Module MATH 2814 - Calculus II v1 (Year/Cycle:2 / Semester:Semester 1 / Delivery Type:Mandatory)

APPROVED

MATH 2814: Calculus II

Module Details

Module Code:	MATH 2814
Module Long Title:	Calculus II APPROVED
Banner Title:	Calculus II
Version:	1
Indicative NFQ level:	Level 7
Valid From:	Sept 2018 (September 2018)
Language of Instruction:	English
ECTS Credits::	5
ISCED Code:	0541 - Mathematics
Current Coordinator::	Laura Cooke
Module Coordinators:	• MAEV P MAGUIRE (03 October 2019 to 13 December 2021) • Laura Cooke (13 December 2021 to ---)
School Responsible:	School of Mathematical Sciences (CC)
Campus:	City Campus
Module Overview	This module aims to build on the basic techniques of calculus that the learner has already encountered and familiarise the learner with more advanced techniques. First and second order differential equations and their applications are investigated. Functions of several variables are introduced. Partial derivatives and directional derivatives are described. Vector differential and integral calculus are explored. Integration in three dimensions, the reversal of the order of integration, changes of coordinates and the fundamental integral theorems are analysed.
Indicative Syllabus	• **First order ordinary differential equations** Solution by direct integration and separation of variables. Methods for first order linear, homogeneous and Bernoulli equations. Examples and applications of first order differential equations. • **Second order ordinary differential equations with constant coefficients** General and particular solutions. Resonance. Applications of second order differential equations. • **Surfaces and functions of more than one independent variable** • **Differential calculus of more than one variable**

	Partial derivatives, gradient, divergence, curl, directional derivatives, maxima and minima problems. Lagrange multipliers. Statement of chain rule and Taylor series in several variables. • **Integral calculus of several variables** Line integrals and curve parameterisation, conservative forces and path independence. Double and triple integrals, reversal of the order of integration, applications to volume and surface integrals. Integral theorems. Change of variables, the Jacobian. • **Polar coordinates** Plane polar, cylindrical and spherical polar coordinates.
Learning and Teaching Methods	Lectures are primarily used to impart module content to the learner. Problem-solving sessions and tutorials support learners and are designed to encourage learners to work both individually and in groups.

Learning Outcomes	
Upon successful completion of this module the learner will be able to	
#	
MLO1	Use integrating factors to solve first order linear differential equations.
MLO2	Make appropriate changes of variables to help in the solution of homogeneous equations and the Bernoulli equation.
MLO3	Evaluate the complementary function and particular integral whilst solving second order ordinary differential equations and use these to obtain general and particular solutions.
MLO4	Compute and interpret partial derivatives of functions of several variables.
MLO5	Maximise and minimise functions of more than one variable, including the use of Lagrange multipliers.
MLO6	Evaluate the gradient, divergence and curl of various scalar and vector fields.
MLO7	Use line integrals to evaluate the work done by a force and prove that if the force is conservative then the work done is independent of the path.
MLO8	Reverse the order of integration and use polar coordinates to evaluate double integrals.
MLO9	Evaluate volume and surface integrals.
MLO10	Verify the integral theorems for particular functions by evaluation.

Requisites	
Assessment Threshold	examination: 35%

Module Content & Assessment

Assessment Breakdown	%
Formal Examination	70.00%
Other Assessment(s)	30.00%

Assessments

Formal Examination

Assessment Type	Written Examination	**% of Total Mark for Module**	70
Indicative Week	Week 15	**Learning Outcomes**	1,2,3,4,5,6,7,8,9,10
Assessment Threshold:	35	**Assessment Role**	Not yet determined
Assessment Authenticity	Not Online	**Pass/Fail**	No

Assessment Description
n/a

Other Assessment(s)

Assessment Type	In Class Test	**% of Total Mark for Module**	30
Indicative Week	Week 7	**Learning Outcomes**	1,2,3,4,5
Assessment Threshold:	None	**Assessment Role**	Not yet determined
Assessment Authenticity	Not Online	**Pass/Fail**	No

Assessment Description
n/a

Module Activity

Full Time hours per semester	
Activity Type	*Duration (Hours)*
Lecture	52
Self Directed	48
Hours (up to 100 for 5 ECTS credits)	100.00

Module MATH 2810 - Geometry v1 (Year/Cycle:2 / Semester:Semester 1 / Delivery Type:Mandatory)

OLLSCOIL TEICNEOLAÍOCHTA BHAILE ÁTHA CLIATH
DUBLIN
TECHNOLOGICAL UNIVERSITY DUBLIN

APPROVED

MATH 2810: Geometry

Module Details

Module Code:	MATH 2810
Module Long Title:	Geometry APPROVED
Banner Title:	Geometry
Version:	1
Indicative NFQ level:	Level 8
Valid From:	Sept 2019 (September 2019)
Language of Instruction:	English
ECTS Credits::	5
ISCED Code:	0541 - Mathematics
Current Coordinator::	MILENA VENKOVA-MCGARRAGHY
Module Coordinators:	MILENA VENKOVA-MCGARRAGHY (19 June 2019 to ---)
School Responsible:	School of Mathematical Sciences (CC)
Campus:	City Campus
Module Overview	This module develops a deep understanding of Euclidean Geometry and introduces the student to non-Euclidean Geometry.
Indicative Syllabus	**Geometry and the Euclidean Plane:** The axiomatic approach to geometry, angle, transformations of the plane, congruent triangles, the axiom of parallels, quadrilaterals and parallelograms, similar triangles, area, Ceva's Theorem, circles, Ptolemy's Theorem.. Parametrization and length of a curve. **Non-Euclidean Geometry:** Examples of geometries in which the axiom of parallels is false, geodesic paths, the punctured plane. **Spherical Geometry:** Geodesics and distance on the sphere, converting from spherical to rectangular coordinates, spherical distance, spherical trigonometry, spherical version of Pythagoras' Theorem, angles and area in spherical geometry
Learning and Teaching Methods	Lectures supported by tutorials

