognitivism and Constructivism
- Designing Instruction: Designing performance objectives, Analysing the learning tasks, Designing instructional sequences, Designing the events of instruction, Selecting appropriate media, Assessing student performance
- Instructional design theories: Instructional design models & frameworks, designing for instruction

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Assess and appraise current trends and technologies used in designing and developing instructional based systems
2. Integrate the learning framework that supports the interactive nature of learning theories and learning styles theories with multimedia technologies.
3. Provide a summative evaluation of key steps within the instructional design process

Essential Material(s)

"Dabbagh, N., Instructional Design Knowledge Base,."
http://classweb.gmu.edu/ndabbaghResources/IDKB/index.htm
"Roblyer, Educational Technology in Action, with CD,." www.prentice-hall.com
Colvin Clark, R. & Mayer, E. R., e-Learning and the Science of Instruction, 2nd Edition, Jossey Bass, 2007. Smaldino, Russell, Heinich & Molenda, Instructional Technology & Media for Learning, 8th Edition, Pearson Education, 2005. Jonassen, Howland, Moore & Marra, Learning to Solve Problems with Technology, 2nd Edition, Prentice-Hall, 2003. Reiser & Dempsey, Trends and Issues in Instructional Design and Technology, Prentice-Hall, 2002.

Laurillard, D., Rethinking University Teaching: A Conversational Framework for the Effective Use of Learning Technologies, 2nd Edition, Routledge, 2001. Gagne, R., Briggs, L. & Wager, W., Principles of instructional design, 4th Edition, Prentice-Hall, 1992.

Supplementary Material(s)

2nd Edition, Prentice-Hall, 2000. Walter, D, and Carey, L., The Systematic Design of Instruction, Harper Collins, 1996. Merrill, Hammons, Vincent, Reynolds & Christensen, Computers in Education, 3rd Edition, Pearson Education, 1996.
Preece, J., Sharp, H. & Rogers, Y., Interaction Design, Beyond Human-Computer Interaction, 2nd Edition, Wiley, 2007. Maddux, Johnson & Wills, Educational Computing: Learning with Tomorrow's Technologies, 3rd, Edition, Prentice-Hall, 2001. Alessi & Trollip, Multimedia for Learning: Methods and Development, 3rd Edition, Pearson Education, 2001. Newby, Stepich, Lehman & Russell, Instructional Technology for Teaching and Learning: Designing Instruction, Integrating Computers and Using Media,

Integrated Marketing	**ECTS 5**	**Banner Code: MARK-0193**	**CRN: 91837**	**Level 7**	**Assessment Methods: CA**

Description of Module / Aims
The aim of this module is to demonstrate how companies apply marketing concepts and strategy in high technology industries.

Indicative Content

- The Marketing Process
- The High Technology Marketing Environment
- The High Technology Marketing Mix
- Developing Market Information in High Technology Industries
- Digital Promotional Campaigns

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Discuss the role of marketing in software and hardware development.
2. Apply marketing research methods used by high tech companies.
3. Apply digital marketing tools to develop an online promotional campaign.
4. Describe market dynamics in high technology marketing industries.
5. Analyse the marketing strategy of high technology companies.

Supplementary Material(s)

Arthur, C. *Digital Wars: Apple, Google, Microsoft and the Battle for the Internet*. London: Kogan Page, 2012.
Brynjolfsson, E. and A. McAffee. *The Second Machine Age - Work, Progress, and Prosperity in a Time of Brilliant Technologies*. New York: W. W. Norton & Company, 2016.
Chaffey, D and F Ellis-Chadwick. *Digital Marketing*. London: Pearson, 2015.
Yoffie, D. and M. Cusumano. *Strategy Rules: Five Timeless Lessons from Bill Gates, Andy Grove, and Steve Jobs*. New York: HarperBusiness, 2015.

Mobile App Development 2	**ECTS 5**	**Banner Code: COMP-0486**	**CRN: 91702**	**Level 8**	**Assessment Methods: CA**

Description of Module / Aims
Evolve a multi-screen mobile application in a networked, message driven, context aware application. Incorporate in the application two-way access to remote REST (Representational State Transfer) and Messaging services. Integrate on-device

context including camera, location, motion, climate and other sensors to deliver a rich user experience. Incorporate 3rd party components to deliver personalized mapping, media and general information services.

Indicative Content

- Advanced application architectural patterns
- The build, test & deploy lifecycle
- Accessing Platform Services: Persistence; Sensors / Subsystems (e.g. Location, camera, movement etc.)
- Accessing External Services: Access Patterns (e.g. REST); Third Party Applications & Components
- Build Processes: Dependency Management; Build Scripts (e.g. Gradle)
- Wireless Subsystem APIs (Application Programming Interfaces)
- App Store interaction, including key management

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Select the appropriate design patterns and tools in the development of complex mobile apps.
2. Comment on the chosen mobile app framework and the underlying hardware components.
3. Design and develop complex multi-screen mobile apps from concept through to completion using best practices and guidelines.
4. Set up the interaction of an application with internal sensors and physical subsystems.
5. Integrate a remote service API within an application, perhaps based on REST principles, to deliver aspects of its core features set. For example: Maps/GIS (Geographic Information Systems), Media Sharing, Social Networking.

Essential Material(s)

"Android Developer site." http://developer.android.com
"Apache Cordova site." https://cordova.apache.org
"iOS Developer site." http://developer.apple.com/ios

Supplementary Material(s)

Camden, R. *Apache Cordova in Action*. New York: Manning, 2015.
Neuburg, M. *iOS 9 Programming Fundamentals with Swift: Swift, Xcode, and Cocoa Basics*. New York: O'Rielly, 2015.
Phillips et al, B. *Android Programming: The Big Nerd Ranch Guide*. New York: Pearson, 2015.

Multimedia Databases	**ECTS 5**	**Banner Code: COMP-0633**	**CRN: 91747**	**Level 8**	**Assessment Methods: Exam**

Description of Module / Aims
This module will introduce the student to the principles and practice of designing distributed and object-oriented databases. The student will gain an understanding of multimedia database concepts, the architecture and design of a multimedia database. This module will also examine the procedures involved in the management and mining of multimedia databases.

Indicative Content

- Advanced Database Concepts: Distributed, Object-Oriented
- Multimedia Data & Metadata
- Modelling Multimedia (MM) Databases: Architectures, Information Models
- Managing MM Databases: Query Processing, Storage Management
- Mining MM Databases: Technologies & Techniques, Mining MM Data
- Management of Text, Image, and Video Databases

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Appraise the concepts, standards, and systems relating to distributed and object-oriented databases.
2. Evaluate the semantic nature of multimedia data, classify, generate and extract metadata for multimedia data types.
3. Determine the requirements and structures for the design, implementation and management of a multimedia database application.
4. Critique technologies and techniques appropriate to mining a multimedia database.
5. Evaluate statistical methods for text analysis, appropriate technologies for image processing and moving images.
6. Design and implement a MM database for a business scenario.

