# BSc (Hons) Mathematics

## 1. Objectives

The BSc (Hons) Mathematics programme offers a combination of lectures and tutorials in Pure & Applied Mathematics, Probability & Statistics, Financial Mathematics and Computational Mathematics. The aims and objectives are:

- to provide a challenging course in Mathematics and its applications for a range of students;
- to provide a course that is suitable both for students aiming to pursue research and for students going into other careers;
- to develop in students the capacity for learning and for clear logical thinking;
- to produce the high calibre graduates in Mathematics sought by employers in the private & public sectors;
- to provide an intellectually stimulating environment in which students have the opportunity to develop their skills to their full potential.

## 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:

| **Degree** | **Core Taught Modules** | **Project** | **Electives** |
|---|---|---|---|
| BSc(Hons) Mathematics | 72 | 7 | Minimum 21[a,b] |

[a] 6 credits from level 1 electives
[b] 6 credits from Mathematics level/year 2 electives & 9 credits from Mathematics level/year 3 electives.

**IMPORTANT NOTE: The student will be allowed to opt for the BSc (Hons) Mathematics, BSc (Hons) Mathematics with Statistics, or BSc (Hons) Mathematics with Finance programme after the common first year. For the specialisation in Finance/Statistics students are required to have 33 credits from Level 2/3 Finance/Statistics modules.**

## 7. Assessment

Each module will be assessed over 100 marks and assessment will be based on a written examination of 2-hour duration for modules carrying less than 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 modules, will be carried out at the end of the year, except for MATH1101(1) and MATH1201(1), which will be examined at the end of the semester.

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 at the end of each semester of the given academic year unless stated otherwise in the Programme Structure.

An overall total of 40% is required for a candidate to pass a module. 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 7 credits for degree award.

The following list of modules will be assessed solely by continuous assessment:

MA1106Y (1)
MA1203(1)
MA3010(5)

## 8. List of Modules

**A. Core Modules (72 + 7 Credits)**

| Code | Module Name | Hrs/Wk/ L+P | Credits |
|---|---|---|---|
| MA1101(1) | Mathematical Techniques I | 3+0 | 3 |
| MA1102(1) | Mathematical Analysis I | 3+0 | 3 |
| MA1103(1) | Applied Mathematics I | 3+0 | 3 |
| MA1104(1) | Algebra | 3+0 | 3 |
| MA1105(1) | Probability & Statistics | 3+0 | 3 |
| MA1106Y(1) | Tools for Scientific Reporting | 2+2 | 6 |
| MA1201(1) | Mathematical Techniques II | 3+0. | 3 |
| MA1202(1) | Mathematical Analysis II | 3+0 | 3 |
| MA1203(1) | Computer Applications in Mathematics | 2+2 | 3 |
| MA2101(3) | Numerical Analysis I | 3+0 | 3 |
| MA2102(3) | Mathematical Methods I | 3+0 | 3 |
| MA2103(3) | Mathematical Statistics | 3+0 | 3 |
| MA2104(3) | Complex Analysis | 3+0 | 3 |
| MA2105(3) | Metric Spaces | 3+0 | 3 |
| MA2201(3) | Linear Algebra | 3+0 | 3 |
| MA2202(3) | Linear Programming | 3+0 | 3 |
| MA2203(3) | Linear Regression Analysis | 3+0 | 3 |
| MA2204(3) | Numerical Analysis II | 3+0 | 3 |
| MA2205(3) | Numerical Linear Algebra | 3+0 | 3 |
| MA3000(5) | Project | - | 7 |
| MA3101(5) | Measure and Integral | 3+0 | 3 |
| MA3102(5) | Fluid Dynamics I | 3+0 | 3 |
| MA3201(5) | Applied Probability | 3+0 | 3 |
| MA3202(5) | Functional Analysis | 3+0 | 3 |

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

| | | | |
|---|---|---|---|
| ACF1000(1) | Accounting For Financial Decision Making | 3+0 | 3 |
| ACF1002(1) | Principles of Finance | 3+0 | 3 |
| MA1001(1) | Financial Mathematics | 3+0 | 3 |
| MA1002(1) | Applied Mathematics II | 3+0 | 3 |
| MA1003(1) | Descriptive Statistics | 3+0 | 3 |
| MA1004(1) | Simulation Modeling and Analysis | 3+0 | 3 |
| MA2001(3) | Group Theory | 3+0 | 3 |
| MA2002(3) | Discrete Mathematics | 3+0 | 3 |
| MA2003(3) | Vector and Tensor Analysis | 3+0 | 3 |
| MA2005(3) | Mathematical Methods II | 3+0 | 3 |
| MA3001(5) | Operational Research | 3+0 | 3 |
| MA3003(5) | Numerical Solution of PDE’s | 3+0 | 3 |
| MA3004(5) | Optimisation | 3+0 | 3 |
| MA3006(5) | Fluid Dynamics II | 3+0 | 3 |
| MA3007(5) | Rings and Fields | 3+0 | 3 |
| MA3008(5) | Topology | 3+0 | 3 |
| MA3009(5) | Dynamical Systems | 3+0 | 3 |
| MA3010(5) | Mathematical Modelling | 3+0 | 3 |

## 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** | | | |
| MA1101(1) | Mathematical Techniques I | 3+0 | 3 | MA1201(1) | Mathematical Techniques II | 3+0 | 3 |
| MA1102(1) | Mathematical Analysis I | 3+0 | 3 | MA1202(1) | Mathematical Analysis II | 3+0 | 3 |
| MA1103(1) | Applied Mathematics I | 3+0 | 3 | MA1203(1) | Computer Applications in Mathematics | 2+2 | 3 |
| MA1104(1) | Algebra | 3+0 | 3 | | | | |
| MA1105(1) | Probability & Statistics | 3+0 | 3 | | | | |
| MA1106Y(1) | Tools for Scientific Reporting | 2+2 | 6 | **TWO ELECTIVES FROM:** | | | |
| | | | | MA1001(1) | Financial Mathematics I | 3+0 | 3 |
| | | | | MA1002(1) | Applied Mathematics II | 3+0 | 3 |
| | | | | MA1003(1) | Descriptive Statistics | 3+0 | 3 |
| | | | | MA1004(1) | Simulation Modeling & Analysis | 3+0 | 3 |
| | | | | ACF1000(1) | Accounting for Financial Decision Making | 3+0 | 3 |
| | | | | ACF1002(1) | Principles of Finance | 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** | | | |
| MA2101(3) | Numerical Analysis I | 3+0 | 3 | MA2201(3) | Linear Algebra | 3+0 | 3 |
| MA2102(3) | Mathematical Methods I | 3+0 | 3 | MA2202(3) | Linear Programming | 3+0 | 3 |
| MA2103(3) | Mathematical Statistics | 3+0 | 3 | MA2203(3) | Linear Regression Analysis | 3+0 | 3 |
| MA2104(3) | Complex Analysis | 3+0 | 3 | MA2204(3) | Numerical Analysis II | 3+0 | 3 |
| MA2105(3) | Metric Spaces | 3+0 | 3 | MA2205(3) | Numerical Linear Algebra | 3+0 | 3 |
| **NOTE: AT LEAST TWO ELECTIVES FROM:** | | | | | | | |
| MA2001(3) | Group Theory | 3+0 | 3 | MA2003(3) | Vector & Tensor Analysis | 3+0 | 3 |
| MA2002(3) | Discrete Mathematics | 3+0 | 3 | MA2005(3) | Mathematical Methods II | 3+0 | 3 |

