UG modules starting in Autumn 2021

Department of Mathematics

Contents

1. Mathematics BSc

Modules

YEAR 1 (starting academic year 2021/2022)

Autumn Teaching:
- Analysis I
- Linear Algebra I
- Fundamentals of Mathematics
- Discrete Mathematics

Spring Teaching:
- Analysis II
- Linear Algebra II
- Computational Mathematics
- Number Theory

YEAR 2 (starting academic year 2022/2023)

Autumn Teaching:
- Calculus of Several Variables
- Ordinary Differential Equations
- Introduction to Probability
- Algebra

Spring Teaching:

- Real Analysis
- Probability and Statistics
- Numerical Analysis
- Differential Equations with Modelling

2. Mathematics MMath

Modules

YEAR 1 (Starting academic year 2021/2022)

Autumn Teaching:

- Analysis I
- Linear Algebra I
- Fundamentals of Mathematics
- Discrete Mathematics

Spring Teaching:

- Analysis II
- Linear Algebra II
- Computational Mathematics
- Number Theory

YEAR 2 (Starting academic year 2022/2023)

Autumn Teaching:

- Calculus of Several Variables
- Ordinary Differential Equations
- Introduction to Probability
- Algebra

Spring Teaching:

- Real Analysis
- Probability and Statistics
- Numerical Analysis
- Differential Equations with Modelling

3. Mathematics (research placement) MMATH

Modules

YEAR 1 (Starting academic year 2021/2022)

Autumn Teaching:

- Analysis I
- Linear Algebra I
- Fundamentals of Mathematics
- Discrete Mathematics

Spring Teaching:

- Analysis II
- Linear Algebra II
- Computational Mathematics
- Number Theory

YEAR 2 (starting academic year 2022/2023)

Autumn Teaching:

- Calculus of Several Variables
- Ordinary Differential Equations
- Introduction to Probability
- Algebra

Spring Teaching:

- Real Analysis
- Probability and Statistics
- Numerical Analysis
- Differential Equations with Modelling

4. Mathematics with Economics BSc

Modules

YEAR 1 (starting academic year 2021/2022)

Autumn Teaching:

- Analysis I
- Linear Algebra I
- Fundamentals of Mathematics
- Introduction to Economics

Spring Teaching:

- Analysis II
- Linear Algebra II
- Computational Mathematics
- Microeconomics 1

YEAR 2 (starting academic year 2022/2023)

Autumn Teaching:

- Calculus of Several Variables
- Ordinary Differential Equations
- Introduction to Probability
- Microeconomics 2

Spring Teaching:

- Real Analysis
- Probability and Statistics
- Numerical Analysis
- Europe in the International Economic Order

5. Mathematics with Economics MMATH

Modules

YEAR 1 (starting academic year 2021/2022)

Autumn Teaching:

- Analysis I
- Linear Algebra I
- Fundamentals of Mathematics
- Introduction to Economics

Spring Teaching:

- Analysis II
- Linear Algebra II
- Computational Mathematics
- Microeconomics 1

YEAR 2 (starting academic year 2022/2023)

Autumn Teaching:

- Calculus of Several Variables
- Ordinary Differential Equations
- Introduction to Probability
- Microeconomics 2

Spring Teaching:

- Real Analysis
- Probability and Statistics
- Numerical Analysis
- Europe in the International Economic Order

6. Mathematics with Finance BSc

Modules

YEAR 1 (starting academic year 2021/2022)

Autumn Teaching:

- Analysis I
- Linear Algebra I
- Fundamentals of Mathematics
- Principles of Finance

Spring Teaching:

- Analysis II
- Linear Algebra II
- Computational Mathematics
- Theory of Investments

YEAR 2 (starting academic year 2022/2023)

Autumn Teaching:

- Calculus of Several Variables
- Ordinary Differential Equations
- Introduction to Probability
- Financial Institutions and Markets

Spring Teaching:

- Real Analysis
- Probability and Statistics
- Numerical Analysis
- Corporate and International Finance

7. Mathematics with Finance MMATH

Modules

YEAR 1 (starting academic year 2021/2022)

Autumn Teaching:

- Analysis I
- Linear Algebra I
- Fundamentals of Mathematics
- Principles of Finance

Spring Teaching:

- Analysis II
- Linear Algebra II
- Computational Mathematics
- Theory of Investments

YEAR 2 (starting academic year 2022/2023)

Autumn Teaching:

- Calculus of Several Variables
- Ordinary Differential Equations
- Introduction to Probability
- Financial Institutions and Markets

Spring Teaching:

- Real Analysis
- Probability and Statistics
- Numerical Analysis
- Corporate and International Finance

8. Module Descriptions for 21/22

Descriptions of modules listed above.

