BSc (Hons) Mathematics - SC320 (Under Review)
(Optional Minor: Biology / Chemistry / Environmental Science / Physics)

1. Objectives

The BSc (Hons) Mathematics programme is designed to meet the need for graduate mathematicians with a wide range of mathematical, statistical and computing skills in order to enable them to pursue careers in teaching, computing and industry. The programme also offers adequate background to those willing to pursue further study and research.

Specific objectives of the programme are:

- to equip graduates with a strong base in the theory of Mathematics and Statistics;
- to provide analytical problem solving skills and other transferable intellectual skills;
- to produce graduates who are competent users of mathematical software and who have good general IT skills.

The programme is based around four themes, algebra and analysis, probability and statistics, applied mathematics, programming and numerical algorithms.

2. General Entry Requirements

As per General Entry Requirements for admission to the University for undergraduate degrees.

3. Programme Requirement

Minimum Grade 'C' in Mathematics at GCE 'A' level.

4. Programme Duration

	Normal	**Maximum**
Degree:	3 years	5 years

5. Credits per Year

Minimum: 18 credits; Maximum (including retake modules): 48 credits

6. Minimum Credits Required for Award of Undergraduate Degree: 100

Breakdown as follows:

	Credits from		
Degree	**Core Taught Modules**	**Project**	**Electives**
BSc(Hons) Mathematics	66	10	Minimum 24[a]

[a] At least 9 credits from level/year 3 Mathematics electives and at least 15 credits in **one** of the following: Mathematics, Biology, Chemistry, Environmental Science and Physics.

7. Assessment

Each yearly module will be assessed over 100 marks whereas each semester module may either be assessed singly over 100 marks or it may be combined with another semester module and assessed jointly over 100 marks with details as follows (unless otherwise specified):

Assessment will be based on a written examination of 2 to 3-hour duration (normally a paper of 2 hour duration for modules carrying less or equal to three credits and 3 hour paper for modules carrying five-six credits) and on continuous assessment done during the semester or year.

Written examinations for all modules, whether taught in semester 1 or in semester 2 or both, will be carried out at the end of the academic year (unless otherwise stated).

The continuous assessment will count for 10-40% of the overall percentage mark of the module(s), except for a Programme where the structure makes for other specific provision(s). Continuous assessment may be based on laboratory work, seminars and/or assignments and should include at least 1 class test.

There will be a compulsory class test for all modules taught in semester 1 at the end of semester 1 of the given academic year unless stated otherwise in the Programme Structure.

A minimum of at least 30% should be attained in each of continuous assessment and written examination, with an overall total of 40% for a candidate to pass a module. For modules being assessed jointly, a minimum of at least 30% should be attained in each of continuous assessment and written examination, with an overall total of 40% for a candidate to pass the two modules. Note that the marks for the two modules will be considered together and not the individual marks for each of the two modules.

Special examinations (e.g. class tests) will be arranged at the end of semester 1 or semester 2 for exchange students who have registered only for one semester. In case of yearly modules, credits will be assigned on a pro-rata basis.

Projects/Dissertations will carry 10 credits for degree award. They will normally be carried out in the area of specialisation.

The following pairs of semester modules will be assessed jointly:
MATH 1131(1)/MATH 1231(1); MATH 1141(1)/MATH 1241(1); MATH 2111(3)/MATH 2211(3); MATH 2131(3)/MATH 2241(3); MATH 2141(3)/MATH 2231(3).

SCI 1010(1) will carry 100 marks and will be assessed solely by continuous assessment.

