Module MATH 3811 - Mathematics Practical v1 (Year/Cycle:3 / Semester:Semester 1 / Delivery Type:Mandatory)

OLLSCOIL TEICNEOLAÍOCHTA BHAILE ÁTHA CLIATH
DUBLIN
TECHNOLOGICAL UNIVERSITY DUBLIN

QUALITY OFFICE

MATH 3811: Mathematics Practical

Module Details

Module Code:	MATH 3811
Module Long Title:	Mathematics Practical QUALITY OFFICE
Banner Title:	Mathematics Practical
Version:	1
Indicative NFQ level:	Level 7
Valid From:	Sept 2019 (September 2019)
Language of Instruction:	English
ECTS Credits::	5
ISCED Code:	0541 - Mathematics
Current Coordinator::	Laura Cooke
Module Coordinators:	• CORMAC BREEN (16 March 2020 to 13 December 2021) • Laura Cooke (13 December 2021 to ---)
School Responsible:	School of Mathematics & Statistics
Campus:	City Campus
Module Overview	This module introduces the student to software packages relevant to the programme content in Stages 3 and 4.
Indicative Syllabus	Students will be instructed on the use of the various packages and will be asked to solve a number of practical problems relevant to Stage 3 Modules. Students will be assisted in the development of their presentation skills.
Learning and Teaching Methods	Lectures supported by computer laboratory sessions.
Rationale for Change :	Each LO is now statement of what the student will be able to do upon successful completion of the module.

Module MATH 3811 - Mathematics Practical v1 (Year/Cycle:3 / Semester:Semester 1 / Delivery Type:Mandatory)

Learning Outcomes	
Upon successful completion of this module the learner will be able to	
#	
MLO1	Use a number of different mathematical and statistical packages e.g., R, Maple
MLO2	Use the University's computer and technologies services effectively
MLO3	Develop team working skills and work as part of a group through group-based activities
MLO4	Communicate information in a clear and concise manner by means of written and oral presentation.

Requisites	
Assessment Threshold	40% on each of 3 tasks. Internal compensation possible with a threshold of 35%.

Module Content & Assessment

Assessment Breakdown	%
Other Assessment(s)	100.00%

Assessments

Other Assessment(s)

Assessment Type	In Class Test	**% of Total Mark for Module**	25
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

Assessment Type	In Class Test	**% of Total Mark for Module**	25
Indicative Week	See Student Handbook	**Learning Outcomes**	1,2,3
Assessment Threshold:	None	**Assessment Role**	Not yet determined
Assessment Authenticity	Not Online	**Pass/Fail**	No

Assessment Description
n/a

Assessment Type	In Class Test	**% of Total Mark for Module**	50
Indicative Week	See Student Handbook	**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

Module MATH 3801 - Numerical Analysis & Applications v1 (Year/Cycle:3 / Semester:Semester 1 / Delivery Type: Mandatory)

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APPROVED

MATH 3801: Numerical Analysis & Applications

Module Details

Module Code:	MATH 3801
Module Long Title:	Numerical Analysis & Applications APPROVED
Banner Title:	Numerical Analy & Applications
Version:	1
Valid From:	Sept 2019 (September 2019)
Language of Instruction:	English
ECTS Credits::	5
ISCED Code:	0540 - Mathematics and statistics not further defined or elsewhere classified
Current Coordinator::	EMIL MIHAYLOV PRODANOV
Module Coordinators:	EMIL MIHAYLOV PRODANOV (21 October 2019 to ---)
School Responsible:	School of Mathematics & Statistics
Campus:	City Campus
Module Overview	This module presents a range of numerical techniques for solving the types of problems that occur in science and mathematics. The aim of this module is to extend on the techniques covered in m MATH 2806 and to introduce the learner to more advanced numerical techniques. The module is suitable for stage 3 learners of the TU873/TU874 course or equivalent.
Learning and Teaching Methods	Lectures are primarily used to impart module content to the learner. Problem solving sessions are designed to encourage learners to work both individually and in groups.