**and /or any other year 2 module offered by the department.**

**YEAR 3**

| Semester 1 Code | Module Name | Hrs/Wk L+P | Credits | Semester 2 Code | Module Name | Hrs/Wk L+P | Credits |
|---|---|---|---|---|---|---|---|
| **CORE** | | | | **CORE** | | | |
| MA3000(5) | Project | - | 7 | | | | |
| MA3101(5) | Measure & Integral | 3+0 | 3 | MA3201(5) | Applied Probability | 3+0 | 3 |
| MA3102(5) | Fluid Dynamics I | 3+0 | 3 | MA3202(5) | Functional Analysis | 3+0 | 3 |
| **NOTE: AT LEAST THREE ELECTIVES FROM** | | | | | | | |
| MA3001(5) | Operational Research | 3+0 | 3 | MA3007(5) | Rings & Fields | 3+0 | 3 |
| MA3003(5) | Numerical Solution of PDEs | 3+0 | 3 | MA3008(5) | Topology | 3+0 | 3 |
| MA3004(5) | Optimisation | 3+0 | 3 | MA3009(5) | Dynamical Systems | 3+0 | 3 |
| MA3006(5) | Fluid Dynamics II | 3+0 | 3 | MA3010(5) | Mathematical Modelling | 3+0 | 3 |

**and /or any other year 3 module offered by the department.**

**Note:**

1. ***Electives may be offered in either semester 1 or 2 & not all electives may be on offer.***
2. ***Students opting for BSc (Hons) Mathematics with Finance should register for ACF 1000(1) and ACF1002(1) as electives in Year I.***

## 10. Outline Syllabus

**PQ: Prerequirement** *(must follow module & sit for exams)*
**MR: Minimum requirement** *(must have the required number of credits)*

## Core Modules

**MA1101(1) - Mathematical Techniques I**
Differentiation/Integration, Differential Equations, Hyperbolic Functions, Partial Differentiation, Double Integration.

**MA1102(1) - Mathematical Analysis I**
The real numbers, Sequences, Infinite series, Limits.

**MA1103(1) - Applied Mathematics I**
Statics, Systems of particles, Dynamics.

**MA1104(1) - Algebra**
Set Theory, Equivalence Relations & Classes, Groups, Subgroups and Homomorphism, Rings & Fields.

**MA1105(1) - Probability & Statistics**
Elementary Probability, Random Variables, Discrete and Continuous Probability Distributions, The Central Limit Theorem (CLT), Estimation, Testing of Hypothesis, Non-parametric Methods. Categorical Data Analysis

**MA1106Y(1) - Tools for Scientific Reporting**
Word Processing, Spreadsheets, VBA, Latex.

**MA1201(1) - Mathematical Techniques II**
Matrix Algebra and Solution of Linear Systems. Column/Row Space. Eigenvalues. Vector Analysis. Change of Variables. Triple Integration.

**MA1202(1) - Mathematical Analysis II (PQ: MA1102(1))**
Continuity of Functions, Intermediate-Value Theorem, Differentiable Functions, Rolle's Theorem, Mean value Theorem, Taylor's Theorem, Riemann Integration, Integral Mean Value Theorem, Improper Integrals.

**MA1203(1) - Computer Applications in Mathematics**
Introduction to C++, Introduction to Mathematica, Symbolic Calculations, Scientific Visualisation.

**MA2101(3) - Numerical Analysis I (PQ: MA1101(1))**
Floating Point Computations. Interpolation, Solution of Linear Equations. Direct and Iterative Methods, Solution of Non-linear Equations. Numerical Differentiation. Numerical Integration.

**MA2102(3) - Mathematical Methods I (PQ: MA1201(1))**
Review of first- and second-order ODEs, Fourier series, First and Second-order Partial Differential Equations, Laplace and Fourier transforms.

**MA2103(3) - Mathematical Statistics (PQ: MA1105(1))**
Axiomatic approach to Probability, Bayes' Theorem, Bivariate Random Variables, Mathematical Expectations, Generating functions, Limit theorems, Probability Distributions.

**MA2104(3) - Complex Analysis(PQ: MA1202(1))**
Complex-valued functions, Cauchy-Riemann equations, Holomorphic and harmonic functions, Complex Integration, Cauchy's Theorem, Cauchy's Integral Formulas, Complex Series, Taylor and Laurent Theorems, Laurent Expansions, Cauchy's Residue Theorem, Residue Calculus.

**MA2105(3) - Metric Spaces (PQ: MA1202(1))**
Metric Spaces. Open and closed sets, Equivalent metrics, Continuity, Convergence and Completeness, Compactness.

**MA2201(3) - Linear Algebra (PQ: MA1104(1))**
Vector spaces. Subspaces. Linear dependence and independence. Basis and dimension. Linear transformations. Change of bases. Eigenvalues and eigenvectors. Invariant subspaces. Quadratic forms.

**MA2202(3) - Linear Programming (PQ: MA1201(1))**
Linear Programming Problems, Integer Programming, Network Problems

**MA2203(3) - Linear Regression Analysis (PQ: MA1105(1))**
Simple Linear Regression. Multiple Linear Regression. Model Adequacy checking. Transformations to correct Model inadequacy. Polynomial regression models Variable selection and model building

**MA2204(3) - Numerical Analysis II (PQ: MA1101(1))**
Initial Value Problems. Basic Methods. Consistency, Zero-Stability and Convergence Runge-Kutta Methods. Explicit and Implicit RK Methods. Order Conditions and Butcher Trees. Collocation RK methods. Linear Multistep Methods. Adams Bashforth and Adams-Moulton Methods. Characteristic Polynomials. Nystrom Methods.

**MA2205(3) - Numerical Linear Algebra (PQ: MA1104(1))**
Matrix Multiplication Problems, Vector and matrix norms. Householder and Givens transformations QR factorisation. Least-Squares problem. Eigenvalue problem. Power method and Rayleigh quotient iteration Householder deflation.

**MA3000(5) - Project (MR: CPA > 45% & at least 42 credits from Maths Core Modules )**
Project work on a topic approved by the Department of Mathematics.

**MA3101(5) - Measure and Integral (PQ: MA1202(1))**
Lebesgue measure on a real line. Measurable functions. The Lebesgue integral on the real line. Convergence theorems. Lebesgue probability space. Cumulative distribution function.

**MA3102(5) - Fluid Dynamics I (PQ: MA2102(3))**
Kinematics and Dynamics of simple flows. Irrotational and rotational flows. Complex potential. Theorems of Milne-Thomson and Blasius.