For Mathematics BSc, MMATH, MMATH with Research Placement

Year 1: Autumn Teaching

1) Analysis 1 (G5135)
In this module we will cover the following topics

- Sequences. Convergence, Cauchy sequences, subsequences.
- Series. Convergence/divergence criteria.
- Limits of functions. Definitions, examples and properties.
- Continuity of functions.

Teaching, Assessments, Contact hours remain as they are for the current
year 1 modules.

2) Linear algebra I (G5134)
In this module we will cover the following topics

- Vectors in n-dimensional spaces. Subspaces, bases, geometry in 2
  and 3-dimensional real spaces.
- Linear systems of equations. Gaussian elimination.
- Matrices. Rank, nullity, determinant, inversion.

- Complex numbers.

Teaching, Assessments, Contact hours remain as they are for the current year 1 modules.

1)   Fundamentals of Mathematics (G5133)
In this module we will cover the following topics

- Sets, functions, cardinality, countability, deMorgan laws.
- Elements of propositional logic, mathematical induction.
- Peano postulates, axiomatic foundations and basics of arithmetic, groups, fields.

Teaching, Assessments, Contact hours remain as they are for the current year 1 modules.

2)   Discrete Mathematics (G5136)
In this module we will cover the following topics

- Graph theory and special graphs
- Counting. Principles of counting, combinatorics, multinomial theorem
- Recursive equations and basic modelling.

Teaching, Assessments, Contact hours remain as they are for the current year 1 modules.

Spring Teaching

1) Computational Mathematics (G5137)
In this module we will cover the following topics

- Teach basic Matlab programming: vectors/matrices, functions, scope, loops, recursion, divide and conquer (quicksort)
- basic computer arithmetic: binary system, floating point
- representation, rounding error, error propagation, error estimates
- interpolation: polynomial, trigonometric, splines, extrapolation
- Numerical integration: Newton-Cotes and Gaussian.

Assessments:
(a) UEX (Unseen examination) – 70 %
(b) Coursework 30% of which:
     (i) PRB × 4 (Problem sets, each 5%)
     (ii) TST (Midterm test, 10%).

2) Linear Algebra 2 (G5138)

In this module we will cover the following topics
- Vectors spaces. Subspaces, bases, inner products.
- Linear transformations. Rank/Nullity, matrices of linear maps, change of basis.
- Eigenvalues/Eigenvectors. Jordan normal form, diagonalisation.
- Special classes of linear transformations and their matrices.

Teaching, Assessments, Contact hours remain as they are for the current year 1 modules.

3) Analysis 2 (G5139)

In this module we will cover the following topics

- Derivative. Definition & properties. Rolle's, Lagrange's, and L'Hospital's theorems.
- Taylor's Theorem.
- Riemann Integral. Definition and properties. Fundamental Theorem of Calculus. Integration techniques.

Teaching, Assessments, Contact hours remain as they are for the current year 1 modules.

4) Number Theory (G5140)

In this module we will cover the following topics

- Arithmetic over Z. Fundamental theorem, Diophantine equations.
- Polynomial arithmetic and parallels with Z.
- Modular arithmetic, Euler's theorem, Fermat's theorem, and Chinese remainder theorem.
- Elementary group theory. Abelian groups, generators.

Teaching, Assessments, Contact hours remain as they are for the current year 1 modules.

Year 2:   Autumn Teaching

1) Calculus of Several Variables (G5141)

In this module we will cover the following topics

- Functions of several variables. Limits, continuity.
- Differentiation of functions of several variables. Directional derivatives, gradient, total and partial differentials. Taylor formula.
- Extrema, constrained minima and maxima. Lagrange multipliers
- Implicit Function Theorem.
- Double and Triple integrals. Polar, cylindrical and spherical coordinates.
- Line and surface integral. Gauss and Stokes Theorem.