Indicative Syllabus
1. Approximation Theory 1.1) Orthogonal polynomials and the least square's approximation, Chebyshev polynomials and economisation of power series, Padé approximations.
2. Numerical Differentiation 2.1) Central differences, forward and backward differences, Richardson's extrapolation, error estimates.
3. Numerical Integration 3.1) Newton-Cotes formulas, composite numerical integration, error estimates.
4. Solution of ordinary differential equations 4.1) Euler's method and higher order Taylor series methods, Runge-Kutta methods, predictor-corrector methods, systems of differential equations.
5. Eigenvalues and Eigenvectors 5.1) Gerschgorin's circle theorem. the Power method, Householder's method and the QR algorithm.

Learning Outcomes	
Upon successful completion of this module the learner will be able to	
#	
MLO1	Demonstrate an understanding of various standard numerical techniques for solving problems of a mathematical and scientific interest
MLO2	Derive the recurrence relation and prove the orthogonality property for Chebyshev polynomials
MLO3	Derive various Padé approximation formulas and use them to get a rational approximation of functions that are given in the form of a power series.
MLO4	Derive various numerical formulas for approximating derivatives and applying them.
MLO5	Apply Richardson's extrapolation method to a variety of numerical techniques.
MLO6	Derive various numerical integration formulas and use them to approximate definite integrals.
MLO7	Demonstrate an ability to solve first order and second order ordinary differential equations which are subject to initial and boundary conditions.
MLO8	Evaluate eigenvalues and eigenvectors using Gerschgorin's circle theorem and the Power method.

Requisites		
Requisite Type	***Module Title***	***Type***
Pre Requisite	MATH 2806 v.1 Numerical Methods [Approved]	Module

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
Assessment Threshold:	35	**Assessment Role**	Not yet determined
Assessment Authenticity	Not Online	**Pass/Fail**	No
Assessment Description Final Exam			

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 Continuous Assessment (in class test)			

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

Richard L. Burden,J. Douglas Faires. (2010), Numerical Analysis, Cengage Learning, p.888, [ISBN: 9780538733519].

Supplementary Book Resources

Curtis F. Gerald,Patrick O. Wheatley. (2004), Applied Numerical Analysis, Addison-Wesley, p.609, [ISBN: 978-0321133045].

Module MATH 3802 - Ordinary Differential Equations v1 (Year/Cycle:3 / Semester:Semester 1 / Delivery Type: Mandatory)

APPROVED

MATH 3802: Ordinary Differential Equations

Module Details

Module Code:	MATH 3802
Module Long Title:	Ordinary Differential Equations APPROVED
Banner Title:	Ordinary Differential Equation
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::	SARAH MORRIS
Module Coordinators:	• CHRIS HILLS (23 May 2019 to 06 December 2021) • SARAH MORRIS (06 December 2021 to ---)
School Responsible:	School of Mathematical Sciences (CC)
Campus:	City Campus
Module Overview	This module introduces the various types of ordinary differential equations, the situations in which they arise and how they are solved.
Indicative Syllabus	**Linear Ordinary Differential Equations:** Definition. Existence and Uniqueness theorem for initial-value problems. Dimension of the solution space (linear independence of functions, vector space, Wronskian). Abel's formula. Variation of parameters (reduction of order). **Laplace Transform:** Transforms of derivatives and integrals, of periodic functions and the various shifting theorems. Convolution theorem. Application to constant coefficient linear ordinary differential equations. **Power Series:** Solution in series of second order linear differential equations. Singular points of such an equation. Cauchy-Euler equation. **Orthogonal Systems of Functions:** Fourier series. Linear operators, adjoint and self-adjoint operators. Eigenvalue problems. Sturm-Liouville problems and the orthogonality property of the solutions.
Learning and Teaching Methods	Lectures supported by tutorials.

Module MATH 3802 - Ordinary Differential Equations v1 (Year/Cycle:3 / Semester:Semester 1 / Delivery Type:Mandatory)

Learning Outcomes	
Upon successful completion of this module the learner will be able to	
#	
MLO1	Recognise the appropriate methods to solve a variety of linear ordinary differential equations
MLO2	Demonstrate ability to solve linear ordinary differential equations using the appropriate methods
MLO3	Understand the concept of linear independence and the Wronskian
MLO4	Solve differential equations using Laplace Transforms
MLO5	Apply methods to find Eigenvalues
MLO6	Solve differential equations using power series
MLO7	Solve differential equations using Fourier series