**MA3201(5) - Applied Probability (PQ: MA2103(3))**
Conditional Expectation. Law of Total Expectation. Generating Functions. Branching Processes Discrete Time Markov Chains. Continuous Time Markov Chains. The Poisson Process

**MA3202(5) - Functional Analysis (PQ: M 2105(3))**
Normed vector spaces. Banach spaces. Finite dimensional spaces. The Hilbert space. Linear operators. Fundamental theorem for normed and Banach spaces Principle of uniform boundedness. Dual spaces. Strong and weak convergence

## Elective Modules

**ACF1000(1) - Accounting For Financial Decision Making**

The Role of Accounting Information; Recording and Summarising Transactions; Accounting Concepts & Preparing Final Accounts; Adjustments to Final Accounts; Capital v/s Revenue Expenditure; Bank Reconciliation Statement; Accounting Ratios; Accounting for Internal Decision Making Techniques; Elements of Cost; Costing Methods & Techniques; Decision Making Techniques; Accounting for Manufacturers; Budgeting.

**ACF1002(1) - Principles of Finance**

Description of the Financial System; Capital Markets; An Analysis of the Mechanisms of the Financial System in the Economy: Theory and Current Statistics; Time value of money; Capital Budgeting: an introduction; Valuation of Financial Assets; Bond Analysis: an introduction; Risk, Return and Diversification; Efficient Market Hypothesis; Multinational Finance: an introduction.

**MA1001(1) - Financial Mathematics**

Time Value of Money. Bonds and Term Structure.

**MA1002(1) - Applied Mathematics II (PQ: MA1103(1))**

Rigid bodies. Moments of Inertia. Generalised coordinates.

**MA1003(1) - Descriptive Statistics**

Characteristics of data, Data collection, Data presentation, Univariate data, Covariance and correlation, Index Numbers.

**MA1004(1) - Simulation Modeling and Analysis**

Basic Simulation Modeling, Random-Number Generators, Generating Random Variates, Output Data Analysis for a Single System, Variance Reduction Techniques, Use of a simulation software.

**MA2001(3) - Group Theory (PQ: MA1104(1))**

Cyclic, Isomorphism theorems. Permutation groups. Automorphism of groups. Symmetric and Alternating groups. Dihedral Groups,Sylow theorems.

**MA2002(3) - Discrete Mathematics (PQ: MA1104(1))**

Fundamental Principles of counting, Generating Functions, Asymptotic bounds, Recurrence relations, Graph Theory and Applications

**MA2003(3) - Vector and Tensor Analysis (PQ: MA1201(1))**

Index notation. Einstein summation convention. Curvilinear coordinates. Basic linear algebra for tensors. General tensors. Tensor operations. Derivative of a tensor. Matrices.

**MA 2005(3) – Mathematical Methods II (PQ: MA2102(3))**

Method of Characteristics. Boundary value problems. Green's functions. Integral equations.

**MA 3001(5) - Operational Research (PQ: MA 2202(3))**

Decision theory. Inventory. Network Flows.

**MA 3003(5) - Numerical Solution of PDEs (PQ: MA2101(3))**

Fourier Transforms. Semi-Discrete Fourier Transforms. Well-Posed Problems, Hyperbolic Problems. Method of Characteristics, Numerical Schemes for Hyperbolic Problems. Consistency, Stability and Convergence Parabolic Equations. The Heat Equation and Crank-Nicolson Scheme. Higher Order Discretisations Elliptic Equations. Iterative Solution Methods

**MA3004(5) - Optimisation (PQ: MA2202(3))**
Nonlinear Programming. Unconstrained Problems. Newton's Method, Multivariable Calculus, Gradient Algorithms. Quasi-Newton and Conjugate Gradient Methods

**MA 3006(5) - Fluid Dynamics II (PQ: MA3102(3))**
Advanced Potential Flows. Governing equations for a Newtonian fluid. Flow at low Reynolds number. Flow at high Reynolds number.

**MA 3007(5) - Rings And Fields (PQ: MA1104(1))**
Characteristics of a ring. Ideals Homomorphism and embedding of rings. Irreducible elements & unique factorisation domains. Principal ideals, Euclidean domains, Finite fields.

**MA 3008(5) – Topology (PQ: MA2105(3))**
Topological spaces, Subspace topology, Hausdorff spaces, Connectedness, Homotopy

**MA 3009(5) – Dynamical Systems (PQ: MA2102(3))**
Linear and Non-linear Systems, Equilibrium Solutions, Fixed Points Stability, Lyapunov functions, The Poincaré-Bendixon theorem, Bifurcation theory.

**MA3010(5) – Mathematical Modelling (PQ: MA2202(3))**
Introduction to modelling; Model analysis: Applications

## OTHER MODULES OFFERED BY DEPARTMENT OF MATHEMATICS

### FINANCE

**MA2006(3) - Alternative Investments**
Open and closed end funds, Exchange traded funds, Real estate, Valuation, Commodities.

**MA2106(3) - Risk Analysis I (PQ: MA1101(1))**
Risk Analysis, Expected Utility and stochastic Dominance, The Mean-Variance Criterion, Two Fund Theorem, Capital Asset Pricing Model (CAPM).

**MA2206(3) - Fixed Income Analysis (PQ: MA1101(1))**
Types of Bonds, Pricing of Bonds and Fixed Income securities, Bond Price Volatility, Risk Management using Fixed Income Derivatives and Credit Derivatives, Mortgage backed Securities and Analysis.

**MA3017(5) – Mathematics for Economics**
Serial Correlation, heteroskedasticity, multicollinearity, Autoregressive-moving average processes, Non-stationary time series models, unit root tests, vector autoregressive models, Causality, Variance Decomposition, Cointegration analysis, Impulse response analysis.

**MA3018(3) - Discrete Time Finance (PQ: MA1101(1))**
Binomial and Trinomial Tree model, Fundamental Theorems of Asset Pricing in a multi-period setting, Equity Price Modelling, term structure modelling.

**MA3104(5) - Risk Analysis II (PQ: MA2106(3))**
Market Risk, Credit Risk, VaR models, Garch, Variance Covariance, Historical and Monte Carlo Models for Calculating VaR. Credit Risk Models. Greeks.

**MA3105(5) - Financial Derivatives**
Forward and Futures, Call and put options, Put-call parity, Hedging, Types of bonds, Swaps, Swaptions, Interest rate Derivative Instruments.

**MA3204(5) - Stochastic Calculus (PQ: MA 2103(3))**
Measure and Integration, Brownian Motion and Weiner Processes, Probability Theory and Conditional Expectations, Stochastic Differential Equations, Ito's Lemma, Risk Neutrality and the Girsanov's Theorem, Martingale Pricing Applications to Option Pricing and Term Structure Models.

## STATISTICS

**MA2004(3) - Computational Statistics (PQ: MA1105(1))**
Exploratory data analysis, Monte Carlo methods for inferential statistics, Data partitioning, Probability density estimation, Markov Chain Monte Carlo Methods, Use of a programming languages - R or MATLAB or any other relevant software.

**MA2007(3) - Survival Analysis (PQ: MA1105(3))**
Concepts and techniques used in the analysis of time to event data, including censoring, hazard rates, estimation of survival curves, parametric & nonparametric models, use of regression techniques and diagnostics.