Module MATH 2810 - Geometry v1 (Year/Cycle:2 / Semester:Semester 1 / Delivery Type:Mandatory)

Learning Outcomes	
Upon successful completion of this module the learner will be able to	
#	
MLO1	State and prove a variety of results in Euclidean Geometry
MLO2	Solve problems based on the geometry of the Euclidean plane
MLO3	Demonstrate an understanding of the relationship between area and Ceva's Theorem
MLO4	State and prove a variety of results in non-Euclidean Geometry
MLO5	Prove some basic results of Spherical Geometry

Requisites	

Assessment Threshold	Formal examination 35%

Module Content & Assessment

Assessment Breakdown	%
Formal Examination	70.00%
Other Assessment(s)	30.00%

Assessments

Formal Examination

Assessment Type	Written Examination	**% of Total Mark for Module**	70
Indicative Week	See Student Handbook	**Learning Outcomes**	1,2,3,4,5
Assessment Threshold:	35	**Assessment Role**	Individual
Assessment Authenticity	Not Online	**Pass/Fail**	No

Assessment Description
n/a

Other Assessment(s)

Assessment Type	In Class Test	**% of Total Mark for Module**	30
Indicative Week	Week 8	**Learning Outcomes**	1,2,3
Assessment Threshold:	None	**Assessment Role**	Individual
Assessment Authenticity	Not Online	**Pass/Fail**	No

Assessment Description
n/a

Module Activity

Full Time hours per semester	
Activity Type	*Duration (Hours)*
Lecture	39
Self Directed	61
Hours (up to 100 for 5 ECTS credits)	100.00

Recommended Reading List

Recommended Book Resources

Roger Fenn. (2007), Geometry, Springer Science & Business Media, p.313, [ISBN: 978-1-85233-058-3].

Supplementary Book Resources

Gareth Williams. (2017), Linear Algebra with Applications, Jones & Bartlett Learning, p.594, [ISBN: 9781284120097].

Patrick D Barry. (2015), Geometry with Trigonometry, Woodhead Publishing, p.280, [ISBN: 9780128050675].

Module MATH 2802 - Linear Algebra II v1 (Year/Cycle:2 / Semester:Semester 1 / Delivery Type:Mandatory)

APPROVED

MATH 2802: Linear Algebra II

Module Details

Module Code:	MATH 2802
Module Long Title:	Linear Algebra II APPROVED
Banner Title:	Linear Algebra
Version:	1
Indicative NFQ level:	Level 7
Valid From:	Sept 2018 (September 2018)
Language of Instruction:	English
ECTS Credits::	5
ISCED Code:	0541 - Mathematics
Current Coordinator::	FIONA MURRAY
Module Coordinators:	• SUSAN LAZARUS (10 April 2019 to 10 July 2023) • FIONA MURRAY (10 July 2023 to ---)
School Responsible:	School of Mathematics & Statistics
Campus:	City Campus
Module Overview	This module builds on the material covered in the MATH1804. It introduces the student to the concepts of vector spaces; and eigenvalues and eigenvectors.
Indicative Syllabus	**Vector Spaces** Introduction and definition of vector spaces. Examples of vector spaces. Euclidean *n* -space. Subspaces. Linear combinations of vectors. Spanning and linearly independent sets. Bases. Dimension of a vector space. Row and column space of a matrix. Rank of a matrix. Complex vector spaces. **Inner Products** Inner product spaces. Orthogonality. Change of basis. Orthogonal matrices. Least squares problems. **Linear Transformations** Linear transformations and their matrices. Kernel and range. Similarity. **Eigenvalues and Eigenvectors** Eigenvalues and eigenvectors. Eigenspace of a matrix. Diagonalization of a matrix. Complex eigenvalues. Applications to systems of differential equations.

Learning and Teaching Methods	Lectures supported by tutorials

Module MATH 2802 - Linear Algebra II v1 (Year/Cycle:2 / Semester:Semester 1 / Delivery Type:Mandatory)

Learning Outcomes	
Upon successful completion of this module the learner will be able to	
#	
MLO1	Demonstrate an understanding of the basic concepts of vector spaces
MLO2	appreciate the importance of vector spaces in various areas of mathematics
MLO3	be familiar with the definition and uses of eigenvalues and eigenvectors.