Requisites	

Assessment Threshold	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	See Student Handbook	**Learning Outcomes**	1,2,3,4,5,6,7
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	See Student Handbook	**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	24
Tutorial	12
Self Directed	64
Hours (up to 100 for 5 ECTS credits)	100.00

Module MATH 3803 - Statistics III: Statistical Models v1 (Year/Cycle:3 / Semester:Semester 1 / Delivery Type: Mandatory)

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MATH 3803: Statistics III: Statistical Models

Module Details

Module Code:	MATH 3803
Module Long Title:	Statistics III: Statistical Models APPROVED
Banner Title:	Statistics III: Stat
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::	JOE CONDON
Module Coordinators:	JOE CONDON (11 April 2019 to ---)
School Responsible:	School of Mathematical Sciences (CC)
Campus:	City Campus
Module Overview	This module builds on the material covered in MATH2805 and MATH1805. The theory of statistical hypothesis testing is expanded to include; statistical power and sample size; further application of MGFs leading to a proof of the central limit theorem; likelihood based statistical modelling, estimation and inference; linear statistical modelling including simple and multiple regression and ANOVA.
Indicative Syllabus	Statistical Power: Type I and II errors; Operating Characteristic curves, power functions and sample size for estimation. Properties of moment generating functions (MGF) with specific application to proving the central limit theorem. Likelihood based model formulation and fitting. Likelihood estimation compared to the method of moments. Likelihood inference for single and multiple parameter cases. Wald based hypothesis testing and confidence intervals. Likelihood ratio tests. Linear statistical models: simple and multiple regression. ANOVA.
Learning and Teaching Methods	Lectures supported by tutorials and computer lab. sessions.

Module MATH 3803 - Statistics III: Statistical Models v1 (Year/Cycle:3 / Semester:Semester 1 / Delivery Type:Mandatory)

Learning Outcomes	
Upon successful completion of this module the learner will be able to	
#	
MLO1	Understand the concept of statistical power and sample size estimation and calculate these in simple cases.
MLO2	Demonstrate a good understanding of MGFs and their uses in statistical theory, including being able to present a proof of the central limit theorem.
MLO3	Apply likelihood based approaches to model formulation, estimation and inference in single and multiple parameter cases. Perform Wald based tests of hypotheses and CIs for single parameters and likelihood ratio tests for multiple parameters.
MLO4	Formulate, fit and report the results of linear statistical models with one and more that one predictor, including regression models and ANOVA.
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**	1,2,3,4,5
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	39
Self Directed	61
Hours (up to 100 for 5 ECTS credits)	100.00

Module MATH 3807 - Algebraic Structures: Groups v1 (Year/Cycle:3 / Semester:Semester 1 / Delivery Type:Elective)

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MATH 3807: Algebraic Structures: Groups

Module Details

Module Code:	MATH 3807
Module Long Title:	Algebraic Structures: Groups APPROVED
Banner Title:	Algebraic Structures: Groups
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 (11 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 introduces the learner to the algebraic structure of Groups and to their application and uses within other scientific and mathematical areas. It aims to form a firm foundation for further study of algebra and other areas of mathematics, including coding and cryptology.
Indicative Syllabus	**Historical motivation of Group Theory:** Symmetry groups of a regular polygon, Groups of transformations, Dihedral groups, Symmetric groups. **Groups:** Group axioms, examples of groups, the integers mod *n* , subgroups, cyclic groups, permutation groups, group homomorphisms and isomorphisms, direct products, cosets, Lagrange's Theorem, normal subgroups and factor groups, Homomorphism theorems.
Learning and Teaching Methods	Lectures supported by tutorials

Module MATH 3807 - Algebraic Structures: Groups v1 (Year/Cycle:3 / Semester:Semester 1 / Delivery Type:Elective)

Learning Outcomes	
Upon successful completion of this module the learner will be able to	
#	
MLO1	Demonstrate an understanding of the fundamental concepts and methodology of Group Theory
MLO2	Demonstrate familiarity with the many examples of groups discussed in class
MLO3	Identify subgroups and normal subgroups of given groups
MLO4	Determine if mappings between groups are homomorphisms and/or isomorphisms
MLO5	Construct factor groups
MLO6	Demonstrate an understanding of the relationship between normal subgroups, homomorphisms and factor groups and applications thereof