Supplementary Material(s)

Connolly, T. and C. Begg. *Database Systems: A Practical Approach to Design, Implementation and Management*. 6th ed.. NY: Addison-Wesley, 2015.
Dunkley, L. *Multimedia Databases: An Object Relational Approach*. UK: Pearson Education, 2003.

Project 2 (Development) (E)	ECTS 10	Banner Code: PROJ-0169	CRN: 92025	Level 8	Assessment Methods: CA

Description of Module / Aims
This module gives the student experience in developing a computing-related project by creating a product or a good prototype for a product. The student will present their work at the end of the module by submitting a final report, in addition to a poster, a short video, and a demonstration.

Indicative Content

- Incorporate feedback from project supervisors/examiners, relating to the work done in Semester 1, namely high level analysis and design and the construction of prototypes and/or early iterations.
- Develop further and document a testing strategy to ensure the quality of each software module, each production-quality iteration and of the final product.
- Further develop the student's ability to write referenced academic and technical reports, principally a required final report, not less than 2000 words and not more than 8000 words, accompanied by a poster and a video.
- To provide the student with the opportunity (and requirement) to meet with a supervisor week by week and to complete the work according to the initial or a revised plan.
- To enable the student to apply their problem-solving and their technical skills to address implementation issues as they arise.

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Integrate feedback from Project 1.
2. Implement a fully tested, working system based on a specification and chosen development methodology.
3. Appraise the limitations and potential of the chosen methodology and resulting solution.
4. Validate the final system, with accompanying report, video and poster and competently discuss the problem area.

- 50%-59%: As above and produces a working, tested system to meet most requirements (unless failure to do so is justified). Documentation and reports are clear and of good quality. Comprehensive knowledge of tools and technologies.
- 60%-69%: As above and requirements fully met unless failure to do so is justified. Demonstrates ability to solve unfamiliar technical problems. Shows good judgement in technology selection. Documentation shows evidence of ability to see limitations or potential in approaches used.
- 70%-100%: As above and produces an excellent, professional calibre stand-alone system with equally excellent documentation. Demonstrates ability to abstract ideas and reflect on the process.

Supplementary Material(s)

Beck, K. *Test-driven development: by example*. Boston: Addison-Wesley, 2003.
Fowler, M. and K. Scott. *UML distilled: a brief guide to the standard object modelling language*. Boston: Addison-Wesley, 2004.
Lacey, M. *The Scrum field guide practical advice for your first year*. Harlow: Addison-Wesley, 2012.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Project 2 (Research) (E)	**10**	**PROJ-0170**	**92029**	**8**	**CA**

Description of Module / Aims
This module gives the student experience in developing a computing-related project by undertaking research, based on the work the student has completed in Project 1, semester 7. The student will present their work at the end of the module by submitting a dissertation, in addition to a poster, a short video, and a presentation.

Indicative Content

- Incorporate feedback from project supervisors/examiners, relating to the work done in Semester 1, that work being a literature review and consequent formulation of research question(s), and initial investigative work on appropriate research methodologies, including data gathering strategies.
- Complete the consideration of the research methodologies to be used, and design of the data collection instruments.
- Complete the development of any customised software tools to be used in investigation or data gathering and analysis.
- Further develop the student's ability to write referenced academic and technical reports, principally a required final dissertation, not less than 6000 words and not more than 12000 words, accompanied by a poster and a video.
- To provide the student with the opportunity (and requirement) to meet with a supervisor week by week and to complete the work according to the initial or a revised plan.
- To enable the student to apply investigative, problem-solving and technical knowledge to address issues as they arise.

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Integrate feedback from Project 1.
2. Complete the process of devising/designing a research methodology.
3. Create the research question(s), using the appropriate tools and methodologies.
4. Reflect on limitations and potential of the chosen methodology and resulting discoveries.
5. Validate the final dissertation, with accompanying video and poster and competently discuss the research area, showing competence in research methods.

Supplementary Material(s)

Bell, J. and C. Opie. *Learning from research: getting more from your data*. Buckingham: Open University Press, 2002.
Bell, J. and S. Waters. *Doing your research project: A Guide for first time researchers*. Buckingham: Open University Press, McGraw-Hill, 2014.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
3D Animation and Transmedia (E)	**5**	**COMP-0635**	**91751**	**8**	**CA**

Description of Module / Aims
This module provides the foundation for advanced animation construction and integration with external media, as well as techniques to automate and optimize development processes. Students will learn advanced rigging and animation

techniques such as Facial Animation, Visual Effects and Motion Capture. In addition, students will be introduced to productivity, management and optimization techniques using asset management services, scripting and expressions.

Indicative Content

- Structured programming to address 3D modelling, animation and customization practice
- Animation techniques for Motion Capture, Facial Animation and Lip Synching
- 3D animation production asset management
- Visual effects (VFX) - incorporate physics elements into animation production
- Integration of 3D Animated assets across multiple media sectors: TV, Gaming, Engineering and Corporate

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Appraise key facial rigging techniques.
2. Evaluate and apply motion capture techniques for CGI use.
3. Assess the practical principles of VFX integration with animated CGI scenes.
4. Evaluate the principles and practice of automated modelling, animation and customized techniques using scripting and computational expressions.
5. Critique the principles of asset, environment and timeline management for 3d animation transmedia projects.

Essential Material(s)

Gould, D. *Complete Maya Programming: An Extensive Guide to MEL and C++ API*. 1st ed.. US: Morgan Kaufmann, 2003.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Advanced Graphic Design (E)	**5**	**COMP-0635**	**91755**	**8**	**CA**

Description of Module / Aims
This module formulates an appreciation of graphic design through the study of historical influences, styles and culture. The student gains an in-depth knowledge of graphic and visual interpretation to develop a fluency in visual and textual problem solving to the provision of solutions for multiple mediums.

Indicative Content

- History of Graphic Design: studies of influences and cultures
- Visual Styles & Approaches
- Graphic Information Design: The Image and Its Role in Design, Infographics
- Expressive Typography
- Advanced Colour Theory
- Graphic Design Processes

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Evaluate historical influences, styles and cultures in graphic design.
2. Arrange and design an infographic campaign.
3. Design text as art and apply expressive typography.
4. Design and create a graphic design project from problem to solution.

Supplementary Material(s)

Eskilson, S.J. *Graphic Design A History*. 2nd ed. London: Laurence King, 2012.
Heller, S. and V. Vienne. *100 Ideas That Changed Graphic Design*. 1st ed. London: Laurence King, 2012.
Skolos, N. and T. Wedell. *Graphic Design Process*. 1st ed. London: Laurence King, 2012.
Taylor, F. *How to Create a Portfolio and Get Hired*. 1st ed. London: Laurence King, 2012.

eLearning (E)	ECTS 5	Banner Code: DESG-0038	CRN: 91759	Level 8	Assessment Methods: CA

Description of Module / Aims
This module is concerned with the authoring of instructionally sound, accessible eLearning for different platforms. This can, for example, be a single part of a course, or all of a course whether it is in an academic environment, part of mandatory business training or a full distance learning course.