Requisites

Assessment Threshold	35% on Final Exam

Module Content & Assessment

Assessment Breakdown	%
Formal Examination	70.00%
Other Assessment(s)	30.00%

Assessments

Formal Examination			
Assessment Type	Written Examination	**% of Total Mark for Module**	70
Indicative Week	Week 14	**Learning Outcomes**	1,2,3
Assessment Threshold:	35	**Assessment Role**	Individual
Assessment Authenticity	Not Online	**Pass/Fail**	No
Assessment Description n/a			

Other Assessment(s)			
Assessment Type	In Class Test	**% of Total Mark for Module**	30
Indicative Week	Week 7	**Learning Outcomes**	1,2
Assessment Threshold:	None	**Assessment Role**	Individual
Assessment Authenticity	Not Online	**Pass/Fail**	No
Assessment Description n/a			

Module Activity

Full Time hours per semester	
Activity Type	*Duration (Hours)*
Lecture	39
Self Directed	61
Hours (up to 100 for 5 ECTS credits)	100.00

Module MATH 2809 - Mathematical Modelling II v2 (Year/Cycle:2 / Semester:Semester 1 & 2 / Delivery Type:Mandatory)

OLLSCOIL TEICNEOLAÍOCHTA BHAILE ÁTHA CLIATH
DUBLIN
TECHNOLOGICAL UNIVERSITY DUBLIN

APPROVED

MATH 2809: Mathematical Modelling II

Module Details

Module Code:	MATH 2809
Module Long Title:	Mathematical Modelling II APPROVED
Banner Title:	Mathematical Modelling
Version:	2
Valid From:	Sept 2023 (September 2023)
Language of Instruction:	English
ECTS Credits::	5
ISCED Code:	0541 - Mathematics
Current Coordinator::	DANA MACKEY
Module Coordinators:	DANA MACKEY (04 September 2023 to ---)
School Responsible:	School of Mathematics & Statistics
Campus:	City Campus
Module Overview	This module expands the use of modelling and simulation techniques learned in the previous modelling module to more complex problems. The projects undertaken in this module rely on more advanced mathematical topics and computational techniques and will incorporate a programming element.
Indicative Syllabus	This module is structured around a number of modelling projects (to include assessments and practice projects). Examples of mathematical topics involved are: fitting models to data, continuous models described by differential equations, compartmental models described by systems of differential equations, basic dynamical systems theory, etc. The models studied are inspired by practical problems in areas such as Physics, Biology, Finance, Environmental Science, and many others.
Learning and Teaching Methods	Discussion-based lectures, team work (under the lecturer's guidance) and computer laboratory sessions. The class is divided into groups, who are responsible for the preparation, submission and presentation of the projects. Each member of the group must present one of the projects.

Module MATH 2809 - Mathematical Modelling II v2 (Year/Cycle:2 / Semester:Semester 1 & 2 / Delivery Type:Mandatory)

Learning Outcomes	
Upon successful completion of this module the learner will be able to	
#	
MLO1	Apply and combine skills and techniques from various mathematical areas towards the solution of one problem.
MLO2	Fit nonlinear models (such as exponential, logistic, etc) to discrete sets of data
MLO3	Construct and analyse differential equations models to describe evolution of simple physical systems
MLO4	Use more advanced computational aids (such as Maple, R, Python) for analysing models
MLO5	Communicate results efficiently in the form of scientific graphs and visualisations
MLO6	Improve skills related to teamwork, collaboration, scientific report writing and presentation.

Requisites

Assessment Threshold	35% on each individual project and the presentation mark

Module Content & Assessment

Assessment Breakdown	%
Other Assessment(s)	100.00%

Assessments

Other Assessment(s)

Assessment Type	Project	**% of Total Mark for Module**	100
Indicative Week	See Student Handbook	**Learning Outcomes**	1,2,3,4,5,6
Assessment Threshold:	None	**Assessment Role**	Individual
Assessment Authenticity	Not Online	**Pass/Fail**	No

Assessment Description
1. Written reports on each of the (typically 3-4) modelling projects submitted as a team (80% of the final mark); 2. Oral presentation of each project by one member of the team (20% of the mark)

Module Activity

Full Time hours per semester	
Activity Type	*Duration (Hours)*
Lecture	52
Self Directed	48
Hours (up to 100 for 5 ECTS credits)	100.00

Recommended Reading List

Supplementary Book Resources

F.R. Giordano, W.P. Fox, S.B. Horton & M.D. Weir. (2008), A first course in Mathematical Modelling, Cengage Learning.

B. Barnes, G..R. Fulford. (2014), Mathematical Modelling with Case Studies: Using Maple and MATLAB, Chapman and Hall/CRC.

Module MATH 2813 - Practical Computing for Mathematics v1 (Year/Cycle:2 / Semester:Semester 1 / Delivery Type: Mandatory)

OLLSCOIL TEICNEOLAÍOCHTA BHAILE ÁTHA CLIATH
DUBLIN
TECHNOLOGICAL UNIVERSITY DUBLIN

APPROVED

MATH 2813: Practical Computing for Mathematics

Module Details

Module Code:	MATH 2813
Module Long Title:	Practical Computing for Mathematics APPROVED
Banner Title:	Practical Computing
Version:	1
Indicative NFQ level:	Level 6
Valid From:	Sept 2018 (September 2018)
Language of Instruction:	English
ECTS Credits::	5
ISCED Code:	0541 - Mathematics
Current Coordinator::	PAUL MOLLOY
Module Coordinators:	PAUL MOLLOY (04 April 2019 to ---)
School Responsible:	School of Mathematical Sciences (CC)
Campus:	City Campus
Module Overview	A continuation of the skills learned in stage one of the Programme with emphasis on Advanced features of Excel. It will also introduce the student to the Linux environment with a look at Shell scripting and use of Python through Linux
Indicative Syllabus	**Linux Environment:** Introduction to the Linux directory structure Use of basic commands in Linux such as ls, cd, pwd, mv Introduction to a Linux editor such as gedit or nano Write basic shell scripts Using Python within a Linux environment **Excel Advanced:** Pivot tables Pivot reporting MOD function

	Advanced formulae such as SumIf, Count, vLookup Use of statistical functions Other advanced functions e.g. pattern matching, index and match **LaTex :** Revisit Latex and use it to write up a project
Learning and Teaching Methods	The material will all be laboratory based with plenty of practice in each discipline.