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
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
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 3814 - Bayesian Learning v1 (Year/Cycle:3 / Semester:Semester 1 / Delivery Type:Elective)

APPROVED

MATH 3814: Bayesian Learning

Module Details

Module Code:	MATH 3814
Module Long Title:	Bayesian Learning APPROVED
Banner Title:	Bayesian Learning
Version:	1
Valid From:	Sept 2023 (September 2023)
ECTS Credits::	5
ISCED Code:	0540 - Mathematics and statistics not further defined or elsewhere classified
Current Coordinator::	ALBERTO CAIMO
Module Coordinators:	ALBERTO CAIMO (23 November 2022 to ---)
School Responsible:	School of Mathematics & Statistics
Module Overview	This module will introduce Bayesian analysis with emphasis on data modelling and computational methods. After an overview of foundational concepts in probability theory, students will be introduced to the basic concepts in Bayesian analysis including prior specification, posterior inference prediction and model selection. Monte Carlo methods will be used to approximate quantities of interest. All the important concepts and methods will be explained via examples using advanced statistical software (e.g., R).
Learning and Teaching Methods	Lectures supported by data analysis sessions and the use of statistical software packages.

Indicative Syllabus
1. Probability theory 1.1) Review of Bayes' theorem and basic probability theory. Monte Carlo methods. Likelihood principle. Subjective probability.
2. Probabilistic modelling 2.1) Conjugate models (e.g. Beta-Binomial, Gamma-Poisson). Prior specification. Posterior inference and prediction. Bayes factor. Linear regression.
3. Simulation methods 3.1) Markov chain Monte Carlo algorithms (e.g. Metropolis-Hastings, Gibbs sampler).
4. Software packages 4.1) Data analysis using advanced statistical packages (e.g. R, RStan).

Module MATH 3814 - Bayesian Learning v1 (Year/Cycle:3 / Semester:Semester 1 / Delivery Type:Elective)

Learning Outcomes	
Upon successful completion of this module the learner will be able to	
#	
MLO1	Explain the principles of Bayesian statistics and the analysis of data and probability distributions to build Bayesian models
MLO2	Design a range of Bayesian models for real-world problems specifying prior distributions for the model parameters
MLO3	Compute and interpret the output of Bayesian analyses within a range of different contexts
MLO4	Derive predictive posterior distributions to evaluate new data scenarios and apply model selection methods, e.g., Bayes factors and compare the predictive performance of various models
MLO5	Implement Bayesian models using standard software (e.g., R), and evaluate the performance of the computational algorithms
MLO6	Apply Monte Carlo sampling algorithms to estimate intractable parameter posterior distributions

Requisites

Module Content & Assessment

Assessment Breakdown	%
Other Assessment(s)	100.00%

Assessments

Other Assessment(s)

Assessment Type	Case Study	**% of Total Mark for Module**	40
Indicative Week	See Student Handbook	**Learning Outcomes**	1,2,3,4,5,6
Assessment Threshold:	35	**Assessment Role**	Individual
Assessment Authenticity	Not Online	**Pass/Fail**	No

Assessment Description
Data analysis project

Assessment Type	In Class Test	**% of Total Mark for Module**	30
Indicative Week	See Student Handbook	**Learning Outcomes**	1,2,4
Assessment Threshold:	35	**Assessment Role**	Individual
Assessment Authenticity	Not Online	**Pass/Fail**	No

Assessment Description
In-class test

Assessment Type	Lab Test	**% of Total Mark for Module**	30
Indicative Week	See Student Handbook	**Learning Outcomes**	3,5,6
Assessment Threshold:	None	**Assessment Role**	Individual
Assessment Authenticity	Not Online	**Pass/Fail**	No

Assessment Description
Lab test

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

Gelman, A., Carlin, J. B., Stern, H. S., & Rubin, D. B.. (2013), Bayesian data analysis, Chapman and Hall/CRC.

Supplementary Book Resources

McElreath, R.. (2020), Statistical Rethinking: A Bayesian course with examples in R and Stan, Chapman and Hall/CRC.