8. List of Modules

A. Mathematics Core Modules (63 + 10 Credits)

Code	Module Name	Hrs/Wk L+P	Credits
CSE 1010e(1)	Introduction to IT	O.E.	3
MATH 1111(1)	Mathematics I	D.E.	3
MATH 1021Y(1)	Analysis	3+0	6
MATH 1131(1)	Mechanics I	3+0	3
MATH 1141(1)	Algebra	3+0	3
MATH 1211(1)	Mathematics II	D.E.	3
MATH 1231(1)	Computer Programming I	2+2	3
MATH 1241(1)	Probability & Statistics	3+0	3
MATH 2111(3)	Complex Analysis	3+0	3
MATH 2021Y(3)	Numerical Analysis	3+0	6
MATH 2131(3)	Mathematical Methods I	3+0	3
MATH 2141(3)	Linear Algebra	3+0	3
MATH 2211(3)	Metric Spaces	3+0	3
MATH 2231(3)	Mathematical Programming	3+0	3
MATH 2241(3)	Mathematical Statistics	3+0	3
MATH 3000(5)	Project	-	10
MATH 3111(5)	Lebesgue Measure and Integral	3+0	3
MATH 3121(5)	Fluid Dynamics I	3+0	3
MATH 3211(5)	Functional Analysis	3+0	3
MATH 3221(5)	Applied Probability	3+0	3
SCI 1010(1)	Computing Environment and Tools for Scientific Reporting	2+2	3

B. Mathematics Electives (Not all modules may be on offer)

MATH 1251(1)	Mechanics II	3+0	3
MATH 2151(3)	Linear Statistical Models	3+0	3
MATH 2161(3)	Group Theory	3+0	3
MATH 2171(3)	Discrete Mathematics	3+0	3
MATH 2181(3)	Vector and Tensor Analysis	3+0	3
MATH 2251(3)	Numerical Linear Algebra	3+0	3
MATH 2261(3)	Mathematical Methods II	3+0	3
MATH 2271(3)	Computer Programming II	2+2	3
MATH 3131(5)	Operational Research	3+0	3
MATH 3141(5)	Multivariate Analysis	3+0	3
MATH 3151(5)	Numerical Solution of PDE’s	3+0	3
MATH 3161(5)	Financial Mathematics	3+0	3
MATH 3231(5)	Optimisation	3+0	3
MATH 3241(5)	Time Series Analysis	3+0	3
MATH 3251(5)	Fluid Dynamics II	3+0	3
MATH 3261(5)	Rings and Fields	3+0	3

C. Other Electives

Approved modules offered by other units/departments.

9. Programme Plan - BSc (Hons) Mathematics

YEAR 1

Semester 1 Code	Module Name	Hrs/Wk L+P	Credits	Semester 2 Code	Module Name	Hrs/Wk L+P	Credits
CORE				**CORE**			
CSE 1010e(1)	Introduction to IT	O.E.	3	MATH 1211(1)	Mathematics II	D.E.	3
MATH 1111(1)	Mathematics I	D.E.	3	MATH 1021Y(1)	Analysis	3+0	6
MATH 1021Y(1)	Analysis	3+0	-	MATH 1231(1)	Computer Programming I	2+2	3
MATH 1131(1)	Mechanics I	3+0	3	MATH 1241(1)	Probability & Statistics	3+0	3
MATH 1141(1)	Algebra	3+0	3				
SCI 1010(1)	Computing Environments & Tools for Sci. Reporting	2+2	3	**ELECTIVES**			
				MATH 1251(1)	Mechanics II	3+0	3

YEAR 2

Semester 1 Code	Module Name	Hrs/Wk L+P	Credits	Semester 2 Code	Module Name	Hrs/Wk L+P	Credits
CORE				**CORE**			
MATH 2111(3)	Complex Analysis	3+0	3	MATH 2211(3)	Metric Spaces	3+0	3
MATH 2021Y(3)	Numerical Analysis	3+0	-	MATH 2021Y(3)	Numerical Analysis	3+0	6
MATH 2131(3)	Mathematical Methods I	3+0	3	MATH 2231(3)	Mathematical Programming	3+0	3
MATH 2141(3)	Linear Algebra	3+0	3	MATH 2241(3)	Mathematical Stats	3+0	3
ELECTIVES				**ELECTIVES**			
MATH 2151(3)	Linear Statistical Models	3+0	3	MATH 2251(3)	Numerical Linear Algebra	3+0	3
MATH 2161(3)	Group Theory	3+0	3	MATH 2261(3)	Mathematical Methods II	3+0	3
MATH 2171(3)	Discrete Mathematics	3+0	3	MATH 2271(3)	Computer Programming II	2+2	3
MATH 2181(3)	Vector and Tensor Analysis	3+0	3				