Pre-Requisite(s): Instructional Design

Indicative Content

- Design and Authoring of eLearning
- Needs and Task Analysis
- Organising Instruction
- Learning Environments
- Using Standards and Guidelines
- Creating, Testing and Validation of Accessible Web Sites

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Evaluate and critique the suitability of eLearning Authoring Tools.
2. Design organised instruction and develop learning environments using Instructional Design Guidelines.
3. Prepare needs and task analysis.
4. Substantiate the creation, testing and validation of accessible user interfaces using guidelines and standards.
5. Develop a computer based, accessible learning environment.

Essential Material(s)

Clark, R. and R. Mayer. *e-Learning and the Science of Instruction: Proven Guidelines for Consumers and Designers of Multimedia Learning*. 3rd ed.. United Stated of America: Pfeiffer, 2011.

Supplementary Material(s)

Horton, W. *E-Learning by Design*. 2nd ed.. United States of America: Pfeiffer, 2011.

2. DEPARTMENT OF SCIENCE

Module Listing for Bachelor of Science in HORTICULTURE

Programme Code: WD_SHORT_D

Year 1			
Semester 1 (Spring)	**Component Code**	**Semester 2 (Autumn)**	**Component Code**
Year 2			
Semester 3 (Spring)	**Component Code**	**Semester 4 (Autumn)**	**Component Code**
Biodiversity & Horticulture	HORT-0030		
Garden Management and Plant Selection	HORT-0040		
Landscape Design (E)	DESG-0010		
Nursery Stock Production (E)	HORT-0006		
Sustainable Food Production (E)	FOOD-0023		
Lab Skills for Plant Micropropagation (E)	HORT-0041		
Sportsturf Science (E)	SPOR-0092		
Year 3			
Semester 5 (Spring)	**Component Code**	**Semester 6 (Autumn)**	**Component Code**
Landscape Design (E)	DESG-0066	Arboriculture	HORT-0043
Nursery Stock Production (E)	HORT-0023	CAD (E)	CADD-0002
Sustainable Food Production (E)	HORT-0026	Greenkeeping (E)	HORT-0019
Sportsturf Science (E)	SPOR-0092	Social and Therapeutic Horticulture (E)	HORT-0049
Lab Skills for Plant Micropropagation (E)	HORT-0041	Interior Landscaping and Floristry (E)	HORT-0047
		Field Crop Production (E)	HORT-0028
		Landscape Design Advanced (E)	DESG-0012
		Garden Centre Operations (E)	HORT-0018

Module Descriptors

Biodiversity and Horticulture	ECTS 5	Banner Code: HORT-0030	CRN: 79023	Level 7	Assessment Methods: Exam

Description of Module / Aims
This module introduces the student to the ethics of biodiversity and the role that horticulture can play in its conservation and development.

Indicative Content

- Ethics of conservation and biodiversity
- Environmental impact assessment (EIS), environmental monitoring methods
- Applications of horticulture to protect, enhance or re-establish biodiversity in a range of sites, e.g. brown field, roads and motor way, reed beds
- Horticultural applications to improve biodiversity and reduce negative environmental impact e.g. use of reed beds, flood amelioration by choice of planting in riparian zones, tree & plant selections for urban areas, land stabilization
- Urban ecology; back gardens urban forestry, green roof, green walls, allotments, water courses
- Pollinating insects and horticultures role
- Principles of ecology - biodiversity, habitats , niche, species interactions, succession, climax community, energy flow
- Range and extent of Irish Flora and key Irish habitats, Horticulture and invasive species, alien species, biosafety, Cartagena protocol
- Legal framework of protection of habitats and biodiversity

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Describe the benefits that horticulture can make towards biodiversity in a range of scenarios
2. Describe the national and European regulations and laws in place to protect biodiversity
3. Discuss the importance of conserving biodiversity and the threats facing it
4. Identify native and alien species of flora and fauna
5. Prepare a limited EIS (or a biodiversity survey) for a designated site

Supplementary Material(s)

Fossitt, J. *A guide to Habitats in Ireland*. Dublin: The Heritage Council, 2000.
Smith, D. *Urban ecology*. : Taylor & Francis, 2006.

Garden Management and Plant Selection	ECTS 10	Banner Code: HORT-0040	CRN: 91334	Level 7	Assessment Methods: Exam

Description of Module / Aims
This module will provide the student with the skills and knowledge required to develop and maintain a garden. Students will be taught to identify a wide range of plants, their cultural requirements, and their suitability for different planting situations.

Indicative Content

- Cultivation of a range of fruit top and soft fruit on small garden scale, e.g. apples, raspberries, gooseberries, blackcurrants, strawberries
- Cultivation of a range vegetables on a small garden scale e.g. onions, salads, tomatoes, carrots, cabbage, broccoli, range of herbs, range of cucurbits
- Principles of design, use of plant materials: Colour, form, texture, structure and layout
- Water features, construction methods, and maintenance regimes
- Factors in managing estates and parks. Layout design and history of parks and estates
- Maintenance of parks and mixed borders

- Growing conditions and selection of ornamentals for the following situations: Ponds, seasonal bedding, hedging, screening, shelter, seaside, climbing, walls, ground cover, shade, dry banks, slope stabilisation, and small gardens
- Ornamental plant identification by relevant characteristics such as leaf and twig, bud and twig, flower, berry, stem using the binomial system
- Specialist plants groups e.g. alpines, ferns, grasses, and bamboos
- Care and management of naturalistic plantings e.g. wild flower meadows

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Appraise the growing of fruit and vegetable crops on a small scale.
2. Demonstrate the use of a range of ornamental plants in the landscape.
3. Recommend appropriate plants for specific site situations.
4. Determine the impact of park management on public spaces.
5. Demonstrate appropriate garden maintenance techniques e.g. planting, pruning, weeding, mowing, and edging.
6. Plan a mixed border demonstrating principles of good design.
7. Use scientific names to identify live specimens of ornamental perennials, annuals, bulbs, trees and shrubs.

Essential Material(s)

Brickell, C. *RHS A-Z Encyclopaedia of Garden Plants*. 3rd ed.. London: DK, 2008.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Landscape Design	**10**	**DESG-0010**	**18272**	**7**	**Exam**

Description of Module / Aims

This module will enable students to design landscapes and to carry out the necessary practices associated with landscape design and to use drawing equipment. Principles of design. Elements of design. History of design and garden styles.