Module MATH 3806 - Classical Mechanics v1 (Year/Cycle:3 / Semester:Semester 1 / Delivery Type:Elective)

APPROVED

MATH 3806: Classical Mechanics

Module Details

Module Code:	MATH 3806
Module Long Title:	Classical Mechanics APPROVED
Banner Title:	Classical Mechanics
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::	CORMAC BREEN
Module Coordinators:	• EMIL MIHAYLOV PRODANOV (21 October 2019 to 12 January 2022) • CORMAC BREEN (12 January 2022 to 13 January 2022) • CORMAC BREEN (13 January 2022 to ---)
School Responsible:	School of Mathematical Sciences (CC)
Campus:	City Campus
Module Overview	This module introduces the learner to a selection of standard introductory topics in classical mechanics. General strategies for problem solving are discussed. The learner will encounter the Newtonian, Lagrangian and Hamiltonian formulations of classical mechanics and develop an understanding of the relationships between these approaches. Numerical simulations are used to develop physical intuition of selected problems.
	Statics Forces; torques; static balance problems. **Newtonian mechanics** Newton’s laws; free-body diagrams; polar and Cartesian coordinate systems; simple, damped, driven, and coupled harmonic motion; solving ODEs arising from Newton’s laws; numerical simulation

Indicative Syllabus	**Conservation laws** Kinetic and potential energy; conservation of energy; work-energy theorem; conservation of momentum; change of reference frame (centre of mass); elastic and inelastic collisions, central forces. **Lagrangian mechanics** Euler-Lagrange equations; principle of least action; constraining forces; generalised and ignorable coordinates; Noether's theorem and conservation laws; small oscillations **Hamiltonian Mechanics** Energy and the Hamiltonian; Hamilton's equations; Legendre transforms; Liouville's theorem
Learning and Teaching Methods	Lectures supported by tutorials

Learning Outcomes	
Upon successful completion of this module the learner will be able to	
#	
MLO1	Apply effective strategies for solving problems in classical mechanics
MLO2	Select an appropriate formalism of classical mechanics for treatment of a given problem
MLO3	Solve a wide range of problems from standard introductory topics in classical mechanics
MLO4	Investigate solutions to problems in classical mechanics with numerical tools

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	See Student Handbook	**Learning Outcomes**	1,2,3
Assessment Threshold:	35	**Assessment Role**	Not yet determined
Assessment Authenticity	Not Online	**Pass/Fail**	No

Assessment Description
Final exam

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
In class test

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

David Morin. (2008), Introduction to Classical Mechanics, Cambridge University Press, p.734, [ISBN: 0521876222].

Supplementary Book Resources

T. W. B. Kibble,Frank H. Berkshire. (2004), Classical Mechanics, Imperial College Press, p.478, [ISBN: 1860944353].

Jorge V. José,Vice President for Research Jorge V José,Eugene J. Saletan. (1998), Classical Dynamics, Cambridge University Press, p.670, [ISBN: 0521636361].

Module MATH 3805 - Complex Analysis v1 (Year/Cycle:3 / Semester:Semester 1 / Delivery Type:Elective)

OLLSCOIL TEICNEOLAÍOCHTA BHAILE ÁTHA CLIATH
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APPROVED

MATH 3805: Complex Analysis

Module Details

Module Code:	MATH 3805
Module Long Title:	Complex Analysis APPROVED
Banner Title:	Complex Analysis
Version:	1
Indicative NFQ level:	Level 8
Valid From:	Semester 1 - 2016/17 (September 2016)
Language of Instruction:	English
ECTS Credits::	5
ISCED Code:	0541 - Mathematics
Current Coordinator::	COLUM WATT
Module Coordinators:	COLUM WATT (05 January 2022 to ---)
School Responsible:	School of Mathematical Sciences (CC)
Campus:	City Campus
Module Overview	This module is devoted to the calculus of functions of a complex variable, that is, to functions whose domain and range are regions of the complex plane rather than subsets of the real line. A grounding in functions of a complex variable is provided and the interplay between analytic and geometric factors in complex function theory is demonstrated. The module aims to develop the manipulative and reasoning skill of each student in this elegant and useful area of mathematics.
Indicative Syllabus	Review of complex numbers and their graphical representation. Manipulation of inequalities. Factorisation of complex polynomials. Contours, simple closed curves, open and connected subsets in the complex plane. **Analytic Functions** Functions of a complex variable, real and imaginary parts, differentiability. Analytic functions and the Cauchy-Riemann conditions. Laplace's equation: harmonic and conjugate harmonic functions. Polynomials, exponential, trigonometric, hyperbolic and logarithmic functions. **Complex Integration** Contour integrals, the Fundamental Theorem of Calculus, Cauchy's integral Theorem and Integral Formulae. Morera's theorem, Liouville's theorem and the Fundamental Theorem of Algebra. **Taylor and Laurent Series**