Assessments:
(a) UEX (Unseen examination) - 80%

(b) Coursework 20% of which:
        (i) PRB × 4 (Problem sets, each 5%), - 20%

        (ii) ESS (Essay (CV) - 10%).

2) Ordinary Differential Equations (G5142)

In this module we will cover the following topics

- Elementary solution methods
- Existence and uniqueness theorems
- Linear equations
- Examples from applications

Assessments:

(a) UEX (Unseen examination) - 70%
(b) Coursework 30% of which:
        (i) PRB × 4 (Problem sets, each 5%) - 20%
        (ii) POF x 1 (Career Component) – 10%

3) Introduction to Probability (G5143)

In this module we will cover the following topics
- Classical probability, basic conditioning.
- Random variables, distribution functions, moments, independence.
- Common continuous and discrete random variables.
- Law of large numbers and central limit theorem.

Assessments:

(a) UEX (Unseen examination) - 80%

(b) Coursework 20% of which:

        (i) PRB × 4 (Problem sets, each 5%) - 20%

4) Algebra (G5144)

In this module we will cover the following topics
- Abelian groups, Lagrange's theorem, homomorphisms.
- Generic finite groups, special subgroups (normal, center), quotient groups.

- Rings, integral domains, euclidean domains, fields.
- Homomorphisms, ideals, quotient rings. Polynomial rings as running examples.

Assessments:

(a) UEX (Unseen examination) - 80%
(b) Coursework 20% of which:
        (i) PRB × 4 (Problem sets, each 5%) - 20%

Spring Teaching

(1) Real Analysis (G5145)

In this module we will cover the following topics

- Power series, Taylor series.
- Pointwise and uniform convergence of a sequence of functions.
- Interchange of limit and Integral. Interchange of limit and differentiation.
- Series of functions. Weierstrass M-test.
- Convergence and uniform convergence of a power series. Integration and differentiation term by term.
- Metric spaces. Basic examples. Basic topology. Separability, completeness.

Assessments:
        (a) UEX (Unseen examination) - 80%

        (b) Coursework 20% of which:
                (i) PRB × 4 (Problem sets, each 5%) - 20%

2) Probability and Statistics (G5146)

In this module we will cover the following topics

- Vector random variables, moments, distributions, transformations.
- Conditional distributions, conditional expectations.
- Multivariate normal distribution. Linear regression.
- Point estimators
- Hypothesis testing, confidence intervals.

Assessments:
        (a) UEX (Unseen examination) - 80%

        (b) Coursework 20% of which:
                (i) PRB × 4 (Problem sets, each 5%) - 20%

3) Numerical Analysis (G5147)

In this module we will cover the following topics
- Numerical differentiation with order of approximation
- Finite Difference approximations of very basic initial value problems
- Direct solvers for linear systems: LU, Cholesky, QR
- Basic iterative solvers: Jacobi/Gauss-Seidel/SOR
- Nonlinear equations: Banach fixed point theorem, Newton's method

Assessments:
(a) UEX (Unseen examination) - 70%
(b) Coursework 30% of which:
(i) PRB × 4 (Problem sets, each 5%) - 20%
(ii) ESS (written piece on LaTeX) - 5%
(iii) PRE (presentation) -5%

4) Differential Equations with Modelling (G5148)

In this module we will cover the following topics

- Deriving differential equations from applications
- Phase diagram and stability analysis
- First order partial differential equations and method of characteristics
- Further methods to solve differential equations such as power series and transform methods

Assessments:
(a) UEX (Unseen examination) - 80%

(b) Coursework 20% of which:
(i) PRB × 4 (Problem sets, each 5%) - 20%

For Mathematics with Economics/Finance BSc and MMATH

Year 1: Autumn Teaching

1) Analysis 1 (G5135)
In this module we will cover the following topics

- Sequences. Convergence, Cauchy sequences, subsequences.
- Series. Convergence/divergence criteria.
- Limits of functions. Definitions, examples and properties.