Indicative Content

- Prepare design plans and specifications for given situations
- Interpreting ordnance survey maps and site plans Linear surveying Level surveying Transferring information to sketch
- Costing
- Principles of design history of design and garden styles
- Use of drawing equipment and drawing standards
- Draft site surveys and site analysis
- Draft site analysis
- Draft masterplans
- Draft section/elevation drawings
- Draft axonometric drawing
- Draft construction details
- Draft planting plans

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Carry out linear and level surveying
2. Understand the principles of design and interpretation of plans and specifications
3. Design landscape projects
4. Draft designs to the detailed plan and specification stage
5. Apply good environmental and safety practices in surveying and levelling

6. Describe the elements of design, history of design and different styles that influence the design process

Essential Material(s)

Brooke, J. *John Brookes Garden design*. : Ward Locke, 2001.
Heinnebaun, L. *Landscape Design - A practical approach*. : Prentice Hall, 1997.
Linsey, , et al. *Landscape design Vol I + II*. : Gower, 1990.

Supplementary Material(s)

Young, C. *RHS encyclopaedia of Garden Design*. London: Dorling Kindersley , 2009.

Nursery Stock Production (E)	ECTS 10	Banner Code: HORT-0006	CRN: 18271	Level 7	Assessment Methods: Exam

Description of Module / Aims
This module is designed to equip students with a knowledge of Nursery stock production, management and planning. Students will also learn nursery stock specific skills of planting, crop protection, IPM, and will perform cultural techniques in the production of trees. Plant health and exporting regulations are also covered.

Indicative Content

- Bedding plants 1.1 Identification of flowering bedding plants 1.2 Production and Management Programmes for Bedding Plants 1.3 Produce a range of half-hardy bedding plants 1.4 Prepare displays of bedding plants 1.5 Economics of production
- Open ground trees and shrubs 2.1 Soil preparation operations before planting 2.2 Demonstrate planting skills 2.3 Plan a crop protection and weed control programme 2.4 Perform cultural techniques 2.5 Harvesting techniques 2.6 Quality standards specifications 2.7 Budding & grafting for tree production
- Containerised trees and shrubs (3.1 Compost specification for various production programmes 3.2 Demonstrate potting skills 3.3 Growing-on systems 3.4 Plan a crop protection and weed control programme 3.5 Perform cultural techniques 3.6 Quality standards specifications
- Nursery stock management 4.1 Plan the physical layout of a nursery 4.2 Schedule production programme for trees and shrubs 4.3 Monitor crop performance
- Liner production 5.1 sources of material 5.2 growing options 5.3 nutrition & irrigation 5.4 perform cultural techniques

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Explain the production of bedding plants
2. Explain the production of open ground trees & shrubs
3. Explain the production of containerised trees &shrubs
4. Develop plan schedules and layout of a nursery
5. operate in a safe working environment
6. Explain the production of liners
7. perform a range of cultural tasks associated with Nursery stock production

Supplementary Material(s)

Davidson H, Mecklenburg R, Curtis Peterson C. *Nursery management: administration and culture*. 4 Edition. UK
Lamb, K Kelly, J. *Nursery Stock manual*. England: Grower books, 1995.
Perry L. *Herbaceous perennials production: a guide from propagation to marketing*.
Whitcomb. *Plant production in containers*. USA: Lacebark, 2003.

Sustainable Food Production (E)	ECTS 10	Banner Code: FOOD-0023	CRN: 91368	Level 7	Assessment Methods: Exam

Description of Module / Aims
The module will enable the student to plan and describe the production of a range of speciality food crops and perform the associated skills to best industry practices.

Indicative Content

- Salad crops, scallions, lettuce and celery: Soil, site and rotation. Cultivars. Sowing/planting and irrigation. Cultivation and nutrition. Weed, pest and disease control including SUD/IPM. Harvesting and grading
- Rhubarbs, asparagus, courgettes and sweetcorn: Site selection and soils. Cultivars. Cultivation and nutrition. Weed, pest and disease control including SUD/IPM. Harvesting and grading
- Leeks, peas and beans: Site selection and soils. Cultivars. Cultivation and nutrition. Weed, pest and disease control including SUD/IPM. Harvesting and grading
- Beetroot, radish and spinach: Site selection and soils. Cultivars. Cultivation and nutrition. Weed, pest and disease control including SUD/IPM. Harvesting and grading
- Herbs (culinary and medicinal): Market size and outlet. Range of herb crops. Site selection and soils. Cultivation and nutrition. Weed, pest and disease control including SUD/IPM. Harvesting and grading
- Blueberries, blackberries and currants: Propagation methods. Choice of varieties. Nutrition Soil preparation and planting. Pest disease and weed control including SUD/IPM. Picking, training and pruning
- Nitrates Directive, FSAI regulations, Bord Bia QA scheme, Origin Green, Pesticide Control/Registration
- Organic Conversion: Time periods, and preparation of application form
- Pest and disease management in an organic system 'v' conventional systems
- Soil fertility and management in an organic system 'v' conventional systems
- Regulation of organic production, grading and marketing of produce

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Analyse the propagation and production of a range of food crops (including vegetables, fruit and herbs) under sustainable systems.
2. Produce a conversion plan for an organic production system.
3. Complete routine tasks associated with specialty crops.
4. Relate the requirements of the quality assurance schemes, EU directives, and other regulations to management strategies in food production systems.

Essential Material(s)

Pollock, M. *RHS Vegetable & Fruit Gardening*. London: Dorling Kindersley, 2012.

Supplementary Material(s)

"Protected Crop Growing, A guide for home and Market Gardeners." http://www.teagasc.ie/. http://www.teagasc.ie/publications/2011/1000/ProtectedCropGrowing.pdf
Dixon, G.R. and D.E. Aldous. *Horticulture: Plants for People and Places, Volume 1*. Amsterdam: Springer Netherlands, 2014.
Larkcom, J. *The Organic Salad Garden*. London: Frances Lincoln, 2006.

Lab Skills for Plant Micropropagation (E)	ECTS 10	Banner Code: HORT-0041	CRN: 91338	Level 7	Assessment Methods: CA

Description of Module / Aims
The module has been designed to enhance the education of science students who will benefit from knowledge of plant culturing techniques, or for students who might require knowledge of establishment and maintenance of environments suitable for sterile culturing of plant, animal or bacterial cultures. Horticultural plant science requires innovation and this

module will provide students with the basic requirements to pursue lab-based project work, and eventually level 9 study in plant science.