	Sequences, series and convergence in the complex plane. Power series: Taylor and Laurent series, uniform convergence of series. Classification of singularities and zeros. The Residue theorem and applications.

Learning and Teaching Methods	Lectures and tutorials

Indicative Syllabus
1. Algebra and Geometry of the Complex Plane 1.1) Review of complex numbers and their graphical representation. Manipulation of inequalities. Factorisation of complex polynomials. Contours, simple closed curves, open and connected subsets in the complex plane.
2. Analytic Functions 2.1) Functions of a complex variable, real and imaginary parts, differentiability. Analytic functions and the Cauchy-Riemann conditions. Laplace's equation: harmonic and conjugate harmonic functions. Polynomials, exponential, trigonometric, hyperbolic and logarithmic functions.
3. Complex Integration 3.1) Contour integrals, the Fundamental Theorem of Calculus, Cauchy's integral Theorem and Integral Formulae. Morera's theorem, Liouville's theorem and the Fundamental Theorem of Algebra.
4. Taylor and Laurent Series 4.1) Sequences, series and convergence in the complex plane. Power series: Taylor and Laurent series, uniform convergence of series. Classification of singularities and zeros. The Residue theorem and applications.

Module MATH 3805 - Complex Analysis v1 (Year/Cycle:3 / Semester:Semester 1 / Delivery Type:Elective)

Learning Outcomes	
Upon successful completion of this module the learner will be able to	
#	
MLO1	factor complex polynomials and manipulate inequalities involving complex variables
MLO2	demonstrate an understanding of the complex logarithm, exponential, trigonometric and hyperbolic functions and how they are related
MLO3	use the Cauchy-Riemann conditions to check for analyticity
MLO4	calculate the harmonic conjugate of a given harmonic function
MLO5	calculate contour integrals directly and, where appropriate, by the use of Cauchy's integral theorems
MLO6	calculate Taylor and Laurent series and classify isolated zeros and singularities
MLO7	evaluate real integrals by the use of Cauchy's residue theorem
MLO8	proceed to further study in areas of mathematics, science and engineering where knowledge of complex function theory is required.

Requisites

Assessment Threshold	There is a threshold of 35% on the formal 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 18	**Learning Outcomes**	1,2,3,4,5,6,7,8
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**	1,2,3,4,5
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

E.B. Saff and A.D. Snider. (2003), Fundamentals of Complex Analysis, 3e. Prentice Hall.

Supplementary Book Resources

J.W. Brown and R.V. Churchill. (2008), Complex Variables and Applications, McGraw-Hill.

J. Reade. (2003), Calculus with Complex Numbers, CRC Press.

J.H. Matthews. (2006), Complex Variables with Applications, 5e. Jones and Bartlett.

Module MATH 3808 - Introduction to Financial Mathematics v2 (Year/Cycle:3 / Semester:Semester 1 / Delivery Type: Elective)

APPROVED

MATH 3808: Introduction to Financial Mathematics

Module Details

Module Code:	MATH 3808
Module Long Title:	Introduction to Financial Mathematics APPROVED
Banner Title:	Intro to Financial Mathematics
Version:	2
Indicative NFQ level:	Level 8
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	The module introduces the learner to the mathematics of Finance, including interest rates and future and present values. The methods of financial markets are examined, especially in the context of financial derivatives. Different methods for valuing these derivatives are considered.
Learning and Teaching Methods	Lectures supported by problem-solving sessions and the use of mathematical software packages.