Learning Outcomes	
Upon successful completion of this module the learner will be able to	
#	
MLO1	Access the Linux server and understand and be able to navigate the directory structure
MLO2	Use and Editor to write shell scripts
MLO3	Change file permissions and execute scripts
MLO4	Write and execute Python scripts within a linux environment
MLO5	Use Excel to produce Pivot tables and reports
MLO6	Use advanced Mathematical and Statistical functions within Excel
MLO7	Use other advanced features of Excel
MLO8	Use LaTeX to produce comprehensive Mathematical reports and project

Requisites

Module Content & Assessment

Assessment Breakdown	%
Other Assessment(s)	100.00%

Assessments

Other Assessment(s)

Assessment Type	Practical/Skills Evaluation	**% of Total Mark for Module**	100
Indicative Week	See Student Handbook	**Learning Outcomes**	1,2,3,4,5,6,7,8
Assessment Threshold:	None	**Assessment Role**	Individual
Assessment Authenticity	Not Online	**Pass/Fail**	No

Assessment Description
n/a

Module Activity

Full Time hours per semester	
Activity Type	*Duration (Hours)*
Lecture	39
Self Directed	61
Hours (up to 100 for 5 ECTS credits)	100.00

Module PROF 2801 - Professional Development II v1 (Year/Cycle:2 / Semester:Semester 1 & 2 / Delivery Type: Mandatory)

APPROVED

PROF 2801: Professional Development II

Module Details

Module Code:	PROF 2801
Module Long Title:	Professional Development II APPROVED
Banner Title:	Professional Develop
Version:	1
Indicative NFQ level:	Level 7
Valid From:	Sept 2018 (September 2018)
Language of Instruction:	English
ECTS Credits::	5
ISCED Code:	0541 - Mathematics
Current Coordinator::	MAEV P MAGUIRE
Module Coordinators:	MAEV P MAGUIRE (03 October 2019 to ---)
School Responsible:	School of Mathematical Sciences (CC)
Campus:	City Campus
Module Overview	This module and the prior Stage 1 module develop the skills and attributes required by students and graduates in mathematical sciences to enhance their employability and develop their research skills and ability to work in a professional, technical environment. This module focusses on research skills, specifically those required by mathematicians in academic writing, and employability skills required for entering the workplace. The module also gives practical experience of interview skills and writing curricula vitae showcasing the skills developed through the programme.
Indicative Syllabus	**Employability** Critically evaluating personal skillsets. Addressing deficiencies. Writing and maintaining curriculum vitae, cover letters and letters of introduction. Proof reading. Highlighting specialist mathematical skillsets, knowledge and prior learning. Researching the employment sector and employers. Interview skills. Preparing for interview: knowing the context of the interviewer, addressing the questions and highlighting your strengths and skills. Emphasising your mathematics degree and specialist skillsets. Attitude, appearance and conduct. **Research skills** Finding information: use of libraries, databases, indexes and online sources. Critical evaluation of sources. Accessing publications. Note taking: accurate note taking and its importance. Referencing: purpose of referencing, referencing systems, the referencing system in the School. Interpreting, summarising and quoting sources. Recognising and avoiding plagiarism. Style guides. Reviewing publications, critiquing and evaluating information. Writing synopses. Writing a proposal: abstract, aims, methodologies, timelines, resources, outcomes and impact.

	Writing dissertations and undertaking projects The academic writing style. Planning and structuring the dissertation. Problem solving: defining the problem, solution strategies, reviewing progress, evaluating success. Time management. Writing abstracts and synopses for the layman. Drawing conclusions. **Practical interview and presentation experience**
Learning and Teaching Methods	The module will be delivered by a combination of lectures, interactive group work, student presentations and formal and informal feedback. It will make use of computing, online, library and other learning resources.

Module PROF 2801 - Professional Development II v1 (Year/Cycle:2 / Semester:Semester 1 & 2 / Delivery Type:Mandatory)

Learning Outcomes	
Upon successful completion of this module the learner will be able to	
#	
MLO1	Communicate professionally with businesses and employers and develop and maintain a strong and appropriate CV highlighting their skills and strengths.
MLO2	Prepare for an interview and present themselves professionally and successfully to external audience.
MLO3	Find information, critically evaluate sources and topics
MLO4	Review and summarise information.
MLO5	Plan a substantial written project or dissertation.
MLO6	Write a formal academic report or dissertation in an academic style.