Indicative Content

- Maintaining sterile conditions: practice the principles of maintaining sterile environments and using lab equipment and glassware correctly to maintain sterility and prevent cross contamination
- Commonly used lab calculations: dilutions, molar concentration, commonly used units and measurements and converting between these units
- Lab solutions: preparing and sterilizing nutrient media and other common lab solutions such as phytohormone stock solutions and reagent doses. Budgeting in the lab
- Measuring plant productivity/stress using parameters such as: stomatal frequency, proline content, photosynthetic pigment concentrations and extent of mycorrhizal inoculation
- Lab equipment: calibrate and use of a pH meter and a conductivity meter, and the safe use of centrifuges and autoclaves
- Plant/cyanobacterial cell cultures: components of nutrient media. Establishment and continuous culture of plant callus and liquid cultures. Evaluating the growth rate and viability of cultured plant cells
- Micropropagation of plant clones: propagation of whole plants from sterile ex-plant material
- Cell death in plants: types of cell death in plants including programmed cell death and necrosis and the role of cell death in the plant hypersensitive response. Methods of inducing cell death in plants for scientific study, and enumerating two different types of cell death using staining techniques

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Demonstrate the techniques used to maintain aseptic conditions in a plant lab.
2. Prepare sterile nutrient media and complete an on-going sub-culturing regime for liquid plant and cyanobacterial cell cultures, plant callus and ex-plants.
3. Use and troubleshoot a range of commonplace lab equipment.
4. Calculate the weight of reagents needed to establish solutions of known concentrations and demonstrate proficiency in converting between the units commonly used in the plant science laboratory.
5. Experiment scientifically, interpret the data obtained, appraise observations, and plan further experimentation.
6. Investigate concepts/protocols used in laboratory plant science and evaluate their use.

Essential Material(s)

Davey, M.R. and P. Anthony. *Plant Cell Culture: Essential Methods*. Oxford, UK: John Wiley & Son, 2010.

Supplementary Material(s)

Jones, A., R. Reed and J. Weyers. *Practical Skills in Biology*. 5th ed. Oxford, UK. : Pearson, 2012.
Lobban, C.S. and M. Schefter. *Successful Laboratory Reports: A Manual for Science Students*. Cambridge, UK. : Cambridge University Press, 1992.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Sportsturf Science (E)	**10**	**SPOR-0092**	**91362**	**7**	**Exam**

Description of Module / Aims
This module aims to enable students to develop an understanding of the construction and maintenance of turf and artificial surfaces used for sports.

Indicative Content

- Turfgrass science: Soils for sportsturf, drainage and irrigation for sportsturf, grass morphology and physiology, turfgrass pathology and entomology, sportsturf weeds and control

- Turfgrass maintenance: Turfgrass mowing, management of organic matter, nutrition of turfgrass, aeration and compaction relief of turfgrass, renovation and repair of turfgrass, topdressing and materials, growth regulation, and other maintenance techniques
- Construction and maintenance of a range of sportsturf facilities: Sports pitches, bowling greens, cricket grounds, lawn tennis courts, equestrian sports and artificial surfaces

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Determine and specify appropriate soil types and root zones for specific sportsturf construction.
2. Interpret the principles of drainage and irrigation and describe appropriate methods for sportsturf.
3. Distinguish the main turf grass species and a range of pests, diseases and weeds associated with turfgrass.
4. Explore the factors influencing pests of turfgrass and propose appropriate IPM control methods in response to turfgrass pests, diseases and weeds.
5. Explore maintenance techniques and equipment required for turfgrass maintenance.
6. Demonstrate a range of turfgrass maintenance techniques.
7. Produce a plan of appropriate maintenance techniques for a range of sportsturf constructions

Supplementary Material(s)

Brown, S. *Sports Turf and Amenity Grassland Management*. Wiltshire: The Crowood Press Ltd, 2005.
Evans, R.D.C. *Bowling greens: Their history, construction and maintenance*. Bingley, West Yorkshire, England: Sports Turf Research Institute, 1992.
Evans, R.D.C. *Cricket grounds: The evolution, maintenance construction of natural turf cricket tables and outfields*. Bingley, West Yorkshire, England: The Sports Turf Research Institute, 1991.
Evans, R.D.C. *Winter games pitches, the construction and maintenance of natural turf pitches*. 1st. Bingley, West Yorkshire, England: Sports Turf Research Institute, 1994.
Fry, J. and B. Huang. *Applied Turfgrass Science and Physiology*. New Jersey: Wiley, 2004.
Lodge, R. and S. Shanks. *All Weather Surfaces for Horses*. 3rd ed. London: J. A. Allen Publishing, 2005.
McCarty, L.B., I.R. Rodriguez, B.R. Bunnell and F.C. Waltz. *Fundamentals of Turfgrass and Agricultural Chemistry*. New Jersey: Wiley, 2003.
Perris, J. *Grass Tennis Courts. How to construct and maintain them*. 1st ed. Bingley, West Yorkshire, England: The Sports Turf Research Institute, 2000.
Phulla, J., J. Krans and M. Goatley. *Sports Fields: A manual for design, construction and maintenance*. 2nd ed. New Jersey: Wiley, 2010.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Landscape Design (E)	**10**	**DESG-0066**	**76783**	**7**	**Exam**

Description of Module / Aims

This module will enable students to design landscapes and to carry out the necessary practices associated with landscape design and to use drawing equipment. Principles of design. Elements of design. History of design and garden styles.

Indicative Content

- Prepare design plans and specifications for given situations
- Interpreting ordnance survey maps and site plans Linear surveying Level surveying Transferring information to sketch
- Costing
- Principles of design history of design and garden styles
- Use of drawing equipment and drawing standards
- Draft site surveys and site analysis
- Draft site analysis
- Draft masterplans
- Draft section/elevation drawings
- Draft axonometric drawing

- Draft construction details
- Draft planting plans

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Carry out linear and level surveying
2. Understand the principles of design and interpretation of plans and specifications
3. Design landscape projects
4. Draft designs to the detailed plan and specification stage
5. Apply good environmental and safety practices in surveying and levelling
6. Describe the elements of design, history of design and different styles that influence the design process

Essential Material(s)

Brooke, J. *John Brookes Garden design*. : Ward Locke, 2001.
Heinnebaun, L. *Landscape Design - A practical approach*. : Prentice Hall, 1997.
Linsey, A, et al. *Landscape design Vol I + II*. : Gower, 1990.

Supplementary Material(s)

Young, C. *RHS encyclopaedia of Garden Design*. London: Dorling Kindersley, 2009.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Nursery Stock Production (E)	**10**	**HORT-0023**	**76779**	**7**	**Exam**

Description of Module / Aims
This module is designed to equip students with a knowledge of Nursery stock production, management and planning. Students will also learn nursery stock specific skills of planting, crop protection, IPM, and will perform cultural techniques in the production of trees. Plant health and exporting regulations are also covered.