Indicative Syllabus
1. Risk management 1.1) Hedging, arbitrage.
2. The time value of money 2.1) Simple and compound interest, present and future values, discount factors, net present value, rate of return, annuities.
3. Financial Markets 3.1) Introduction to financial markets: derivatives, forwards and futures, options, swaps.
4. Pricing techniques 4.1) Replication, the Law of One Price, the Arbitrage Theorem.
5. Discrete/continuous pricing models 5.1) The Binomial Model, introduction to Brownian motion and Black-Scholes.
6. Software Packages 6.1) Use of mathematical packages to model financial instruments.

Learning Outcomes	
Upon successful completion of this module the learner will be able to	
#	
MLO1	Define the terms used in finance.
MLO2	Explain how markets operate.
MLO3	Discuss the time value of money.
MLO4	Price financial instruments using a variety of methods.

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
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**	30
Indicative Week	See Student Handbook	**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

Sheldon M. Ross. (2011), An Elementary Introduction to Mathematical Finance, Cambridge University Press, [ISBN: 9780521192538].

Supplementary Book Resources

John Hull. Options, Futures and Other Derivatives, [ISBN: 9780130090560].

Salih N. Neftci. (2000), An Introduction to the Mathematics of Financial Derivatives, Elsevier, p.527, [ISBN: 9780080478647].

Module MATH 3813 - Network Analysis & Transportation v1 (Year/Cycle:3 / Semester:Semester 1 / Delivery Type: Elective)

APPROVED

MATH 3813: Network Analysis & Transportation

Module Details

Module Code:	MATH 3813
Module Long Title:	Network Analysis & Transportation APPROVED
Banner Title:	Network Analysis & Transportation
Version:	1
Valid From:	Sept 2018 (September 2018)
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 expands on the fundamental concepts of network analysis and transportation covered in MATH 2804. It introduces the minimal spanning tree problem and the maximal flow problem; and the theory behind the solution of such problems. It also introduces the assignment and transhipment models and their solutions. Case studies of all models will be presented, formulated and solved using appropriate software.
Indicative Syllabus	Network Models Review of network analysis and shortest route problem. Further applications of shortest route problem. Minimal spanning tree problem and solution. Maximal flow problem and solution. Solution with Excel. Case studies of above models. Transportation Review of transportation model and northwest corner method of solution. Least Cost Method and Vogel method of solution. Examples of non-traditional transportation models. Assignment Model. Definition and solution. Hungarian method of solution. Simplex explanation of Hungarian method. Transshipment Model. Definitions and solution. Case studies of above models.
Learning and Teaching	Lecture supported by tutorials

Methods	

Learning Outcomes	
Upon successful completion of this module the learner will be able to	
#	
MLO1	Apply network analysis to shortest route, minimal spanning tree and maximal flow problems
MLO2	Use various methods to solve the problems outlined above
MLO3	Formulate and solve transportation, assignment and transshipment problems
MLO4	Be familiar with case studies of network and transportation models
MLO5	Use computer software to solve network and transportation problems.

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
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 3804 - Topics in Analysis v2 (Year/Cycle:3 / Semester:Semester 1 / Delivery Type:Elective)

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MATH 3804: Topics in Analysis

Module Details

Module Code:	MATH 3804
Module Long Title:	Topics in Analysis APPROVED
Banner Title:	Topics in Analysis
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::	SUSAN LAZARUS
Module Coordinators:	SUSAN LAZARUS (11 May 2023 to ---)
School Responsible:	School of Mathematics & Statistics
Campus:	City Campus
Module Overview	This module develops and consolidates the student's knowledge of elementary real analysis, with a view to providing a sound foundation for more advanced studies in pure and applied mathematics. The concept of limits of sequences is extended to sequences of functions and the student is introduced to elementary topological notions, basic properties of metric spaces, Banach's Fixed-Point Theorem and some of its applications.
Indicative Syllabus	**Sequences and Series of Functions** Sequences of functions: pointwise and uniform convergence, applications of uniform convergence. **Metric Spaces** Definition, elementary properties and examples including: Euclidean Metric, Taxicab metric (application in pattern recognition), Sup metric, Discrete metric, Hamming metric (applications in Coding Theory). Open, closed and bounded sets; accumulation points, closure, interior and boundary of a set. Sequences, continuous functions, Cauchy sequences and completeness. **Banach's Fixed Point Theorem** Statement and proof of the theorem. Applications to differential and linear equations.

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.

