MATHEMATICS (PURE AND APPLIED)

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Mathematics (MAT) and ***Applied Mathematics*** (MAP) may be taken as major subjects for the degrees of BSc, BA, BJourn, BCom, BBusSci, BEcon and BSocSc, and for the diploma HDE(SEC).

To major in Mathematics, a candidate is required to obtain credit in the following courses: MAT1C; MAM2; MAT3.

To major in Applied Mathematics, a candidate is required to obtain credit in the following courses: MAT1C, MAM2; MAP3. See Rule S.23.

The attention of students who hope to pursue careers in the field of Bioinformatics is drawn to the recommended curriculum that leads to postgraduate study in this area, in which Mathematics is a recommended co-major with Biochemistry, and for which two years of Computer Science and either Mathematics or Mathematical Statistics are prerequisites. Details of this curriculum can be found in the entry for the Department of Biochemistry and Microbiology.

See the departmental web page for further details, particularly on the content of courses.

Overview of first-year level courses

Mathematics 1 (MAT1C): This is a year-long semesterized two-credit course. Credit in MAT1C must be obtained by students who wish to major in certain subjects (such as Applied Mathematics, Physics and Mathematical Statistics) and by students registered for the BBusSci degree.

Introductory Mathematics (MAT1S): A semester-long course recommended for Pharmacy students and for Science students who do not need MAT1C or MAT1C1.

Mathematics 1F (MAT1F): A full year course for students who do not qualify for entry into any of the first year courses mentioned above. This is particularly suitable for students in the Social Sciences and Biological Sciences who need to become numerate or achieve a l basic level in mathematics. A successful pass in this course gives admission toMAT1S, and a 60% pass gives admission to MAT1C.

First year
Mathematics 1 (MAT1C)
There are two first-year courses in Mathematics for candidates planning to major in Mathematics or Applied Mathematics. MAT1C1 is held in the first semester and MAT1C2 in the second semester. Credit may be obtained in each course separately and, in addition, an aggregate mark of at least 50% will be deemed to be equivalent to the two-credit course MAT1C, provided that a candidate obtains the required sub-minimum (40%) in each component. Supplementary examinations may be recommended in either course, provided that a candidate achieves a minimum standard specified by the department. Candidates must obtain at least 40% for MAT1C1 in order to be permitted to continue with MAT1C2.

Syllabus:
MAT1C1 (First semester): Basic concepts (number systems, functions), calculus (limits, continuity, differentiation, curve sketching, introduction to integration), propositional calculus, proof techniques, permutations, combinations, binomial theorem, vectors, lines and planes, matrices and systems of linear equations.

MAT1C2 (Second semester): Calculus (integration, applications of integration, improper integrals, ordinary differential equations), complex numbers, sequences and series including Taylor series.

MAT 1S (Introductory Mathematics)

MAT1S is offered in the first semester. A supplementary examination may be recommended provided that the candidate achieves a minimum standard specified by the department.

Syllabus: Estimation, ratios, scales (log scales), change of units, measurements; vectors, systems of equations, matrices, in 2-dimensions; Functions: Review of coordinate geometry, absolute values (including graphs); Inequalities; Power functions, trig functions, exponential functions, the number *e* (including graphs); Inverse functions: roots, logs, ln (including graphs); Graphs and working with graphs; Interpretation of graphs, modeling; Descriptive statistics (mean, standard deviation, variance) with examples including normally distributed data; Introduction to differentiation and basic derivatives; Differentiation techniques (product, quotient and chain rules); Introduction to integration and basic integrals; modeling, translation of real-world problems into mathematics.

MAT 1F (Foundation Mathematics)

This full-year course helps students develop appropriate mathematical tools necessary to represent and interpret information quantitatively. It also develops skills and meaningful ways of thinking, reasoning and arguing with quantitative ideas in order to solve problems in any given context.

Syllabus: Arithmetic: Units of scientific measurement, scales, dimensions; Error and uncertainty in measure values. Fractions and percentages - usages in basic science and commerce; use of calculators and spreadsheets.

Algebra: Polynomial, exponential, logarithmic and trigonometric functions and their graphs; modelling with functions; fitting curves to data; setting up and solving equations. Sequences and series, presentation of statistical data.

Differential Calculus: Limits and continuity; Rules of differentiation; Applications of Calculus in curve sketching and optimisation.

Second Year

Mathematics 2 comprises two semesterized courses, MAM201 and MAM202. Credit may be obtained in each course separately. An aggregate mark of 50% will grant the two-credit course MAM2, provided a sub-minimum of 40% is achieved in both semesters.

MAM201 (First semester):

MAM201 is comprised of three modules which run concurrently throughout the semester:

Advanced Calculus: Partial differentiation: directional derivatives and the gradient vector; maxima and minima of surfaces; Lagrange multipliers. Multiple integrals: surface and volume integrals in general coordinate systems. Vector calculus: vector fields, line integrals, fundamental theorem of line integrals, Green's theorem, curl and divergence, parametric curves and surfaces.

Ordinary Differential Equations: First order ordinary differential equations, linear differential equations of second order, Laplace transforms, systems of equations, series solutions.

Mathematical Modeling and Programming 1: Introduction to the MATLAB language, basic syntax, tools, programming principles. Applications taken from MAM2 modules. This course continues in the second semester.

MAM202 (Second semester):

MAM202 is comprised of four modules which run concurrently throughout the semester:

Linear Algebra: Linear spaces, inner products, norms. Vector spaces, spans, linear independence, basis and dimension. Linear transformations, change of basis, eigenvalues, diagonalization and its applications.