YEAR 3

Semester 1 Code	Module Name	Hrs/Wk L+P	Credits	Semester 2 Code	Module Name	Hrs/Wk L+P	Credits
CORE				**CORE**			
MATH 3000(5)	Project	-	-	MATH 3000(5)	Project	-	10
MATH 3111(5)	Lebesgue Measure & Integral	3+0	3	MATH 3211(5)	Functional Analysis	3+0	3
MATH 3121(5)	Fluid Dynamics I	3+0	3	MATH 3221(5)	Applied Probability	3+0	3
ELECTIVES				**ELECTIVES**			
MATH 3131(5)	Operational Research	3+0	3	MATH 3231(5)	Optimisation	3+0	3
MATH 3141(5)	Multivariate Analysis	3+0	3	MATH 3241(5)	Time Series Analysis	3+0	3
MATH 3151(5)	Numl. Soln. of PDEs	3+0	3	MATH 3251(5)	Fluid Dynamics II	3+0	3
MATH 3161(5)	Financial Mathematics	3+0	3	MATH 3261(5)	Rings and Fields	3+0	3

NOTE: NOT ALL ELECTIVES MAY BE ON OFFER

The following pairs of semester modules will be assessed jointly:
MATH 1131(1)/MATH 1231(1); MATH 1141(1)/MATH 1241(1); MATH 2111(3)/MATH 2211(3); MATH 2131(3)/MATH 2241(3); MATH 2141(3)/MATH 2231(3).

10. Outline Syllabus

PQ: Prerequirement *(must follow module & sit for exams)*
PR: Prerequisite *(must attain a minimum of grade E or G)*
MR: Minimum requirement *(must have the required number of credits)*

CSE 1010e(1) - INTRODUCTION TO INFORMATION TECHNOLOGY
IT and Computers; Stepping in the Computer; Input and Output Devices; Secondary Storage; Programming; Systems Software; Applications Software; Systems Development; Computer Networks; The Internet; Computer Security; Software Utilities; Issues and Trends in IT.

MATH 1021Y(1) - ANALYSIS (PR: A-Level Mathematics)
Real numbers. Supremum and Infimum. Open and closed Intervals in **R**. Convergence and divergence of real sequences. Sub-sequences, Cauchy's criterion. Limit of a function. Continuous functions. Uniform continuity. Extreme Value Theorem. Intermediate Value Theorem.
Differentiable functions. Rolle's theorem. Mean value theorem. Taylor's theorem. Real series. Convergence tests. Riemann integration. Integral Mean value theorem. Fundamental theorem of Calculus. Improper integrals.

MATH 1111(1) - MATHEMATICS I (PR: A-Level Mathematics)
Calculus of one and several variables. Polar coordinates. Complex numbers. Hyperbolic functions. Limits. Ordinary differential equations.

MATH 1131(1) - MECHANICS I (PR: A-Level Mathematics)
Kinematics. Newton's Laws of Motion. Hooke's Law. Simple Harmonic Motion. Conservation of energy and linear momentum. Equilibrium of a particle and a rigid body. Moments and couples. Motion of a particle in 2-D using Cartesian and Polar coordinates.

MATH 1141(1) - ALGEBRA (PR: A-Level Mathematics)
Equivalence Relations and equivalence classes. Binary operations on sets. Groups. Normal Subgroups and Homomorphism. Rings and Fields.

MATH 1211(1) - MATHEMATICS II (PR: A-Level Mathematics)
Matrix Algebra: Matrices and determinants. Solution of linear systems of equations. Eigenvalues and eigenvectors.
Infinite Series: Comparison test and Ratio test for non-negative series.
Vector Algebra: Scalar and vector products, triple products. Vector equations.
Vector Analysis: Gradient, divergence and curl. Line and multiple integrals. Green's theorem in the plane, Divergence theorem and Stokes' theorem.

MATH 1231(1) - COMPUTER PROGRAMMING I (PR: A-Level Mathematics)
Introduction to C^{++}. Basic Types. Expressions and Statements. Derived Types. Namespaces and Files. Object Oriented Design. Classes. Templates.

MATH 1241(1) - PROBABILITY & STATISTICS (PR: A-Level Mathematics)
Elementary probability. Conditional probability. Discrete and continuous distributions. The Central Limit Theorem. Estimation and Hypothesis testing. Non-parametric methods.