**MA2008(3) - Statistical Quality Control (PQ: MA1105(3))**
Properties, designs and application of control charts, Shewhart charts, straight moving average chart, cumulative sum chart, exponentially weighted moving average chart, basic concepts of acceptance sampling, single, multiple and sequential sampling by attributes, variable sampling.

**MA2009(3) - Actuarial Mathematics**
Survival Models, Life Tables, Life Insurance, Life Annuities, Benefit Premiums and Reserves, Multiple Life Functions and Decrement Tables, Markov Chains, Poisson Processes.

**MA2107(3) - Survey Methodology (PQ: MA1105(1))**

Planning surveys, Questionnaire design, Inference and error in surveys, Target populations, Sampling frames and coverage error, Sample design and sampling errors, Methods of data collection, Nonresponse in sample surveys, Probability proportion to size with and without replacement sampling, Sample size determination, Case problems including market research.

**MA2207(3) - Design and Analysis of Experiments (PQ: MA2107(3))**
Experimental designs, analysis of one-way and two way layout data, multiple comparisons, factorial designs, $2^k$-factorial designs, blocking and confounding, fractional factorial design and nested designs.

**MA3002(5) - Longitudinal Data Analysis (PQ: MA2203(3))**
Introduction to longitudinal studies, exploring longitudinal data, analysis of variance for repeated measures, general linear models for longitudinal data, growth curves, models for covariance structure, generalized linear models for longitudinal discrete data.

**MA3005(5) - Statistical Methods for Finance (PQ: MA2203(3))**
Statistical properties of returns, Regression analysis applications to pricing models, Multivariate analysis with applications in Markowitz's portfolio management, Volatilities, Nonparametric methods with applications to option pricing and interest rate markets, Portfolio optimization and the Capital Asset Pricing Model.

**MA3011(5) - Time Series Analysis (PQ: MA 2203(3))**
Time Series Data. Forecasting Accuracy. Moving Averages. Decomposition Methods, Exponential Smoothing Models. State Space Models, ARIMA Models. Model Identification and Forecasting.

**MA3012(5) - Geostatistics (PQ: MA2103(3))**
Exploratory spatial data analysis, Sample data set: Spatial continuity, Random function models for spatial data, Point Estimation, Ordinary and block Kriging, Applications using softwares. (At least one of R, Surfer, ArcGIS).

**MA3013(5) - Statistical Data Mining (PQ: MA2103(3))**
Data Preprocessing, Data Warehousing, Patterns and Associations, Classification, Cluster Analysis, Non-linear models.

**MA3014(5) - Categorical Data Analysis (PQ: MA2203(3))**
Categorical response data and contingency tables, Framework of generalised linear models, Logistic regression, Multicategory Logit model, Loglinear models for contingency tables.

**MA3015(5) - Bayesian Statistics (PQ:MA2103(3))**
Bayesian principles such as subjective probability, Bayesian inference and decision making, the likelihood principle, predictivism and numerical methods of approximating posterior distributions. Models and applications including univariate and multivariate regression models, the general linear model and Bayesian classification. Case studies.

**MA3016(5) - Game Theory (PQ:MA2103(3))**
Impartial Combinatorial Games. Two-Person Zero-Sum Games. Two-Person General-Sum Games. Games in Coalitional Form.

**MA3103(5) - Generalised Linear Models (PQ: MA2203(3))**
Generalised linear models; the exponential family, the linear predictor, link functions, analysis of deviance, parameter estimation, deviance residuals, Model choice, fitting and validation.

**MA3203(5) - Multivariate Analysis (PQ: MA2103(3))**
Multidimensional random variables, Multivariate Normal Distribution. Wishart Distribution. Hottelings T2. Multivariate Analysis of Variance. Principal Components Discriminant Analysis.

## BSc (Hons) Mathematics with Statistics

**1. Objectives**

Mathematics and Statistics are the means by which we interpret large amount of data that science, government and industry generate. With mathematical tools and theoretical understanding students are better equipped to understand and analyse these information. This degree will provide very good knowledge and skills of both mathematics and statistics which keep career options broad. Also, logical thinking, problem-solving and analytical skills will allow one to take up roles as diverse as management, consulting, marketing and journalism.

The first year develops and strengthens the background of probability and statistics, but also introduces professional software such as Mathematica and statistical softwares like R and SPSS. In the second year students can master more advanced statistical techniques such as regression analysis, survey methodology and design of experiments. After this sound base is established, the final year features more choice, including time series and multivariate analysis.

**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:

| **Degree** | **Core Taught Modules** | **Project** | **Electives** |
|---|---|---|---|
| BSc(Hons)Mathematics with Statistics | 75 | 7 | Minimum 18[a, b, c] |

[a] 6 credits from level/year 1 electives.
[b] at least 3 credits from level/year 2.
[c] at least 9 credits from level/year 3.

**IMPORTANT NOTE: The student will be allowed to opt for the BSc (Hons) Mathematics, BSc (Hons) Mathematics with Statistics, or BSc (Hons) Mathematics with Finance programme after the common first year. For the specialisation in Finance/Statistics students are required to have 33 credits from Level 2/3 Finance/Statistics modules.**

## 7. Assessment

Each module will be assessed over 100 marks and assessment will be based on a written examination 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 modules will be carried out at the end of the year, except for MATH1101(1) and MATH1201(1), which will be examined at the end of the semester.

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 at the end of each semester of the given academic year unless stated otherwise in the Programme Structure.

An overall total of 40% is required for a candidate to pass a module. 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 7 credits for degree award.

The following list of modules will be assessed solely by continuous assessment:

MA1106Y (1)
MA1203(1)
MA3010(5)

**8. List of Modules**

**A. Core Modules (75+7 credits)**

| Code | Module Name | Hrs/Wk/L+P | Credits |
|---|---|---|---|
| MA1101(1) | Mathematical Techniques I | 3+0 | 3 |
| MA1102(1) | Mathematical Analysis I | 3+0 | 3 |
| MA1103(1) | Applied Mathematics I | 3+0 | 3 |
| MA1104(1) | Algebra | 3+0 | 3 |
| MA1105(1) | Probability & Statistics | 3+0 | 3 |
| MA1106Y(1) | Tools for Scientific Reporting | 2+2 | 6 |
| MA1201(1) | Mathematical Techniques II | 3+0 | 3 |
| MA1202(1) | Mathematical Analysis II | 3+0 | 3 |
| MA1203(1) | Computer Applications in Mathematics | 2+2 | 3 |
| MA2101(3) | Numerical Analysis I | 3+0 | 3 |
| MA2102(3) | Mathematical Methods I | 3+0 | 3 |
| MA2103(3) | Mathematical Statistics | 3+0 | 3 |
| MA2104(3) | Complex Analysis | 3+0 | 3 |
| MA2105(3) | Metric Spaces | 3+0 | 3 |
| MA2107(3) | Survey Methodology | 3+0 | 3 |
| MA2201(3) | Linear Algebra | 3+0 | 3 |
| MA2202(3) | Linear Programming | 3+0 | 3 |
| MA2203(3) | Linear Regression Analysis | 3+0 | 3 |
| MA2205(3) | Numerical Linear Algebra | 3+0 | 3 |
| MA2207(3) | Design and Analysis of Experiments | 3+0 | 3 |
| MA3000(5) | Project | - | 7 |
| MA3101(5) | Measure and Integral | 3+0 | 3 |
| MA3103(5) | Generalised Linear Models | 3+0 | 3 |
| MA3201(5) | Applied Probability | 3+0 | 3 |
| MA3203(5) | Multivariate Analysis | 3+0 | 3 |