- Continuity of functions.

Teaching, Assessments, Contact hours remain as they are for the current year 1 modules.

2) Linear algebra I (G5134)
In this module we will cover the following topics

- Vectors in n-dimensional spaces. Subspaces, bases, geometry in 2 and 3-dimensional real spaces.
- Linear systems of equations. Gaussian elimination.
- Matrices. Rank, nullity, determinant, inversion.
- Complex numbers.

Teaching, Assessments, Contact hours remain as they are for the current year 1 modules.

3) Fundamentals of Mathematics (G5133)
In this module we will cover the following topics

- Sets, functions, cardinality, countability, deMorgan laws.
- Elements of propositional logic, mathematical induction.
- Peano postulates, axiomatic foundations and basics of arithmetic, groups, fields.

Teaching, Assessments, Contact hours remain as they are for the current year 1 modules.

Spring Teaching

1) Computational Mathematics (G5137)

In this module we will cover the following topics

- Teach basic Matlab programming: vectors/matrices, functions, scope, loops, recursion, divide and conquer (quicksort)
- basic computer arithmetic: binary system, floating point
- representation, rounding error, error propagation, error estimates
- interpolation: polynomial, trigonometric, splines, extrapolation
- Numerical integration: Newton-Cotes and Gaussian.

Assessments:
  (a) UEX (Unseen examination) – 70 %
  (b) Coursework 30% of which:
      (i) PRB × 4 (Problem sets, each 5%)

(ii) TST (Midterm test, 10%).

2) Linear Algebra 2 (G5138)

In this module we will cover the following topics
- Vectors spaces. Subspaces, bases, inner products.
- Linear transformations. Rank/Nullity, matrices of linear maps, change of basis.
- Eigenvalues/Eigenvectors. Jordan normal form, diagonalisation.
- Special classes of linear transformations and their matrices.

Teaching, Assessments, Contact hours remain as they are for the current year 1   modules.

3) Analysis 2 (G5139)

In this module we will cover the following topics

- Derivative. Definition & properties. Rolle's, Lagrange's, and L'Hospital's theorems.
- Taylor's Theorem.
- Riemann Integral. Definition and properties. Fundamental Theorem of Calculus. Integration techniques.

Teaching, Assessments, Contact hours remain as they are for the current year 1 modules.

Year 2:   Autumn Teaching

1) Calculus of Several Variables (G5141)

In this module we will cover the following topics

- Functions of several variables. Limits, continuity.
- Differentiation of functions of several variables. Directional derivatives, gradient, total and partial differentials. Taylor formula.
- Extrema, constrained minima and maxima. Lagrange multipliers
- Implicit Function Theorem.
- Double and Triple integrals. Polar, cylindrical and spherical coordinates.
- Line and surface integral. Gauss and Stokes Theorem.

Assessments:
(a) UEX (Unseen examination) - 80%

(b) Coursework 20% of which:

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2) Ordinary Differential Equations (G5142)

In this module we will cover the following topics

- Elementary solution methods
- Existence and uniqueness theorems
- Linear equations
- Examples from applications

Assessments:

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(b) Coursework 30% of which:
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Assessments:

(a) UEX (Unseen examination) - 80%

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Spring Teaching

(1) Real Analysis (G5145)

In this module we will cover the following topics

- Power series, Taylor series.
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- Convergence and uniform convergence of a power series. Integration and differentiation term by term.
- Metric spaces. Basic examples. Basic topology. Separability, completeness.

Assessments:

  (a) UEX (Unseen examination) - 80%

  (b) Coursework 20% of which:
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In this module we will cover the following topics

- Vector random variables, moments, distributions, transformations.
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- Multivariate normal distribution. Linear regression.
- Point estimators
- Hypothesis testing, confidence intervals.

Assessments:

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- Nonlinear equations: Banach fixed point theorem, Newton's method

Assessments:

  (a) UEX (Unseen examination) - 70%
  (b) Coursework 30% of which:
  　　　(i) PRB × 4 (Problem sets, each 5%) - 20%
  　　　(ii) ESS (written piece on LaTeX) - 5%
  　　　(iii) PRE (presentation) -5%