Introduction to Algebra (First term): Set theory; mappings; binary operations; equivalence relations and order; groups.

Introduction to Analysis (Second term): Real numbers; open and closed intervals; sequences and series (convergence); functions of a real variable (continuity, limit); series of functions; Taylor series.

Mathematical Modeling and Programming 2: Problem-based continuation of Semester 1.

Third-year

Mathematics (MAT) and Applied Mathematics (MAP) are offered at the third year level. Credit for MAM 2 is required before admission to the third year courses.

The two majors are organized into the modules listed below:

Code	Topic	Semester	Major
MAM311	Complex Analysis	1	MAP and MAT
MAP311	Numerical Analysis	2	MAP
MAP312	Dynamical Systems	2	MAP
MAP314	Partial Differential Equations	1	MAP
MAT311	Algebra	2	MAT
MAT313	Real Analysis	1	MAT
MAT315	Topics in Mathematics	2	MAT

A major in MAP requires an average mark of at least 50% over the four modules MAP311, MAP312, MAP314 and MAM311, with at least 40% in each course.

A major in MAT requires an average mark of at least 50% over the four modules MAT311, MAT313, MAT315 and MAM311, with at least 40% in each course.

Students who obtain an average of at least 50% over all seven courses will be granted credit for both MAP3 and MAT3, provided that the average of the MAP modules is at least 50% and the average of the MAT modules is at least 50%, and a minimum of 40% is achieved in each module.

Individual module credits may be carried forward from year to year.
Changes to the topics offered may be made from time-to-time depending on the interests of the academic staff.

MAM311 - Complex Analysis: (This is a common course required by both MAP and MAT majors.) Revision of complex numbers, Cauchy- Riemann equations, analytic and harmonic functions, elementary functions and their properties, branches of logarithmic functions, complex differentiation, integration in the complex plane, Cauchy's Theorem and integral formula, Taylor and Laurent series, Residue theory and applications. Fourier Integrals.

MAP311 - Numerical Analysis: Systems of non-linear equations, polynomial interpolation, cubic splines, numerical linear algebra, numerical computation of eigenvalues, numerical differentiation and integration, numerical solution of ordinary and partial differential equations, finite differences, approximation theory, discrete Fourier transform.

MAP312 - Dynamical Systems: Differential equations and iterated maps as dynamical systems. Geometric representation of trajectories. Limiting behaviour of trajectories in linear and nonlinear systems. Equilibria of linear systems and linearisation of hyperbolic equilibria of nonlinear systems. Invariant sets and attractors. Bifurcation and chaos in nonlinear maps. Notions of stability. Some applications of dynamical systems in modeling.

MAP314 - Partial Differential Equations: First-order partial differential equations, classification of second-order equations, construction and behaviour of solutions, the method of characteristics, shocks and nonlinear phenomena, maximum principles, energy integrals, Fourier transform methods.

MAT311 - Algebra: Sets, equivalence relations, groups, rings, fields, integral domains, homorphisms, isomorphisms, and their elementary properties.

MAT313 - Real Analysis: Topology of the real line, continuity and uniform continuity, Heine-Borel, Bolzano-Weierstrass, uniform convergence, introduction to metric spaces.

MAT315 - Topics in Mathematics: This course will cover one of the following two areas. Please consult the department to determine which is offered in a given year:

Differential Geometry: Curves (in the plane and in the space), curvature, global properties of curves, surfaces, the first fundamental form, isometries, the second fundamental form, the normal and principal curvatures, the Gaussian and mean curvatures, the Gauss map, geodesics.

Discrete Mathematics: Permutations, combinations, generating functions, recursions, inclusion-exclusion, congruences, residue classes, graphs, Pythagorean triples, sums of 2 and 4 squares, Diophantine equations, continued fractions.

Mathematics and Applied Mathematics Honours
Each of the two courses (Mathematics and Applied

Mathematics) consists of six topics and one project. A Mathematics Honours degree usually requires the candidate to have majored in Mathematics (MAT 3). An Applied Mathematics Honours degree usually requires the candidate to have majored in Applied Mathematics (MAP 3).

The topics are selected from the following general areas covering a wide spectrum of contemporary mathematics: Algebra; Algebraic Graph Theory; Combinatorics; Functional Analysis; General Relativity; Geometry; Information Theory; Manifolds, Measure Theory; Number Theory; Numerical Modelling; Statistical mechanics; Continuum Mechanics; Topology.

Joint Honours in Mathematics or Applied Mathematics: For Joint Honours programmes, an approved selection of topics may be taken from the options listed above. These modules must contribute to between 40% and 60% of the final grade.

It is also possible to substitute individual modules from other departments into a Mathematics or Applied Mathematics honours programme, with the approval of the Heads of the departments concerned. Alternatively, honours modules from the Department of Mathematics may be considered by other departments as components of their postgraduate courses, again with the approval of the departments concerned.

Master's and Doctoral degrees in Mathematics or Applied Mathematics

Suitably qualified students are encouraged to proceed to these degrees under the direction of the staff of the Department. Requirements for these degrees are given in the General Rules.

A Master's degree in either Mathematics or Applied Mathematics may be taken by thesis only, or by a combination of course work and a thesis. If course work is offered, normally four examination papers and/or essays are required in addition to the thesis. The course of study must be approved by the Head of Department.