MATH 1251(1) - MECHANICS II (PQ: MATH 1131(1))
Systems of particles. Linear and Angular Momentum. General Motion of a rigid body in 2-D. Impulsive motion. Generalised coordinates. Derivation of Lagrange's equation for a holonomic system. Generalised components of momentum and impulse.

MATH 2021Y(3) - NUMERICAL ANALYSIS (PR: A-Level Mathematics)
Floating point computations.
Interpolation.
Solution of non-linear equations. Fixed point iterative methods and the Newton-Raphson method.

Solution of linear equations. Direct and iterative methods.
Numerical differentiation. Numerical integration: Romberg integration, Richardson extrapolation, Gaussian quadrature.
Ordinary differential equations: Initial value problems for systems of first-order ode's. Single and multistep methods. Order, Convergence. Linear stability theory (intervals of absolute stability), A-stability, L-stability. Runge-Kutta and predictor-corrector methods. Numerical methods for second-order initial value problems.

MATH 2111(3) - COMPLEX ANALYSIS (PR: MATH 1021Y(1))
Function of a complex variable. Holomorphic functions. Cauchy-Riemann equations.
Integration along a path. Cauchy's theorem. Cauchy's integral formula and Cauchy's formula for derivatives. Complex power series. Taylor's series.
Laurent's theorem and classification of singularities.
Cauchy's residue theorem and applications of contour integration.

MATH 2131(3) - MATHEMATICAL METHODS I (PQ: MATH 1211(1))
Qualitative theory of ode's. Fourier series. First and second-order partial differential equations. Laplace and Fourier transforms.

MATH 2141(3) - LINEAR ALGEBRA (PQ: MATH 1141(1))
Vector spaces. Subspaces. Linear dependence and independence. Basis and dimension.
Linear transformations. Rank and Nullity. Change of bases. Eigenvalues and eigenvectors. Invariant subspaces. Quadratic forms.

MATH 2151(3) - LINEAR STATISTICAL MODELS (PQ: MATH 1241(1))
Simple Linear Regression. Multiple Linear Regression. Model Adequacy checking. Transformations to correct Model inadequacy. Analysis of variance.

MATH 2161(3) - GROUP THEORY (PQ: MATH 1141(1))
Cyclic, Dihedral, Symmetric and Alternating groups. Permutation groups.
Automorphism of groups. Isomorphism theorems. Sylow theorems.

MATH 2171(3) - DISCRETE MATHEMATICS (PQ: MATH 1141(1))
Graphs and Algorithms. Trees and spanning trees. Prim's algorithm and Kruskal's algorithm.
Permutations and Combinations. Recurrence relations. Generating functions.

MATH 2181(3) - VECTOR AND TENSOR ANALYSIS (PQ: MATH 1211(1))
Curvilinear coordinates. Einstein summation convention. Basic linear algebra for tensors. General tensors. Tensor operations. The metric tensor. Derivative of a tensor. Applications.

MATH 2211(3) - METRIC SPACES (PR: MATH 1021Y(1))
Metric spaces. Open and closed sets. Equivalent metrics. Continuity. Convergence and completeness. Compactness. Arzela-Ascoli theorem.

MATH 2231(3) - MATHEMATICAL PROGRAMMING (PQ: MATH 1211(1))
Linear Programming: Simplex method, duality and sensitivity analysis. Integer Programming. Branch and bound techniques. Transportation and assignment problems. Introduction to Dynamic programming.

MATH 2241(3) - MATHEMATICAL STATISTICS (PQ: MATH 1241(1))
Axiomatic approach to probability. Bayes' theorem. Product moments. Conditional Expectations.
Generating functions. Limit theorems. Functions of random variables: Transformation techniques and Joint distributions.

MATH 2251(3) - NUMERICAL LINEAR ALGEBRA (PQ: MATH 2141(3))
Vector and matrix norms. Householder and Givens transformations. QR factorisation. Least-Squares problem. Eigenvalue problem. Power method and Rayleigh quotient iteration. Householder deflation.

MATH 2261(3) - MATHEMATICAL METHODS II (PQ: MATH 2131(3))
Boundary value problems. Green's functions. Perturbation techniques. Integral equations.