Indicative Content

- Bedding plants
  1.1 Identification of flowering bedding plants
  1.2 Production and Management Programmes for Bedding Plants
  1.3 Produce a range of half-hardy bedding plants
  1.4 Prepare displays of bedding plants
  1.5 Economics of production
- Open ground trees and shrubs
  2.1 Soil preparation operations before planting
  2.2 Demonstrate planting skills
  2.3 Plan a crop protection and weed control programme
  2.4 Perform cultural techniques
  2.5 Harvesting techniques
  2.6 Quality standards specifications
  2.7 Budding & grafting for tree production
- Containerised trees and shrubs
  3.1 Compost specification for various production programmes
  3.2 Demonstrate potting skills
  3.3 Growing-on systems
  3.4 Plan a crop protection and weed control programme
  3.5 Perform cultural techniques
  3.6 Quality standards specifications
- Nursery stock management
  4.1 Plan the physical layout of a nursery
  4.2 Schedule production programme for trees and shrubs

4.3 Monitor crop performance
- Liner production
  5.1 sources of material
  5.2 growing options
  5.3 nutrition & irrigation
  5.4 perform cultural techniques

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Explain the production of bedding plants
2. Explain the production of open ground trees & shrubs
3. Explain the production of containerised trees &shrubs
4. Develop plan schedules and layout of a nursery
5. operate in a safe working environment
6. Explain the production of liners
7. perform a range of cultural tasks associated with Nursery stock production

Supplementary Material(s)

Davidson H, Mecklenburg R, Curtis Peterson C. *Nursery management: administration and culture*. 4 Edition. UK
Lamb, K Kelly, J. *Nurserystock manual*. England: Grower books, 1995.
Perry L. *Herbaceous perennials production: a guide from propagation to marketing*.
Whitcomb. *Plant production in containers*. USA: Lacebark, 2003.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Sustainable Food Production (E)	**10**		**91367**	**7**	**Exam**

Description of Module / Aims
The module will enable the student to plan and describe the production of a range of speciality food crops and perform the associated skills to best industry practices.

Indicative Content

- Salad crops, scallions, lettuce and celery: Soil, site and rotation. Cultivars. Sowing/planting and irrigation. Cultivation and nutrition. Weed, pest and disease control including SUD/IPM. Harvesting and grading
- Rhubarbs, asparagus, courgettes and sweetcorn: Site selection and soils. Cultivars. Cultivation and nutrition. Weed, pest and disease control including SUD/IPM. Harvesting and grading
- Leeks, peas and beans: Site selection and soils. Cultivars. Cultivation and nutrition. Weed, pest and disease control including SUD/IPM. Harvesting and grading
- Beetroot, radish and spinach: Site selection and soils. Cultivars. Cultivation and nutrition. Weed, pest and disease control including SUD/IPM. Harvesting and grading
- Herbs (culinary and medicinal): Market size and outlet. Range of herb crops. Site selection and soils. Cultivation and nutrition. Weed, pest and disease control including SUD/IPM. Harvesting and grading
- Blueberries, blackberries and currants: Propagation methods. Choice of varieties. Nutrition Soil preparation and planting. Pest disease and weed control including SUD/IPM. Picking, training and pruning
- Nitrates Directive, FSAI regulations, Bord Bia QA scheme, Origin Green, Pesticide Control/Registration
- Organic Conversion: Time periods, and preparation of application form
- Pest and disease management in an organic system 'v' conventional systems
- Soil fertility and management in an organic system 'v' conventional systems
- Regulation of organic production, grading and marketing of produce

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Analyse the propagation and production of a range of food crops (including vegetables, fruit and herbs) under sustainable systems.
2. Produce a conversion plan for an organic production system.

3. Complete routine tasks associated with specialty crops.
4. Relate the requirements of the quality assurance schemes, EU directives, and other regulations to management strategies in food production systems.

Essential Material(s)

Pollock, M. *RHS Vegetable & Fruit Gardening*. London: Dorling Kindersley, 2012.

Supplementary Material(s)

"Protected Crop Growing, A guide for home and Market Gardeners." http://www.teagasc.ie/. http://www.teagasc.ie/publications/2011/1000/ProtectedCropGrowing.pdf
Dixon, G.R. and D.E. Aldous. *Horticulture: Plants for People and Places, Volume 1*. Amsterdam: Springer Netherlands, 2014.
Larkcom, J. *The Organic Salad Garden*. London: Frances Lincoln, 2006.

Sportsturf Science (E)	ECTS 10	Banner Code: SPOR-0092	CRN: 91362	Level 7	Assessment Methods: Exam

Description of Module / Aims
This module aims to enable students to develop an understanding of the construction and maintenance of turf and artificial surfaces used for sports.

Indicative Content

- Turfgrass science: Soils for sportsturf, drainage and irrigation for sportsturf, grass morphology and physiology, turfgrass pathology and entomology, sportsturf weeds and control
- Turfgrass maintenance: Turfgrass mowing, management of organic matter, nutrition of turfgrass, aeration and compaction relief of turfgrass, renovation and repair of turfgrass, topdressing and materials, growth regulation, and other maintenance techniques
- Construction and maintenance of a range of sportsturf facilities: Sports pitches, bowling greens, cricket grounds, lawn tennis courts, equestrian sports and artificial surfaces

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Determine and specify appropriate soil types and root zones for specific sportsturf construction.
2. Interpret the principles of drainage and irrigation and describe appropriate methods for sportsturf.
3. Distinguish the main turf grass species and a range of pests, diseases and weeds associated with turfgrass.
4. Explore the factors influencing pests of turfgrass and propose appropriate IPM control methods in response to turfgrass pests, diseases and weeds.
5. Explore maintenance techniques and equipment required for turfgrass maintenance.
6. Demonstrate a range of turfgrass maintenance techniques.
7. Produce a plan of appropriate maintenance techniques for a range of sportsturf constructions

Supplementary Material(s)

Brown, S. *Sports Turf and Amenity Grassland Management*. Wiltshire: The Crowood Press Ltd, 2005.
Evans, R.D.C. *Bowling greens: Their history, construction and maintenance*. Bingley, West Yorkshire, England: Sports Turf Research Institute, 1992.
Evans, R.D.C. *Cricket grounds: The evolution, maintenance construction of natural turf cricket tables and outfields*. Bingley, West Yorkshire, England: The Sports Turf Research Institute, 1991.
Evans, R.D.C. *Winter games pitches, the construction and maintenance of natural turf pitches*. 1st. Bingley, West Yorkshire, England: Sports Turf Research Institute, 1994.
Fry, J. and B. Huang. *Applied Turfgrass Science and Physiology*. New Jersey: Wiley, 2004.
Lodge, R. and S. Shanks. *All Weather Surfaces for Horses*. 3rd ed. London: J. A. Allen Publishing, 2005.
McCarty, L.B., I.R. Rodriguez, B.R. Bunnell and F.C. Waltz. *Fundamentals of Turfgrass and Agricultural Chemistry*. New Jersey: Wiley, 2003.

Perris, J. *Grass Tennis Courts. How to construct and maintain them*. 1st ed. Bingley, West Yorkshire, England: The Sports Turf Research Institute, 2000.
Phulla, J., J. Krans and M. Goatley. *Sports Fields: A manual for design, construction and maintenance*. 2nd ed. New Jersey: Wiley, 2010.

