BSc (Hons) Mathematics with Computer Science - SCE321 (Under Review)

1. Objectives

The interface between Mathematics and Computer Science is of major importance as these disciplines now form the nucleus of a new science of information and communication. Mobile computing, security and encryption and concurrency are examples of topics which are attracting much interest in the academic world and which have a significant commercial impact.

The BSc (Hons) Mathematics with Computer Science covers the fundamentals of mathematics and computer science. It aims at preparing graduates for employment in application areas that require substantial input from both these two disciplines. The programme also aims in providing students with sufficient knowledge to enable them to pursue further studies in advanced computer science and computational mathematics.

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**[a]	**GEMs**	**Electives**
BSc (Hons) Mathematics with Computer Science	66	10	6	Minimum 18[b]

[a] Project normally in Major.
[b] A minimum of 18 credits to be obtained from Computer Science electives with at least 12 credits from level/year 2 and level/year 3 electives.

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	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 2151(3)	Linear Statistical Models	3+0	3
MATH 2171(3)	Discrete Mathematics	3+0	3
MATH 2251(3)	Numerical Linear Algebra	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 3231(5)	Optimisation	3+0	3
MATH 3241(5)	Time Series Analysis	3+0	3
MATH 3251(5)	Fluid Dynamics II	3+0	3

C. COMPUTER SCIENCE ELECTIVES (Not all modules may be on offer)

CSE 1002Y(3)	Programming Methodology	2+2	6
CSE 1004Y(1)	Structured Systems Development	2+2	6
CSE 2002Y(3)	Database Systems	2.5+1	6
CSE 2004Y(3)	Prog Languages and Algorithms	2+2	6
CSE 2006Y(3)	Systems Software	2+2	6
CSE 3001Y(5)	Distributed Systems and Multimedia	3+0	6
CSE 3002Y(5)	Computer Networks	3+0	6

E. OTHER ELECTIVES

Approved modules offered by other units/departments.

9. Programme Plan - BSc (Hons) Mathematics with Computer Science

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 1111(1)	Mathematics I	D.E.	3	MATH 1211(1)	Mathematics II	D.E.	3
MATH 1021Y(1)	Analysis	3+0	-	MATH 1021Y(1)	Analysis	3+0	6
MATH 1131(1)	Mechanics I	3+0	3	MATH 1231(1)	Computer Programming I	2+2	3
MATH 1141(1)	Algebra	3+0	3	MATH 1241(1)	Probability & Statistics	3+0	3
SCI 1010(1)	Computing Environments & Tools for Sci. Reporting	2+2	3				
ELECTIVES				**ELECTIVES**			
CSE 1002Y(3)	Programming Methodology	2+2	-	CSE 1002Y(3)	Programming Methodology	2+2	6
CSE 1004Y(1)	Structured Systems Development	2+2	-	CSE 1004Y(1)	Structured Systems Development	2+2	6

One 6-credits GEM may be chosen from selection by department and/or modules to be chosen from any other units/departments for that year

YEAR 2

Semester 1				Semester 2			
Code	**Module Name**	**Hrs/Wk L+P**	**Credits**	**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**			
CSE 2002Y(3)	Database Systems	2.5+1	-	CSE 2002Y(3)	Database Systems	2.5+1	6
CSE 2004Y(3)	Programming Languages and Algorithms	2+2	-	CSE 2004Y(3)	Programming Languages and Algorithms	2+2	6
CSE 2006Y(3)	Systems Software	2+2	-	CSE 2006Y(3)	Systems Software	2+2	6
MATH 2151(3)	Linear Statistical Models	3+0	3	MATH 2251(3)	Numerical Linear Algebra	3+0	3
MATH 2171(3)	Discrete Mathematics	3+0	3	MATH 2271(3)	Computer Programming II	2+2	3

One GEM may be chosen from selection by department and/or modules to be chosen from any other units/departments

One GEM may be chosen from selection by department

YEAR 3

Semester 1				Semester 2			
Code	**Module Name**	**Hrs/Wk L+P**	**Credits**	**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**			
CSE 3001Y(5)	Distributed Systems and Multimedia	3+0	-	CSE 3001Y(5)	Distributed Systems and Multimedia	3+0	6
CSE 3002Y(5)	Computer Networks	3+0	-	CSE 3002Y(5)	Computer Networks	3+0	6
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

One GEM may be chosen from selection by department and/or modules to be chosen from any other units/departments.