**B. Elective Modules (Not all modules may be offered)**

| Code | Module Name | Hrs/Wk/ L+P | Credits |
|---|---|---|---|
| ACF1000(1) | Accounting For Financial Decision Making | 3+0 | 3 |
| ACF1002(1) | Principles of Finance | 3+0 | 3 |
| MA1001(1) | Financial Mathematics I | 3+0 | 3 |
| MA1002(1) | Applied Mathematics II | 3+0 | 3 |
| MA1003(1) | Descriptive Statistics | 3+0 | 3 |
| MA1004(1) | Simulation Modeling and Analysis | 3+0 | 3 |
| MA2004(3) | Computational Statistics | 3+0 | 3 |
| MA2007(3) | Survival Analysis | 3+0 | 3 |
| MA2008(3) | Statistical Quality Control | 3+0 | 3 |
| MA2009(3) | Actuarial Mathematics | 3+0 | 3 |
| MA2106(3) | Risk Analysis I | 3+0 | 3 |
| MA3002(5) | Longitudinal Data Analysis | 3+0 | 3 |

| | | | |
|---|---|---|---|
| MA3005(5) | Statistical Methods for Finance | 3+0 | 3 |
| MA3011(5) | Time Series Analysis | 3+0 | 3 |
| MA3012(5) | Geostatistics | 3+0 | 3 |
| MA3013(5) | Statistical Data Mining | 3+0 | 3 |
| MA3014(5) | Categorical Data Analysis | 3+0 | 3 |
| MA3015(5) | Bayesian Statistics | 3+0 | 3 |
| MA3016(5) | Game Theory | 3+0 | 3 |

## 9. Programme Plan - BSc(Hons) Mathematics with Statistics

**YEAR 1**

| **Semester 1** | | | | **Semester 2** | | | |
|---|---|---|---|---|---|---|---|
| **Code** | **Module Name** | **Hrs/ Wk L+P** | **Credits** | **Code** | **Module Name** | **Hrs/Wk L+P** | **Credits** |
| **CORE** | | | | **CORE** | | | |
| MA1101(1) | Mathematical Techniques I | 3+0 | 3 | MA1201(1) | Mathematical Techniques II | 3+0 | 3 |
| MA1102(1) | Mathematical Analysis I | 3+0 | 3 | MA1202(1) | Mathematical Analysis II | 3+0 | 3 |
| MA1103(1) | Applied Mathematics I | 3+0 | 3 | MA1203(1) | Computer Applications in Mathematics | 2+2 | 3 |
| MA1104(1) | Algebra | 3+0 | 3 | | | | |
| MA1105(1) | Probability & Statistics | 3+0 | 3 | | | | |
| MA1106Y(1) | Tools for Scientific Reporting | 2+2 | 6 | **TWO ELECTIVES FROM:** | | | |
| | | | | MA1001(1) | Financial Mathematics I | 3+0 | 3 |
| | | | | MA1002(1) | Applied Mathematics II | 3+0 | 3 |
| | | | | MA1003(1) | Descriptive Statistics | 3+0 | 3 |
| | | | | MA1004(1) | Simulation Modeling & Analysis | 3+0 | 3 |
| | | | | ACF1000(1) | Accounting for Financial Decision Making | 3+0 | 3 |
| | | | | ACF1002(1) | Principles of Finance | 3+0 | 3 |

**YEAR 2**

| **Semester 1** | | | | **Semester 2** | | | |
|---|---|---|---|---|---|---|---|
| **Code** | **Module Name** | **Hrs/Wk L+P** | **Credits** | **Code** | **Module Name** | **Hrs/Wk L+P** | **Credits** |
| **CORE** | | | | **CORE** | | | |
| MA2101(3) | Numerical Analysis I | 3+0 | 3 | MA2201(3) | Linear Algebra | 3+0 | 3 |
| MA2102(3) | Mathematical Methods I | 3+0 | 3 | MA2202(3) | Linear Programming | 3+0 | 3 |
| MA2103(3) | Mathematical Statistics | 3+0 | 3 | MA2203(3) | Linear Regression Analysis | 3+0 | 3 |
| MA2104(3) | Complex Analysis | 3+0 | 3 | MA2205(3) | Numerical Linear Algebra | 3+0 | 3 |
| MA2105(3) | Metric Spaces | 3+0 | 3 | MA2207(3) | Design & Analysis of Experiments | 3+0 | 3 |
| MA2107(3) | Survey methodology | 3+0 | 3 | | | | |
| **NOTE: AT LEAST ONE ELECTIVE FROM:** | | | | | | | |
| MA2004(3) | Computational Statistics | 3+0 | 3 | MA2008(3) | Statistical Quality Control | 3+0 | 3 |
| MA2007(3) | Survival Analysis | 3+0 | 3 | | | | |
| MA2106(3) | Risk Analysis I | 3+0 | 3 | MA2009(3) | Actuarial Mathematics | 3+0 | 3 |

**and /or any other year 2 module offered by the 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** | | | |
| MA3000(5) | Project | - | 7 | MA3201(5) | Applied Probability | 3+0 | 3 |
| MA3101(5) | Measure & Integral | 3+0 | 3 | MA3203(5) | Multivariate Analysis | 3+0 | 3 |
| MA3103(5) | Generalised Linear Models | 3+0 | 3 | | | | |
| **NOTE: AT LEAST THREE ELECTIVES FROM:** | | | | | | | |
| MA3002(5) | Longitudinal Data Analysis | 3+0 | 3 | MA3013(5) | Statistical Data Mining | 3+0 | 3 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| MA3005(5) | Statistical Methods for Finance | 3+0 | 3 | MA3014(5) | Categorical Data Analysis | 3+0 | 3 |
| MA3011(5) | Time Series Analysis | 3+0 | 3 | MA3015(5) | Bayesian Statistics | 3+0 | 3 |
| MA3012(5) | Geostatistics | 3+0 | 3 | MA3016(5) | Game Theory | 3+0 | 3 |

**and /or any other year 3 module offered by the department.**

**Note:**

1. ***Electives may be offered in either semester 1 or 2 & not all electives may be on offer.***
2. ***Students opting for BSc (Hons) Mathematics with Finance should register for ACF 1000(1) and ACF1002(1) as electives in Year I.***

**10. Outline Syllabus**

**PQ: Prerequirement** *(must follow module & sit for exams)*
**MR: Minimum requirement** *(must have the required number of credits)*

## Core Modules

**MA1101(1) - Mathematical Techniques I**
Differentiation/Integration, Differential Equations, Hyperbolic Functions, Partial Differentiation, Double Integration.