Rationale for Change :	The introduction of the module MATH 2816, Introduction to Analysis, in second year created a significant amount of overlap between it and this module. The new module now has a heavier balance towards metric spaces and also introduces the learner to Banach's Fixed Point Theorem. As such the name Real Analysis no longer properly reflects the content of the module. Hence the change of module name to Topics in Analysis.

Learning Outcomes	
Upon successful completion of this module the learner will be able to	
#	
MLO1	Demonstrate an understanding of the difference between pointwise and uniform convergence of sequences of real functions.
MLO2	Determine whether or not a given function is a metric
MLO3	Verify and use the axioms of a metric space to prove basic results of metric spaces
MLO4	Demonstrate an understanding of the notion of convergence of a sequence in a metric space
MLO5	Identify if a subset of a metric space is open and/or closed
MLO6	Identify the closure and accumulation points of a subset of a metric space
MLO7	Determine if a given function between metric spaces is continuous
MLO8	Determine whether or not a metric space is complete
MLO9	Apply Banach's Fixed Point Theorem to relevant applications

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**	1,2,3,4,5,6
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

Kenneth A. Ross. (2013), Elementary Analysis, Springer Science & Business Media, p.417, [ISBN: 978-1-4614-6271-2].

John R. Giles,John Robilliard Giles. (1987), Introduction to the Analysis of Metric Spaces, Cambridge University Press, p.276, [ISBN: 9780521359283].

Supplementary Book Resources

Robert G. Bartle,Donald R. Sherbert. (2011), Introduction to Real Analysis, Wiley, p.0, [ISBN: 978-0471433316].

Erwin Kreyszig. (1991), Introductory Functional Analysis with Applications, John Wiley & Sons, p.706, [ISBN: 978-0-471-50459-7].

John M. Howie. (2006), Real Analysis, Springer Science & Business Media, p.292, [ISBN: 978-1852333140].

Module MATH 3812 - Work Placement v1 (Year/Cycle:3 / Semester:Semester 2 / Delivery Type:Mandatory)

APPROVED

MATH 3812: Work Placement

Module Details

Module Code:	MATH 3812
Module Long Title:	Work Placement APPROVED
Banner Title:	Work Placement
Version:	1
Indicative NFQ level:	Level 7
Valid From:	Jan 2019 (January 2019)
Language of Instruction:	English
ECTS Credits::	25
ISCED Code:	0541 - Mathematics
Current Coordinator::	Laura Cooke
Module Coordinators:	• CORMAC BREEN (19 June 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 provides the student with an opportunity to work in a relevant industrial placement for a six month or three month period.
Learning and Teaching Methods	This full module is taken off-site as an industrial placement. During that time, the student will be using and enhancing their skills with input from the relevant industrial contacts at the placement company. Students may be working as part of a team or individually at the placement company, depending upon the individual requirements of the company. In addition, students will be assigned a work placement monitor from TU Dublin who will visit the student during the placement to ascertain how the placement is progressing.

Module MATH 3812 - Work Placement v1 (Year/Cycle:3 / Semester:Semester 2 / Delivery Type:Mandatory)

Learning Outcomes	
Upon successful completion of this module the learner will be able to	
#	
MLO1	Gain a practical exposure to working in industry
MLO2	Use and enhance the specialist skills already gained in their programme such as subject-specific knowledge and technical skills
MLO3	Work in a commercial and professional environment
MLO4	Demonstrate that they can work independently and use their own initiative
MLO5	Demonstrate interpersonal skills and how they can communicate effectively
MLO6	Develop general skills such as problem-solving and flexibility
MLO7	Demonstrate an understanding of a particular project/area of work in which they have been involved
MLO8	Present the outcomes of their work placement

Requisites

Module Content & Assessment

Assessment Breakdown	%
Other Assessment(s)	100.00%

Assessments

Other Assessment(s)

Assessment Type	Work Placement Report	**% 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**	Not yet determined
Assessment Authenticity	Not Online	**Pass/Fail**	No

Assessment Description
n/a

Module MATH 3812 - Work Placement v1 (Year/Cycle:3 / Semester:Semester 2 / Delivery Type:Mandatory)

Module Activity

Full Time hours per semester	
Activity Type	*Duration (Hours)*
Placement	500
Hours (up to 100 for 5 ECTS credits)	500.00