One GEM may be chosen from selection by department

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.

CSE 1002Y(3) - PROGRAMMING METHODOLOGY (L/P - 6)
Pseudocode; Structured Programming Techniques; Program Structure; Simple Data Type; Control Structures; Modularity; Structured Data Types; Introduction to Object Oriented Programming; Programming Style and Testing, Abstract Data Types, Arrays, Linked Lists, Stacks, Queues, Trees, Graphs, Operations on Trees and Graphs.

CSE 1004Y(1) - STRUCTURED SYSTEMS DEVELOPMENT (L/P - 6)
Introduction to SSAD; Software life cycles, Introduction to information systems, Components in a system, Preliminary investigation, Requirements Gathering, Requirements Modeling, Data flow analysis, DFD, Data Dictionary, Systems Design, ERD, State Transition Diagram, systems implementation, software design, flowcharts, review methods, managing the development process, estimation and management of development time, Testing, Maintenance Fundamentals of computer applications development, Application Architectures, Databases, Implementation of databases, User interface development, Query By Example, Queries using SQL, Database Access, Forms and Controls, Reports.

CSE 2002Y(3) - DATABASE SYSTEMS (L/P - 6) (PQ: CSE 1004Y(1))
DBMS functions/Components, Database Abstractions, Relational Model ERD, Relational algebra, Normalization, Query Language – SQL, DB design issues, Optimization, Security Issues, Transactions, Distributed Computing, Synchronization, Overview Of Distributed Databases, Distribution Transparency, Distributed Database Design - Commit Protocols and Concurrency Control, Query Processing.

CSE 2004Y(3) - PROGRAMMING LANGUAGES AND ALGORITHMS (L/P - 6) (PQ: CSE 1002Y(3))
Overview of programming languages; language design and implementation issues; language evaluation and selection issues; programming paradigms; programming environments; programming constructs, compilation process; Algorithms Analysis Techniques; Algorithms Design Techniques; Sorting; Searching; String Processing; Graph Algorithms; Dynamic Programming; Backtracking; Mathematical algorithms.

CSE 2006Y(3) - SYSTEMS SOFTWARE (L/P - 6)
Overview of Computer Systems, Processes, threads, Memory Management, Processor Scheduling, Input/Output, Files, Computer Security, Systems programming. Stored Program Computer, Advancements in Architectures, Pipelined Systems, Implementation of Pipelining, RISC, RISC v/s CISC, Comparative Architectures.

CSE 3001Y(5) - DISTRIBUTED SYSTEMS AND MULTIMEDIA (L - 6) (PQ: CSE 2006Y(3))
Characterization of distributed systems, system models, Interprocess Communication, Remote Method Invocations, Distributed OS and File Services, Security, Name Services, Replication. Emergence of Multimedia, System Requirements, Existing Supports.

CSE 3002Y(5) - COMPUTER NETWORKS (L - 6) (PQ: CSE 2004Y(3) and CSE 2006Y(3))
Reference Models (TCP/IP, ATM); Physical Layers (SONET/SDH, ISDN, X21); Data Link Layer (MAC, LLC); Network Layer (IP, ATM); Transport Layer (TCP, UDP, RTP, XTP)); Application Layer (Email, Directory Services, File Transfer); ISP Network Design In-depth Application layers (Email, Directory Services, File Transfer); Introduction to Network Design.

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 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 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 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 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 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 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 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 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 I & II 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 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.

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.

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