Requisites

Assessment Threshold	Each Task component will have a threshold of 40%

Module Content & Assessment

Assessment Breakdown	%
Other Assessment(s)	100.00%

Assessments

Other Assessment(s)

Assessment Type	In Class Test	**% of Total Mark for Module**	100
Indicative Week	See Student Handbook	**Learning Outcomes**	1,2,3,4,5,6
Assessment Threshold:	None	**Assessment Role**	Not yet determined
Assessment Authenticity	Not Online	**Pass/Fail**	No

Assessment Description
n/a

Module Activity

Full Time hours per semester	
Activity Type	*Duration (Hours)*
Lecture	52
Self Directed	48
Hours (up to 100 for 5 ECTS credits)	100.00

Module MATH 2805 - Statistics II v1 (Year/Cycle:2 / Semester:Semester 1 / Delivery Type:Mandatory)

APPROVED

MATH 2805: Statistics II

Module Details

Module Code:	MATH 2805
Module Long Title:	Statistics II APPROVED
Banner Title:	Statistics II
Version:	1
Indicative NFQ level:	Level 6
Valid From:	Sept 2018 (September 2018)
Language of Instruction:	English
ECTS Credits::	5
ISCED Code:	0541 - Mathematics
Current Coordinator::	JOE CONDON
Module Coordinators:	JOE CONDON (04 April 2019 to ---)
School Responsible:	School of Mathematical Sciences (CC)
Campus:	City Campus
Module Overview	This module builds on the material covered in MATH 1805 to include jointly distributed random variables, moments of random variables and moment generating functions and introduces the mathematics of statistical sampling theory and inference.
Indicative Syllabus	Generating functions: Properties of expectation and variance. Moments of the standard discrete and continuous probability distributions. Moment generating functions; properties and uses. Jointly Distributed Random Variables: Jointly distributed discrete and continuous random variables. The expected value of functions of two or more random variables. Independence. Covariance and correlation. Statistical Inference: The Central Limit Theorem. Estimation: Confidence intervals and their interpretation based on the Central Limit Theorem, small sample intervals (chi-squared & t-distributions). Hypothesis Testing: Null and alternative hypotheses. P-values and their use. Types I and II errors. Z, chi-squared and t tests for single sample and two sample data. Chi-squared tests for contingency tables.
Learning and Teaching Methods	Lectures supported by tutorials and computer laboratory sessions.

Module MATH 2805 - Statistics II v1 (Year/Cycle:2 / Semester:Semester 1 / Delivery Type:Mandatory)

Learning Outcomes	
Upon successful completion of this module the learner will be able to	
#	
MLO1	Define and find the expectation and variance of simple and standard discrete/continuous random variables and linear transformations of random variables. Be able to find moment generating functions of random variables, understand the properties of MGFs and find moments using MGFs.
MLO2	Understand jointly distributed random variables (mass and density functions), covariance and correlation.
MLO3	Construct and interpret confidence intervals for both large and small samples for population means, proportions and variances.
MLO4	Perform commonly used tests of hypothesis for large and small samples (e.g. Z, chi-squared and T tests)
MLO5	Use a major statistical software package for data analysis (R or equivalent), applying techniques covered in the module.

Requisites	
Assessment Threshold	End of semester exam 35%

Module Content & Assessment

Assessment Breakdown	%
Formal Examination	70.00%
Other Assessment(s)	30.00%

Assessments

Formal Examination

Assessment Type	Written Examination	**% of Total Mark for Module**	70
Indicative Week	Week 15	**Learning Outcomes**	1,2,3,4
Assessment Threshold:	35	**Assessment Role**	Not yet determined
Assessment Authenticity	Not Online	**Pass/Fail**	No

Assessment Description
n/a

Other Assessment(s)

Assessment Type	In Class Test	**% of Total Mark for Module**	30
Indicative Week	Week 7	**Learning Outcomes**	1,2,5
Assessment Threshold:	None	**Assessment Role**	Not yet determined
Assessment Authenticity	Not Online	**Pass/Fail**	No

Assessment Description
n/a

Module Activity

Full Time hours per semester	
Activity Type	*Duration (Hours)*
Lecture	39
Self Directed	61
Hours (up to 100 for 5 ECTS credits)	100.00

Module MATH 2811 - Discrete Mathematics II v2 (Year/Cycle:2 / Semester:Semester 2 / Delivery Type:Mandatory)

APPROVED

MATH 2811: Discrete Mathematics II

Module Details

Module Code:	MATH 2811
Module Long Title:	Discrete Mathematics II APPROVED
Banner Title:	Discrete Mathematics II
Version:	2
Indicative NFQ level:	Level 6
Valid From:	Sept 2023 (September 2023)
Language of Instruction:	English
ECTS Credits::	5
ISCED Code:	0541 - Mathematics
Current Coordinator::	FIONA MURRAY
Module Coordinators:	FIONA MURRAY (27 July 2023 to ---)
School Responsible:	School of Mathematics & Statistics
Campus:	City Campus
Module Overview	This module builds on and expands the material covered in the previous Discrete Mathematics 1 module. It introduces the student to mathematical logic, topics in number theory and graph theory.
Indicative Syllabus	**Logic** Propositional logic, truth tables, implication, logical equivalence, Predicate logic, Syntax, Semantics, translations, proof techniques. **Number Theory** Integers, Induction and Recursion, divisibility, prime numbers, Euclidean Algorithm, equivalence relations, the integers modulo *n* , applications to Coding Theory and Cryptology. **Graph Theory** Definitions, applications and uses in computing, isomorphic graphs, planar graphs, computer representation of graphs, Euler paths and Hamiltonian cycles, trees, tree traversal algorithms, decision trees.
Learning and Teaching Methods	2 hours of lectures and 1 hour tutorial session per week. The lectures will provide theoretical material which will be underpinned by many examples to demonstrate the use of this material. The tutorial sessions will provide students with supervised practice time using appropriate exercises.