**MA1102(1) - Mathematical Analysis I**
The real numbers, Sequences, Infinite series, Limits.

**MA1103(1) - Applied Mathematics I**
Statics, System of particles, Dynamics.

**MA1104(1) - Algebra**
Set Theory, Equivalence Relations & Classes, Groups, Subgroups and Homomorphism, Rings & Fields.

**MA1105(1) - Probability & Statistics**
Elementary Probability, Random Variables, Discrete and Continuous Probability Distributions, The Central Limit Theorem (CLT), Estimation, Testing of Hypothesis, Non-parametric Methods. Categorical Data Analysis

**MA1106Y(1) - Tools for Scientific Reporting**
Word Processing, Spreadsheets, VBA, Latex.

**MA1201(1) - Mathematical Techniques II**
Matrix Algebra and Solution of Linear Systems. Column/Row Space, Eigenvalues, Vector Analysis, Change of Variables/ Triple Integration.

**MA1202(1) - Mathematical Analysis II (PQ: MA1102(1))**
Continuity of Functions, Intermediate-Value Theorem, Differentiable Functions, Rolle's Theorem, Mean value Theorem, Taylor's Theorem, Riemann Integration, Integral Mean Value Theorem, Improper Integrals.

**MA1203(1) - Computer Applications in Mathematics**
Introduction to C++, Introduction to Mathematica, Symbolic Calculations, Scientific Visualisation.

**MA2101(3) - Numerical Analysis I (PQ: MA1101(1))**
Floating Point Computations. Interpolation, Solution of Linear Equations. Direct and Iterative Methods, Solution of Non-linear Equations. Numerical Differentiation. Numerical Integration.

**MA2102(3) - Mathematical Methods I (PQ: MA1201(1))**

Review of first- and second-order ODEs, Fourier series, First and Second-order Partial Differential Equations, Laplace and Fourier transforms.

**MA2103(3) - Mathematical Statistics (PQ: MA1105(1))**
Axiomatic approach to Probability, Bayes' Theorem, Bivariate Random Variables, Mathematical Expectations, Generating functions, Limit theorems, Probability Distributions.

**MA2104(3) - Complex Analysis (PQ: MA1202(1))**
Complex-valued functions, Cauchy-Riemann equations, Holomorphic and harmonic functions, Complex Integration, Cauchy's Theorem, Cauchy's Integral Formulas, Complex Series, Taylor and Laurent Theorems, Laurent Expansions, Cauchy's Residue Theorem, Residue Calculus.

**MA2105(3) - Metric Spaces (PQ: MA1202(1))**
Metric Spaces. Open and closed sets, Equivalent metrics, Continuity, Convergence and Completeness, Compactness.

**MA2107(3) - Survey Methodology (PQ: MA1105(1))**

Planning surveys, Questionnaire design, Inference and error in surveys, Target populations, Sampling frames and coverage error, Sample design and sampling errors, Methods of data collection, Nonresponse in sample surveys, Probability proportion to size with and without replacement sampling, Sample size determination, Case problems including market research.

**MA2201(3) - Linear Algebra (PQ: MA1104(1))**
Vector spaces. Subspaces. Linear dependence and independence. Basis and dimension. Linear transformations. Change of bases. Eigenvalues and eigenvectors. Invariant subspaces. Quadratic forms.

**MA2202(3) - Linear Programming (PQ: MA1201(1))**
Linear Programming Problems, Integer Programming, Network Problems.

**MA2203(3) - Linear Regression Analysis (PQ: MA1105(1))**
Simple Linear Regression. Multiple Linear Regression. Model Adequacy checking. Transformations to correct Model inadequacy. Polynomial regression models Variable selection and model building.

**MA2205(3) - Numerical Linear Algebra (PQ: MA1104(1))**
Matrix Multiplication Problems, Vector and matrix norms. Householder and Givens transformations QR factorisation. Least-Squares problem. Eigenvalue problem. Power method and Rayleigh quotient iteration Householder deflation.

**MA2207(3) - Design and Analysis of Experiments (PQ: MA2107(3))**
Experimental designs, analysis of one-way and two way layout data, multiple comparisons, factorial designs, $2^k$-factorial designs, blocking and confounding, fractional factorial design and nested designs.

**MA3000(5) - Project (MR: CPA > 45% & at least 42 credits from Maths Core Modules )**
Project work on a topic approved by the Department of Mathematics.

**MA3101(5) - Measure and Integral (PQ: MA1202(1))**
Lebesgue measure on a real line. Measurable functions. The Lebesgue integral on the real line. Convergence theorems. Lebesgue probability space. Cumulative distribution function.

**MA3103(5) - Generalised Linear Models (PQ: MA2203(3))**
Generalised linear models; the exponential family, the linear predictor, link functions, analysis of deviance, parameter estimation, deviance residuals, Model choice, fitting and validation.

**MA3201(5) - Applied Probability (PQ: MA2103(3))**
Conditional Expectation. Law of Total Expectation. Generating Functions. Branching Processes Discrete Time Markov Chains. Continuous Time Markov Chains. The Poisson Process.

**MA3203(5) - Multivariate Analysis (PQ: MA2103(3))**
Multidimensional random variables, Multivariate Normal Distribution. Wishart Distribution. Hottelings T2. Multivariate Analysis of Variance. Principal Components Discriminant Analysis.

## Elective Modules

**ACF1000(1) - Accounting For Financial Decision Making**

The Role of Accounting Information; Recording and Summarising Transactions; Accounting Concepts & Preparing Final Accounts; Adjustments to Final Accounts; Capital v/s Revenue Expenditure; Bank Reconciliation Statement; Accounting Ratios; Accounting for Internal Decision Making Techniques; Elements of Cost; Costing Methods & Techniques; Decision Making Techniques; Accounting for Manufacturers; Budgeting.

**ACF1002(1) - Principles of Finance**
Description of the Financial System; Capital Markets; An Analysis of the Mechanisms of the Financial System in the Economy: Theory and Current Statistics; Time value of money; Capital Budgeting: an introduction; Valuation of Financial Assets; Bond Analysis: an introduction; Risk, Return and Diversification; Efficient Market Hypothesis; Multinational Finance: an introduction.

**MA1001(1) - Financial Mathematics**
Time Value of Money. Bonds and Term Structure.

**MA1002(1) - Applied Mathematics II (PQ: MA1103(1))**
Rigid bodies. Moments of Inertia. Generalised coordinates.

**MA1003(1) - Descriptive Statistics**
Characteristics of data, Data collection, Data presentation, Univariate data, Covariance and correlation, Index Numbers.

**MA1004(1) - Simulation Modeling and Analysis**
Basic Simulation Modeling, Random-Number Generators, Generating Random Variates, Output Data Analysis for a Single System, Variance Reduction Techniques, Use of a simulation softwares.

**MA2004(3) - Computational Statistics (PQ: MA1105(1))**
Exploratory data analysis, Monte Carlo methods for inferential statistics, Data partitioning, Probability density estimation, Markov Chain Monte Carlo Methods, Use of a programming languages - R or MATLAB or any other relevant software.