Lab Skills for Plant Micropropagation (E)	ECTS 10	Banner Code: HORT-0041	CRN: 91338	Level 7	Assessment Methods: CA

Description of Module / Aims
The module has been designed to enhance the education of science students who will benefit from knowledge of plant culturing techniques, or for students who might require knowledge of establishment and maintenance of environments suitable for sterile culturing of plant, animal or bacterial cultures. Horticultural plant science requires innovation and this module will provide students with the basic requirements to pursue lab-based project work, and eventually level 9 study in plant science.

Indicative Content

- Maintaining sterile conditions: practice the principles of maintaining sterile environments and using lab equipment and glassware correctly to maintain sterility and prevent cross contamination
- Commonly used lab calculations: dilutions, molar concentration, commonly used units and measurements and converting between these units
- Lab solutions: preparing and sterilizing nutrient media and other common lab solutions such as phytohormone stock solutions and reagent doses. Budgeting in the lab
- Measuring plant productivity/stress using parameters such as: stomatal frequency, proline content, photosynthetic pigment concentrations and extent of mycorrhizal inoculation
- Lab equipment: calibrate and use of a pH meter and a conductivity meter, and the safe use of centrifuges and autoclaves
- Plant/cyanobacterial cell cultures: components of nutrient media. Establishment and continuous culture of plant callus and liquid cultures. Evaluating the growth rate and viability of cultured plant cells
- Micropropagation of plant clones: propagation of whole plants from sterile ex-plant material
- Cell death in plants: types of cell death in plants including programmed cell death and necrosis and the role of cell death in the plant hypersensitive response. Methods of inducing cell death in plants for scientific study, and enumerating two different types of cell death using staining techniques

Essential Material(s)

Davey, M.R. and P. Anthony. *Plant Cell Culture: Essential Methods*. Oxford, UK: John Wiley & Son, 2010.

Supplementary Material(s)

Jones, A., R. Reed and J. Weyers. *Practical Skills in Biology*. 5th ed. Oxford, UK. : Pearson, 2012.
Lobban, C.S. and M. Schefter. *Successful Laboratory Reports: A Manual for Science Students*. Cambridge, UK. : Cambridge University Press, 1992.

Arboriculture	ECTS 5	Banner Code: HORT-0043	CRN: 91399	Level 7	Assessment Methods: Exam

Description of Module / Aims
Arboriculture aims to provide the student with an understanding of the principles and processes involved in the establishment and management of amenity trees.
Indicative Content

- Benefits of trees and valuation of trees
- Tree establishment and management; species selection, planting including semi-mature trees, pruning, tree response to wounding

- Decay detection in trees
- Tree hazard assessment and management
- Importance and management of veteran, ancient and heritage trees
- Protection of trees in the development process
- Amenity woodland management

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Debate the benefits of trees and apply a method for valuing amenity trees.
2. Relate the processes involved in tree establishment and maintenance to the development of healthier trees.
3. Compare a range of technologies for detecting decay in trees.
4. Inspect trees for hazards and propose appropriate solutions.
5. Examine the importance and principles of managing veteran, ancient and heritage trees.
6. Associate the potential impacts of the development process on trees with the strategies used to protect trees in this context.
7. Analyse the importance of amenity woodlands and explain the processes involved in managing these woodlands.

Essential Material(s)

Collins, K, ed. *Amenity Trees and Woodlands: A Guide to their Management in Ireland*. Dublin: Tree Council of Ireland, 2010.
Watson, R. *Trees: Their Use, Management, Cultivation and Biology*. Wiltshire: Crowwood Press, 2006.

Supplementary Material(s)

British Standards Institution. *BS 3998 Tree Work: Recommendations* London. 2010.
British Standards Institution. *BS 5837 Trees in Relation to Design, Demolition and Construction: Recommendations* London. 2012.

CAD (E)	ECTS 5	Banner Code: CADD-0002	CRN: 60303	Level 7	Assessment Methods: CA

Description of Module / Aims
To enable students to be able to produce simple landscape design plans using CAD,and to print out drawings to scale.

Indicative Content

- Identify components of a CAD system
- Use quick setup wizard
- Use menu commands
- Use snap, grid, ortho, object snap,
- Use scale grids
- Use drawing tools
- Use layers
- Dimensions and leaders
- Produce a hard copy of a file
- Plot to scale

Learning Outcomes

On successful completion of this module, a student will be able to:

1. Complete simple landscape drawing using CAD, save files and print drawing to scale

Greenkeeping (E)	ECTS 5	Banner Code: HORT-0019	CRN: 60377	Level 7	Assessment Methods: Exam

Description of Module / Aims
This subject is aimed at enabling students to develop an understanding of the maintenance, management and construction of modern golf courses.

Indicative Content

- Golf course maintenance The rules of golf Changing holes Golf courses markers Temporary playing surfaces for golf Trees, shrubs and flowers for golf courses Water courses, ponds and lakes on golf courses. Rough and fairway maintenance, Bunker maintenance, Green maintenance, Tee box maintenance, Golf course presentation for major events Financial management Event management Golf facility management Operation of maintenance machinery Ecology and environmental management for golf courses - IPM
- Golf course construction Planning and environmental legislative implications for golf courses Principles of golf course design Project management for golf course developments Earthmoving and site clearance Construction of greens Construction of tees, bunkers and fairways Establishment of fairways Irrigation systems for golf courses Evaluation of construction machinery
- Turfgrass Maintenance: Nutrient management of a golf course Renovation and repair of turfgrass Calculations for turfgrass Maintenance specifications Rough and fairway maintenance Bunker maintenance Tee box maintenance of sand based and push up golf greens

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Carry out operations in golf course maintenance
2. Describe principals of golf course construction
3. Assess a golf course for environmentally sound management techniques
4. Describe environmentally sound management techniques
5. Describe principals of golf course management

Essential Material(s)

Beard, J. *Turf Management for Golf Courses*. : Ann Arbor Press, 2000.
Christians, N. *The Mathematics of Turfgrass Maintenance.* : Ann Arbor Press, 1997.
Hayes, Evans, Isaac. *The Care of the Golf Course*. Bingley, West Yorkshire, England: The Sports Turf Research Institute, 1992.
Hurdzan, M. *Golf Course Architecture*. : Sleeping Bear Press, 1996.
Vargas, J. M., Turgeon A. J. *Poa annua, Physiology, Culture and Control of Annual Bluegrass*. Hoboken, New Jersey: Wiley, 2004.

Social and Therapeutic Horticulture (E)	ECTS 5	Banner Code: HER-0049	CRN: 91435	Level 7	Assessment Methods: Exam

Description of Module / Aims
This module will provide students with an opportunity to review current practices in horticultural therapy and to gain an understanding of the benefits and uses of horticulture for the needs of different groups.