Module MATH 2811 - Discrete Mathematics II v2 (Year/Cycle:2 / Semester:Semester 2 / Delivery Type:Mandatory)

Learning Outcomes	
Upon successful completion of this module the learner will be able to	
#	
MLO1	Create truth tables to test for logical equivalence
MLO2	Translate between logically quantified statements and English language
MLO3	Use different types of proof techniques for propositional and predicate logic
MLO4	Prove mathematical statements using the Principle of Mathematical Induction
MLO5	Solve first order linear recurrence relations
MLO6	Use modular arithmetic and understand some of its applications in Coding Theory and Cryptology
MLO7	Determine whether or not two graphs are isomorphic
MLO8	Determine whether or not a graph contains an Euler Path
MLO9	Determine whether or not a graph is planar

Requisites

Assessment Threshold	35% on Invigilated Examination

Module Content & Assessment

Assessment Breakdown	%
Formal Examination	70.00%
Other Assessment(s)	30.00%

Assessments

Formal Examination

Assessment Type	Written Examination	**% of Total Mark for Module**	70
Indicative Week	Week 14	**Learning Outcomes**	1,2,3,4,5,6,7,8,9
Assessment Threshold:	35	**Assessment Role**	Individual
Assessment Authenticity	Not Online	**Pass/Fail**	No

Assessment Description
n/a

Other Assessment(s)

Assessment Type	In Class Test	**% of Total Mark for Module**	30
Indicative Week	Week 7	**Learning Outcomes**	1,2,3,4
Assessment Threshold:	None	**Assessment Role**	Individual
Assessment Authenticity	Not Online	**Pass/Fail**	No

Assessment Description
n/a

Module Activity

Full Time hours per semester	
Activity Type	*Duration (Hours)*
Lecture	39
Self Directed	61
Hours (up to 100 for 5 ECTS credits)	100.00

Recommended Reading List

Recommended Book Resources

Judith Gersting. (2014), Mathematical Structures for Computer Science, WH Freeman, [ISBN: 9781429215107].

Supplementary Book Resources

Rowan Garnier,John Taylor. (2009), Discrete Mathematics, CRC Press, [ISBN: 9781439812808].

Module MATH 2816 - Introduction to Analysis v1 (Year/Cycle:2 / Semester:Semester 2 / Delivery Type:Mandatory)

OLLSCOIL TEICNEOLAÍOCHTA BHAILE ÁTHA CLIATH
DUBLIN
TECHNOLOGICAL UNIVERSITY DUBLIN

APPROVED

MATH 2816: Introduction to Analysis

Module Details

Module Code:	MATH 2816
Module Long Title:	Introduction to Analysis APPROVED
Banner Title:	Introduction to Analysis
Version:	1
Indicative NFQ level:	Level 7
Valid From:	Jan 2019 (January 2019)
Language of Instruction:	English
ECTS Credits::	5
ISCED Code:	0541 - Mathematics
Current Coordinator::	CORMAC BREEN
Module Coordinators:	CORMAC BREEN (17 May 2019 to ---)
School Responsible:	School of Mathematical Sciences (CC)
Campus:	City Campus
Module Overview	This module develops the learner's knowledge of elementary analysis in a rigorous manner and provides a solid foundation in topics in pure mathematics relating to calculus. Sequences and series are analysed. Limits of functions, continuity and properties of continuous functions are investigated. The theory of differentiable functions, Rolle's theorem, Taylor's theorem and L'Hopital's rule are studied. The learner is also introduced to the analysis of integration and the Riemann integral.
Indicative Syllabus	**Sequences and series** Introduction to sequences, bounds and convergence. Properties of convergent sequences. Cauchy Sequences. Series. Standard limits, subsequences and convergence theorems. Tests for convergence. **Functions** Polynomial and rational functions. Limits of functions and continuity. Properties of continuous functions and the intermediate value theorem. **Calculus** Derivatives and differentiability. Properties of derivatives. Rolle's theorem, the mean value theorem. Inverse functions. L'hôpital's rule. Higher derivatives. Taylor's theorem and Maclaurin and Taylor series. Approximation. The Riemann integral.
Learning and Teaching Methods	Lectures are primarily used to impart module content to the learner. Problem-solving sessions and tutorials support the learner and are designed to encourage learners to work both individually and in groups.

Module MATH 2816 - Introduction to Analysis v1 (Year/Cycle:2 / Semester:Semester 2 / Delivery Type:Mandatory)

Learning Outcomes	
Upon successful completion of this module the learner will be able to	
#	
MLO1	Demonstrate an understanding of the theoretical basis of elementary calculus.
MLO2	Rigorously prove results that arise in the context of real analysis.
MLO3	Evaluate standard limits of sequences.
MLO4	Determine whether or not real series are convergent.
MLO5	Demonstrate an understanding of functions, limits and continuity.
MLO6	Analyse limits and continuity of sums, products, compositions of functions as well as polynomial and rational functions.
MLO7	Prove Rolle's theorem and the mean value theorem and use some applications of these.