**MA2007(3) - Survival Analysis (PQ: MA1105(3))**

Concepts and techniques used in the analysis of time to event data, including censoring, hazard rates, estimation of survival curves, parametric & nonparametric models, use of regression techniques and diagnostics.

**MA2008(3) - Statistical Quality Control (PQ: MA1105(3))**
Properties, designs and application of control charts, Shewhart charts, straight moving average chart, cumulative sum chart, exponentially weighted moving average chart, basic concepts of acceptance sampling, single, multiple and sequential sampling by attributes, variable sampling.

**MA2009(3) - Actuarial Mathematics**
Survival models and life tables, life annuities, assurances and premiums, reserves, joint life and last survivor statuses, multiple decrement tables, expenses, individual and collective risk theory.

**MA2106(3) - Risk Analysis I (PQ: MA 1101(1))**
Risk Analysis, Expected Utility and Stochastic Dominance, The Mean-Variance Criterion, Two Fund Theorem, Capital Asset Pricing Model (CAPM)

**MA3002(5) - Longitudinal Data Analysis (PQ: MA2203(3))**
Introduction to longitudinal studies, exploring longitudinal data, analysis of variance for repeated measures, general linear models for longitudinal data, growth curves, models for covariance structure, generalized linear models for longitudinal discrete data.

**MA3005(5) - Statistical Methods for Finance (PQ: MA2203(3))**
Statistical properties of returns, Regression analysis applications to pricing models, Multivariate analysis with applications in Markowitz's portfolio management, Volatilities, Nonparametric methods with applications to option pricing and interest rate markets, Portfolio optimization and the Capital Asset Pricing Model.

**MA3012(5) - Geostatistics (PQ: MA2103(3))**
Exploratory spatial data analysis, Sample data set: Spatial continuity, Random function models for spatial data, Point Estimation, Ordinary and block Kriging, Applications using softwares (At least one of R, Surfer, ArcGIS).

**MA3013(5) - Statistical Data Mining (PQ: MA2103(3))**
Data Preprocessing, Data Warehousing, Patterns and Associations, Classification, Cluster Analysis, Non-linear models.

**MA3014(5) - Categorical Data Analysis (PQ: MA2203(3))**
Categorical response data and contingency tables, Framework of generalised linear models, Logistic regression, Multicategory Logit model, Loglinear models for contingency tables.

**MA3015(5) - Bayesian Statistics (PQ: MA2103(3))**
Bayesian principles such as subjective probability, Bayesian inference and decision making, the likelihood principle, predictivism and numerical methods of approximating posterior distributions. Models and applications including univariate and multivariate regression models, the general linear model and Bayesian classification. Case studies.

**MA3016(5) - Game Theory (PQ: MA2103(3))**
Impartial Combinatorial Games. Two-Person Zero-Sum Games. Two-Person General-Sum Games. Games in Coalitional Form.

**MA3011(5) - Time Series Analysis (PQ: MA2203(3))**
Time Series Data. Forecasting Accuracy. Moving Averages. Decomposition Methods, Exponential Smoothing Models. State Space Models, ARIMA Models. Model Identification and Forecasting.

## OTHER MODULES OFFERED BY DEPARTMENT OF MATHEMATICS

## FINANCE

**MA2006(3) - Alternative Investments**
Open and closed end funds, Exchange traded funds, Real estate, Valuation, Commodities.

**MA2206(3) - Fixed Income Analysis (PQ: MA 1101(1))**
Types of Bonds, Pricing of Bonds and Fixed Income securities, Bond Price Volatility, Risk Management using Fixed Income Derivatives and Credit Derivatives, Mortgage backed Securities and Analysis.

**MA3017(5) - Mathematics for Economics**
Serial Correlation, heteroskedasticity, multicollinearity, Autoregressive-moving average processes, Non-stationary time series models, unit root tests, vector autoregressive models, Causality, Variance Decomposition, Cointegration analysis, Impulse response analysis.

**MA3018(5) - Discrete Time Finance (PQ: MA 1101(1))**
Binomial and Trinomial Tree model, Fundamental Theorems of Asset Pricing in a multi-period setting, Equity Price Modelling, term structure modelling.

**MA3104(5) - Risk Analysis II (PQ: MA 2106(3))**
Market Risk, Credit Risk, VaR models, Garch, Variance Covariance, Historical and Monte Carlo Models for Calculating VaR. Credit Risk Models. Greeks.

**MA3105(5) - Financial Derivatives**
Forward and Futures, Call and put options, Put-call parity, Hedging, Types of bonds, Swaps, Swaptions, Interest rate Derivative Instruments.

**MA3204(5) - Stochastic Calculus (PQ: MA 2103(3))**
Measure and Integration, Brownian Motion and Weiner Processes, Probability Theory and Conditional Expectations, Stochastic Differential Equations, Ito's Lemma, Risk Neutrality and the Girsanov's Theorem, Martingale Pricing Applications to Option Pricing and Term Structure Models.

## MATHEMATICS

**MA2001(3) - Group Theory (PQ: MA 1104(1))**
Cyclic, Isomorphism theorems. Permutation groups. Automorphism of groups. Symmetric and Alternating groups. Dihedral Groups,Sylow theorems.

**MA2002(3) - Discrete Mathematics (PQ: MA 1104(1))**
Fundamental Principles of counting, Generating Functions, Asymptotic bounds, Recurrence relations, Graph Theory and Applications

**MA2005(3) – Mathematical Methods II (PQ: MA 2102(3))**
Method of Characteristics. Boundary value problems. Green's functions. Integral equations.

**MA2204(3) - Numerical Analysis II (PQ: MA 1101)**
Initial Value Problems. Basic Methods. Consistency, Zero-Stability and Convergence Runge-Kutta Methods. Explicit and Implicit RK Methods. Order Conditions and Butcher Trees. Collocation RK methods. Linear Multistep Methods. Adams Bashforth and Adams-Moulton Methods. Characteristic Polynomials. Nystrom Methods.

**MA2205(3) – Numerical Linear Algebra (PQ: MA 1104(1))**
Matrix Multiplication Problems, Vector and matrix norms. Householder and Givens transformations QR factorisation. Least-Squares problem. Eigenvalue problem. Power method and Rayleigh quotient iteration Householder deflation

**MA3001(5) - Operational Research (PQ: MA 2202(3))**
Decision theory. Inventory. Network Flows.

**MA3003(5) - Numerical Solution Of Pdes (PQ: MA 2101(3))**
Fourier Transforms. Semi-Discrete Fourier Transforms. Well-Posed Problems, Hyperbolic Problems. Method of Characteristics, Numerical Schemes for Hyperbolic Problems. Consistency, Stability and Convergence Parabolic Equations. The Heat Equation and Crank-Nicolson Scheme. Higher Order Discretisations Elliptic Equations. Iterative Solution Methods

**MA3004(5) - Optimisation (PQ: MA 2101(3))**
Nonlinear Programming. Unconstrained Problems. Newton's Method, Multivariable Calculus, Gradient Algorithms. Quasi-Newton and Conjugate Gradient Methods

**MA3010(5) - Mathematical Modelling (PQ: MA 2202(3))**
Introduction to modelling; Model analysis: Applications

**MA3102(5) - Fluid Dynamics I (PQ: MA 2102(3))**
Kinematics and Dynamics of simple flows. Irrotational and rotational flows. Complex potential. Theorems of Milne-Thomson and Blasius.