Indicative Content

- Origins of horticultural therapy, history of use
- Examine range of applications, needs of different groups, prison gardens, care farms, visually impaired, learning difficulties, physical disabilities, and school gardens
- Examine the range of adaptive equipment available for different needs, therapeutic qualities of plants, plant selection for different needs, and design considerations

- Methods used in assessment to modify horticultural activities and assess abilities at horticultural tasks, resources available, and case studies

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Explore the origins of horticulture therapy.
2. Analyse the impact of horticultural therapy on a range of different user groups
3. Recommend a range of tools and suitable plants for a variety of therapeutic situations.
4. Develop appropriate session plans for a group in a horticulture setting.

Essential Material(s)

Adil, J.R. *Accessible gardening: A guide for people with disabilities*. U.S: Woodbine, 1994.
Simson, S.P. and M.C. Straus. *Horticulture as therapy: Principles and Practices*. NY: Haworth Press, 1998.

Supplementary Material(s)

Hewson, M.L. *Horticulture as therapy: A practical guide to using horticulture as a therapeutic tool*. Canada: Hewson, 1994.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Interior Landscaping and Floristry (E)	**5**	**HORT-0047**	**91423**	**7**	

Description of Module / Aims
This module covers two complimentary areas; floral design and interior plantscaping. The module will enable the student to identify, select and understand the use of a wide range of interior plants. It will also enable the student to identify, use floral materials, and create suitable compositions.

Indicative Content

- Functional use of interior plants, market potential
- Theory of design, appraise features of good design in interior landscaping, range of products available for the industry e.g. planters and watering systems
- Identify a wide range of interior foliage and flowering plants, their requirements and suitability for different situations
- Site evaluation: Site survey and analysis, measure light temperature and relative humidity of interior landscape
- Maintenance: Acclimatisation, cleaning, pruning, watering, feeding, pest and disease control
- Materials for floristry, identify flower, foliage and materials, and care for and preparation of flowers and foliage material at all stages
- Design in floristry: Principles and elements in floristry design and their application - Colour wheel, depth of colour and harmonies colours for special occasions
- Mechanics: Wire, securing, receptacles, frames, display holders, and accessories
- Floristry assembles: Wired assemblies, presentation bouquets, and corporate arrangements

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Explore potential applications of interior landscaping.
2. 2. Appraise features of good design of interior landscape features
3. Demonstrate and practice care requirements for interior plants, cut flowers, and equipment.
4. Analyse the suitability of a site for an interior display.
5. Plan a maintenance programme for range of interior plant displays.
6. Determine influences on of a site on the selection and management of interior displays.
7. Compare and contrast principles of floral design.
8. Create floral assemblies.

Essential Material(s)

McHoy, P. *An Illustrated A-Z Guide to Houseplants: Everything You Need to Know to Identify, Choose and Care for 350 of the Most Popular Houseplants*. Erehwon: Lorenz Books, 2013.

Supplementary Material(s)

DelPrince, J. *Interior Plantscaping: Principles and Practices*. New York: Delmar Cengage Learning, 2013.
Fediw, K. *The Manual of Interior Plantscaping: A Guide to Design, Installation, and Maintenance*. Portland: Timber Press, 2015.
Interflora, A. *Practical Floristry - The Interflora Training Manual*. London: Hodder Educational, 1993.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Field Crop Production (E)	**5**	**HORT-0028**	**79049**	**7**	**Exam**

Description of Module / Aims
The module will enable the student to plan and describe the production of a range of food crops at a large field scale and perform the associated skills to best industry practices.

Pre-Requisite(s): Conventional and Organic Food Production

Indicative Content

- Brassicas: Plan production and management schedules for all year round cabbage, sprouts, cauliflower and broccoli production
- Rootcrops: Plan production and management scheduled for vegetable root crops: carrots such as parsnips and swedes
- Potato production and storage
- Fruit: Apple production and storage. Extended season strawberry production
- Onion production and storage
- Evaluate the economics of mixed vegetables, potatoes and fruit
- Produce a plan for 25 ha of mixed vegetables

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Analyse the production of a range of vegetables including brassicas, rootcrops.
2. Analyse the production of potatoes.
3. Compare different production systems used for fruit crops such as apples, strawberries.
4. Plan a production programme for 25ha of mixed vegetables.
5. Appraise the economics of producing food crops.
6. Demonstrate skills associated with vegetable and fruit production employing proper health and safety practices.
7. Distinguish good environmental practices in food crop production.

Supplementary Material(s)

Brewster, J.L. *Onions and other Vegetable Alliums, Volume 15 of Crop production science in horticulture*. Wallingford: CABI, 2008.
Dixon, G.R. *Vegetable Brassicas and Related Crucifers, Volume 14 of Crop production science in horticulture*. Wallingford: CABI, 2007.
Rubatzky, V., C. Quiros and P. Simon. *Carrots and Related Vegetable Umbelliferae*. Wallingford: CABI, 1999.

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Landscape Design Advanced (E)	**5**	**DESG-0012**	**60338**	**7**	**CA**

Description of Module / Aims
This module will enable students to design public sites.

Indicative Content

- Draft site surveys Draft site analyses
- Draft masterplans Draft section/elevation drawings
- Draft axonometric projections Draft construction details
- Draft planting plans

Learning Outcomes

On successful completion of this module, a student will be able to:
1. be able to survey and analyse public sites
2. design an appropriate design meeting the needs of the client and working within the constraints of the site
3. draft a management plan and or costings for selected site
4. draft a variety of drawings types

	ECTS	Banner Code:	CRN:	Level	Assessment Methods:
Garden Centre Operations (E)	**5**	**HORT-0018**	**60376**	**7**	**Exam**

Description of Module / Aims
This module is designed to equip students with a knowledge of garden centre management and planning. Students will also learn about the promotion and sales methods, display and maintainence of garden centre plants. The student will learn how to critique a garden centre.

Indicative Content

- Garden centre planning Types of garden centre Location
  Site development Creating identity Range of products Security
- Garden centre operations Developing short term and long term goals and objectives Business plans Cash flow budgets Types of costs Relating costs to individual items Pricing policy Setting price Stock control Processing sales
- Promotion and product display Advertising Sale promotion and product display Shop layout and customer flow Packaging Maintenance of displays Sales techniques
- Display and maintenance of plants Receiving plants Retailing environmental requirements Standing areas for plants Displaying plants Maintenance of plants Sales techniques

Learning Outcomes

On successful completion of this module, a student will be able to:
1. Make recommendations on garden centre planning
2. Plan customer flow and product displays
3. Identify different sales techniques
4. Analyse business and cash flow plans for garden centre
5. Implement a safe working environment
6. Critique a garden centre layout

Supplementary Material(s)

C.Snook & K.Carter. *Garden centre manager*. England: Grower books, 1999.
Stanley J. *The complete guide to garden center management*. : Ball , 2002.