Requisites	

Assessment Threshold	35% on end of module examination

Module Content & Assessment

Assessment Breakdown	%
Formal Examination	70.00%
Other Assessment(s)	30.00%

Assessments

Formal Examination

Assessment Type	Written Examination	**% of Total Mark for Module**	70
Indicative Week	Week 14	**Learning Outcomes**	1,2,3,4,5,6,7
Assessment Threshold:	35	**Assessment Role**	Not yet determined
Assessment Authenticity	Not Online	**Pass/Fail**	No

Assessment Description
n/a

Other Assessment(s)

Assessment Type	In Class Test	**% of Total Mark for Module**	30
Indicative Week	See Student Handbook	**Learning Outcomes**	1,2,3,4
Assessment Threshold:	None	**Assessment Role**	Not yet determined
Assessment Authenticity	Not Online	**Pass/Fail**	No

Assessment Description
n/a

Module Activity

Full Time hours per semester	
Activity Type	*Duration (Hours)*
Lecture	39
Self Directed	61
Hours (up to 100 for 5 ECTS credits)	100.00

APPROVED

MATH 2812: Introduction to Ordinary Differential Equations through Python

Module Details

Module Code:	MATH 2812
Module Long Title:	Introduction to Ordinary Differential Equations through Python APPROVED
Banner Title:	Intro Ord Diff Equat Sc Python
Version:	2
Indicative NFQ level:	Level 7
Valid From:	Sept 2023 (September 2023)
Language of Instruction:	English
ECTS Credits::	5
ISCED Code:	0541 - Mathematics
Current Coordinator::	FIONA MURRAY
Module Coordinators:	FIONA MURRAY (27 July 2023 to ---)
School Responsible:	School of Mathematics & Statistics
Campus:	City Campus
Module Overview	This module introduces the learner to ordinary differential equations in problems from mathematical physics through scientific Python. The module will build on the learner's prior knowledge of Python to develop a phenomenelogical perspective of mathematical models described by ordinary differential equations. No prior knowledge of ODEs is required. This module lays the foundation for advanced scientific programming in Python for models described by systems of PDEs.
Learning and Teaching Methods	The module will be delivered through a combination of lectures and tutorials. Learning will be supported through provided sample programs and laboratory sessions.

Indicative Syllabus
1. Review of Python programming 1.1) Variables, strings, lists, tuples, loops, functions, modules, errors and exceptions.
2. Effective scientific program design 2.1) Sample input and output, user interface, pseudo-code, assessing available modules.
3. Introduction to object-orentied programming and classes 3.1) n/a
4. NumPy library 4.1) Array handing, meshes.
5. SciPy library 5.1) Scientific constants, functions, integration.
6. Verification of codes

6.1) Use of Matplotlib to present visualization of solution.
7. Solving first- and second-order linear equations 7.1) Eg. reaction equations, equations of motion, electrical circuits; plotting results.
8. Nonlinear systems and phenomena and stability 8.1) Eg. predator-prey models, nonlinear mechanical models, dynamical systems and chaos.

Learning Outcomes	
Upon successful completion of this module the learner will be able to	
#	
MLO1	Describe and implement the NumPy, SciPy and Matplotlib libraries
MLO2	Discuss the properties of mathematical models described by ODEs: linearity, order, dimension, boundary/initial conditions, existence/uniqueness
MLO3	Effectively use object-oriented programming techniques in scientific programming and demonstrate an understanding of classes in Python programming
MLO4	Design an appropriate program and user interface
MLO5	Verify and visualise solutions to selected problems from the mathematical sciences using Python code
MLO6	Use debugging techniques effectively.

Requisites

Assessment Threshold	Continuous assessment: 35%; Examination: 35%.

Module Content & Assessment

Assessment Breakdown	%
Formal Examination	30.00%
Other Assessment(s)	70.00%

Assessments

Formal Examination

Assessment Type	Written Examination	**% of Total Mark for Module**	30
Indicative Week	Week 15	**Learning Outcomes**	1,2,3,4,5
Assessment Threshold:	35	**Assessment Role**	Individual
Assessment Authenticity	Not Online	**Pass/Fail**	No

Assessment Description
End of semester examination.

Other Assessment(s)

Assessment Type	In Class Test	**% of Total Mark for Module**	70
Indicative Week	See Student Handbook	**Learning Outcomes**	1,3,4,5,6
Assessment Threshold:	35	**Assessment Role**	Individual
Assessment Authenticity	Not Online	**Pass/Fail**	No

Assessment Description
N/A

Module Activity

Full Time hours per semester	
Activity Type	*Duration (Hours)*
Lecture	39
Self Directed	61
Hours (up to 100 for 5 ECTS credits)	100.00

Recommended Reading List

Recommended Book Resources

Christian Hill. (2016), Learning Scientific Programming with Python, Cambridge University Press, p.457, [ISBN: 9781107428225].

Supplementary Book Resources

C. Henry Edwards,David E. Penney,David Calvis. (2014), Differential Equations and Boundary Value Problems, Pearson College Division, p.780, [ISBN: 978-0321796981].

Claus Fuhrer,Jan Erik Solem,Olivier Verdier. Scientific Computing with Python 3 - Second Edition, [ISBN: 978-1786463517].

Module MATH 2806 - Numerical Methods v1 (Year/Cycle:2 / Semester:Semester 2 / Delivery Type:Mandatory)

OLLSCOIL TEICNEOLAÍOCHTA BHAILE ÁTHA CLIATH
DUBLIN
TECHNOLOGICAL UNIVERSITY DUBLIN

APPROVED

MATH 2806: Numerical Methods

Module Details

Module Code:	MATH 2806
Module Long Title:	Numerical Methods APPROVED
Banner Title:	Numerical Methods
Version:	1
Valid From:	Jan 2019 (January 2019)
Language of Instruction:	English
ECTS Credits::	5
ISCED Code:	0541 - Mathematics
Current Coordinator::	SARAH MORRIS
Module Coordinators:	SARAH MORRIS (13 June 2019 to ---)
School Responsible:	School of Mathematical Sciences (CC)
Campus:	City Campus
Module Overview	This module introduces the learner to the concept of numerical methods. It covers some of the techniques used to solve problems that cannot be solved analytically
Indicative Syllabus	Mathematical Preliminaries Types of computational error, algorithms and convergence, Taylor series Solution of equations in one variable Bracketing methods, fixed point iteration, the Newton-Raphson method, error analysis of iterative methods. Interpolation Linear interpolation, the Lagrange interpolating polynomial, Divided difference methods, Hermite interpolation, spline interpolation. Error formulae. Solving Systems of Linear Equations LU decomposition, the Cholesky method, Jacobi iteration, Gauss-Seidel method, relaxation methods, error estimates and iterative refinement.
Learning and Teaching Methods	Lectures supported by tutorials