MATH 2271(3) - COMPUTER PROGRAMMING II (PQ: MATH 1231(1))
Class Inheritance. Exception Handling. Foundation Data Structures. Queues. Lists. Hashing. Trees. Graphs and Graph Algorithms.

MATH 3000(5) - PROJECT (MR: At least 39 credits from Level/Year 1 & 2 core modules)
Project work on a topic approved by the department.

MATH 3111(5) - LEBESGUE MEASURE AND INTEGRAL (PQ: MATH 2211(3))
Lebesgue measure on a real line. Measurable functions. The Lebesgue integral on the real line. Convergence theorems. L^p spaces. Fubini's theorem.

MATH 3121(5) - FLUID DYNAMICS I (PQ: MATH 2131(3))
Kinematics and Dynamics of simple flows. Irrotational and rotational flows. Complex potential. Theorems of Milne-Thomson and Blasius. Water waves.

MATH 3131(5) - OPERATIONAL RESEARCH (PQ: MATH 2231(3))
Decision theory. Sequential Decision Making. Inventory. Deterministic and Stochastic Models. Network Flows. The Ford-Fulkerson algorithm. Cuts and the Max-Flow-Min-Cut theorem.

MATH 3141(5) - MULTIVARIATE ANALYSIS (PQ: MATH 2151(3))
Multidimensional random variables. Multivariate Normal Distribution. Wishart Distribution. Hottelings T^2. Multivariate Analysis of Variance. Discriminant Analysis.

MATH 3151(5) - NUMERICAL SOLUTION OF PDEs (PQ: MATH 2021Y(3))
Method of characteristics for first- and second-order hyperbolic equations. Finite difference methods for parabolic and hyperbolic equations. Local truncation errors, Consistency, Stability (von Neumann and matrix methods), Convergence. A-stability and L-stability.
Finite difference methods for elliptic partial differential equations. The Maximum Principle. Introduction to Finite element methods.

MATH 3161(5) - FINANCIAL MATHEMATICS (PQ: MATH 2131(3))
Basic Financial Mathematics. Term structure of Interest Rates. Continuous-time Financial Mathematics.

MATH 3211(5) - FUNCTIONAL ANALYSIS (PQ: MATH 3111(5))
Normed vector spaces. Banach spaces. Finite dimensional spaces. The Hilbert space. Linear operators. The Hahn-Banach theorem. Baire Category theorem. Principle of uniform boundedness. Dual spaces. Strong and weak convergence.

MATH 3221(5) - APPLIED PROBABILITY (PQ: MATH 2231(3))
Random Walk. Branching processes. Discrete-time Markov chains. The Poisson Process. Queuing theory.

MATH 3231(5) - OPTIMISATION (PQ: MATH 2121(3))
Unconstrained optimisation. Multivariate problems: Steepest descent, Newton and quasi-Newton methods, Conjugate direction methods. Constrained optimisation.

MATH 3241(5) - TIME SERIES ANALYSIS (PQ: MATH 2151(3))
Components of Time Series data. Exponential smoothing and moving averages. Decomposition methods. Stochastic Time Series. ARMA processes. Estimation of mean and autocovariance. Forecasting.

MATH 3251(5) - FLUID DYNAMICS II (PQ: MATH 2131(3))
Governing equations for a Newtonian fluid. Effects of viscosity on flow of incompressible fluids. Flow at low and high Reynolds number. Generation and confinement of Vorticity.

MATH 3261(5) - RINGS AND FIELDS (PQ: MATH 2161(3))
Ideals of a ring. Characteristics of a ring. Homomorphism and embedding of rings. Euclidean domains, principal ideals, irreducible elements and unique factorisation domains. Finite fields.

SCI 1010(1) - COMPUTING ENVIRONMENTS & TOOLS FOR SCIENTIFIC REPORTING

Introduction to Windows, Linux and Internet.

Word processing: Document Layout, Design Features, Styles and Templates, Automating Processes, Document Formats.

Spreadsheets: Worksheets, Formatting the Workbook, Charting and Layout, Large Worksheets and Productivity Tools, Creating a Spreadsheet, Applying Functions, Statistical Functions, Macros, Extracting Data.

Technical Writing and Presentations.

September 2012