Module MATH 2806 - Numerical Methods v1 (Year/Cycle:2 / Semester:Semester 2 / Delivery Type:Mandatory)

Learning Outcomes	
Upon successful completion of this module the learner will be able to	
#	
MLO1	Recognize the types of problems that require numerical techniques for their solution
MLO2	Demonstrate understanding of the computation of error analysis and convergence
MLO3	Apply root finding methods
MLO4	Demonstrate understanding of principles of interpolation
MLO5	Apply numerical methods for solving systems of simultaneous equations

Requisites

Module Content & Assessment

Assessment Breakdown	%
Formal Examination	70.00%
Other Assessment(s)	30.00%

Assessments

Formal Examination

Assessment Type	Written Examination	**% of Total Mark for Module**	70
Indicative Week	Week 14	**Learning Outcomes**	1,2,3,4,5
Assessment Threshold:	35	**Assessment Role**	Not yet determined
Assessment Authenticity	Not Online	**Pass/Fail**	No

Assessment Description
n/a

Other Assessment(s)

Assessment Type	In Class Test	**% of Total Mark for Module**	30
Indicative Week	Week 8	**Learning Outcomes**	1
Assessment Threshold:	None	**Assessment Role**	Not yet determined
Assessment Authenticity	Not Online	**Pass/Fail**	No

Assessment Description
n/a

Module Activity

Full Time hours per semester	
Activity Type	*Duration (Hours)*
Lecture	24
Tutorial	12
Self Directed	64
Hours (up to 100 for 5 ECTS credits)	100.00

Module MATH 2804 - Operations Research v1 (Year/Cycle:2 / Semester:Semester 2 / Delivery Type:Mandatory)

APPROVED

MATH 2804: Operations Research

Module Details

Module Code:	MATH 2804
Module Long Title:	Operations Research APPROVED
Banner Title:	Operations Research
Version:	1
Indicative NFQ level:	Level 7
Valid From:	Jan 2019 (January 2019)
Language of Instruction:	English
ECTS Credits::	5
ISCED Code:	0541 - Mathematics
Current Coordinator::	MAEV P MAGUIRE
Module Coordinators:	MAEV P MAGUIRE (03 October 2019 to ---)
School Responsible:	School of Mathematical Sciences (CC)
Campus:	City Campus
Module Overview	This module introduces the learner to the area of Operations Research. It covers the basics of Stochastic Processes, Queuing Theory, Linear Programming, Transportation and Network Analysis. It emphasises the problem solving and application aspects of the subject.
Indicative Syllabus	Stochastic Processes Introduction to Markov Chains. Transition Matrices. Limiting State Probabilities. Applications. Queuing Theory Introduction to queuing theory and its notation. Simple M/M/1 queueing model. Calculation of idle times, busy times, L, L_q, W and W_q for this model. Linear Programming Introduction to and examples of linear programmes. Graphical representation. Use of simplex method to solve simple problems. Transportation Formulation of simple transportation models. Sources, destinations, costs. Formulation of problems as linear programming models. Northwest corner method for initial basic feasible solution. Network Analysis

	Introduction to Networks. Minimal Spanning Tree Method.
Learning and Teaching Methods	Lectures supported by problem-solving sessions and the use of mathematical software packages.

Module MATH 2804 - Operations Research v1 (Year/Cycle:2 / Semester:Semester 2 / Delivery Type:Mandatory)

Learning Outcomes	
Upon successful completion of this module the learner will be able to	
#	
MLO1	Apply Markov Chains to simple applications
MLO2	Evaluate quantities of interest for a single server queuing model
MLO3	Formulate simple problems in linear programming
MLO4	Understand and be able to formulate and solve simple transportation problems and find an initial basic feasible solution.
MLO5	Understand the basics of network analysis
MLO6	Use computer software to solve operations research problems.

Requisites

Assessment Threshold	Examination: 35%

Module Content & Assessment

Assessment Breakdown	%
Formal Examination	70.00%
Other Assessment(s)	30.00%

Assessments

Formal Examination

Assessment Type	Written Examination	**% of Total Mark for Module**	70
Indicative Week	Week 14	**Learning Outcomes**	1,2,3,4,5,6
Assessment Threshold:	None	**Assessment Role**	Not yet determined
Assessment Authenticity	Not Online	**Pass/Fail**	No

Assessment Description
n/a

Other Assessment(s)

Assessment Type	In Class Test	**% of Total Mark for Module**	30
Indicative Week	Week 7	**Learning Outcomes**	1,2,3
Assessment Threshold:	None	**Assessment Role**	Not yet determined
Assessment Authenticity	Not Online	**Pass/Fail**	No

Assessment Description
n/a

Module Activity

Full Time hours per semester	
Activity Type	*Duration (Hours)*
Lecture	39
Self Directed	61
Hours (up to 100 for 5 ECTS credits)	100.00