**MA3202(5) - Functional Analysis (PQ: MA 2105(3))**
Normed vector spaces. Banach spaces. Finite dimensional spaces. The Hilbert space. Linear operators. Fundamental theorem for normed and Banach spaces. Principle of uniform boundedness. Dual spaces. Strong and weak convergence

# BSc (Hons) Mathematics with Finance

## 1. Objectives

The BSc (Hons) Mathematics with Finance programme offers a combination of lectures and tutorials in Pure & Applied Mathematics, Probability & Statistics and Finance, including general and applied financial theory. The aims and objectives are:

• to provide a challenging course in Mathematics, combined with Finance and its applications, for a range of students;
• to provide a course that is both suitable for students aiming to pursue research and for students going into other careers;
• to develop in students the analytical and logical skills related to the knowledge of Finance, backed up by mathematical knowledge, that are highly valued by employers;
• to produce the high calibre graduates sought by employers in the private and public sectors, in areas of banking, accountancy, insurance, offshore, sales and marketing;
• to provide an intellectually stimulating environment in which students have the opportunity to develop their skills to their full potential.

## 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:

| Degree | Core Taught Modules | Project | Electives |
|---|---|---|---|
| BSc(Hons) Mathematics with Finance | 72 | 7 | Minimum 21[a,b,c] |

[a] 6 credits from level/year 1 electives
[b] 6 credits from level/year 2 finance module electives
[c] 9 credits from level/year 3 electives with at least 6 credits from finance modules.

**IMPORTANT NOTE: The student will be allowed to opt for the BSc (Hons) Mathematics, BSc (Hons) Mathematics with Statistics, or BSc (Hons) Mathematics with Finance programme after the common first year. For the specialisation in Finance/Statistics students are required to have 33 credits from Level 2/3 Finance/Statistics modules.**

## 7. Assessment

Each module will be assessed over 100 marks and assessment will be based on a written examination 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 modules, will be carried out at the end of the year, except for MATH1101(1) and MATH1201(1), which will be examined at the end of the semester.

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 at the end of each semester of the given academic year unless stated otherwise in the Programme Structure.

An overall total of 40% is required for a candidate to pass a module. 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 7credits for degree award. They will normally be carried out in the area of specialisation.

The following list of modules will be assessed solely by continuous assessment:
MA1106Y(1)
MA1203(1)
MA3010(5)

## 8. List of Modules

### A. Core Modules (72 + 7 Credits)

| Code | Module Name | Hrs/Wk L+P | Credits |
|---|---|---|---|
| MA1101(1) | Mathematical Techniques I | 3+0 | 3 |
| MA1102(1) | Mathematical Analysis I | 3+0 | 3 |
| MA1103(1) | Applied Mathematics I | 3+0 | 3 |
| MA1104(1) | Algebra | 3+0 | 3 |
| MA1105(1) | Probability & Statistics | 3+0 | 3 |
| MA1106Y(1) | Tools for Scientific Reporting | 2+2 | 6 |
| MA1201(1) | Mathematical Techniques II | 3+0. | 3 |
| MA1202(1) | Mathematical Analysis II | 3+0 | 3 |
| MA1203(1) | Computer Applications in Mathematics | 2+2 | 3 |
| MA2101(3) | Numerical Analysis I | 3+0 | 3 |
| MA2102(3) | Mathematical Methods I | 3+0 | 3 |
| MA2103(3) | Mathematical Statistics | 3+0 | 3 |
| MA2106(3) | Risk Analysis I | 3+0 | 3 |
| MA2201(3) | Linear Algebra | 3+0 | 3 |
| MA2202(3) | Linear Programming | 3+0 | 3 |
| MA2203(3) | Linear Regression Analysis | 3+0 | 3 |
| MA2206(3) | Fixed Income Analysis | 3+0 | 3 |
| DFA2002Y(3) | Corporate Finance | 3+0 | 6 |
| MA3000(5) | Project | - | 7 |
| MA3104 (5) | Risk Analysis II | 3+0 | 3 |
| MA3105(5) | Financial Derivatives | 3+0 | 3 |
| MA3201(5) | Applied Probability | 3+0 | 3 |
| MA3204(5) | Stochastic Calculus | 3+0 | 3 |

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

| | | | |
|---|---|---|---|
| ACF1000(1) | Accounting for Financial Decision Making | 3+0 | 3 |
| ACF1002(1) | Principles of Finance | 3+0 | 3 |
| MA1001(1) | Financial Mathematics | 3+0 | 3 |
| MA1002(1) | Applied Mathematics II | 3+0 | 3 |
| MA1003(1) | Descriptive Statistics | 3+0 | 3 |
| MA1004(1) | Simulation Modeling and Analysis | 3+0 | 3 |
| MA2006(3) | Alternative Investments | 3+0 | 3 |
| MA2009(3) | Actuarial Mathematics | 3+0 | 3 |
| DFA2012Y(3) | Portfolio Theory & Fixed Income Securities | 3+0 | 6 |
| MA3005(5) | Statistical Methods for Finance | 3+0 | 3 |
| MA3011(5) | Time Series Analysis | 3+0 | 3 |
| MA3017(5) | Mathematics for Economics | 3+0 | 3 |
| MA3018(5) | Discrete Time Finance | 3+0 | 3 |

| | | | |
|---|---|---|---|
| DFA3006Y(5) | International Finance | 3+0 | 6 |

## 9. Programme Plan - BSc (Hons) Mathematics with Finance

**YEAR 1**

| Semester 1 | | | | Semester 2 | | | |
|---|---|---|---|---|---|---|---|
| **Code** | **Module Name** | **Hrs/Wk L+P** | **Credits** | **Code** | **Module Name** | **Hrs/Wk L+P** | **Credits** |
| **CORE** | | | | **CORE** | | | |
| MA1101(1) | Mathematical Techniques I | 3+0 | 3 | MA1201(1) | Mathematical Techniques II | 3+0 | 3 |
| MA1102(1) | Mathematical Analysis I | 3+0 | 3 | MA1202(1) | Mathematical Analysis II | 3+0 | 3 |
| MA1103(1) | Applied Mathematics I | 3+0 | 3 | MA1203(1) | Computer Applications in Mathematics | 2+2 | 3 |
| MA1104(1) | Algebra | 3+0 | 3 | | | | |
| MA1105(1) | Probability & Statistics | 3+0 | 3 | **TWO ELECTIVES FROM** | | | |
| MA1106Y(1) | Tools for Scientific Reporting | 2+2 | 6 | MA1001(1) | Financial Mathematics | 3+0 | 3 |
| | | | | MA1002(1) | Applied Mathematics II | 3+0 | 3 |
| | | | | MA1003(1) | Descriptive Statistics | 3+0 | 3 |
| | | | | MA1004(1) | Simulation Modelling & Analysis | 3+0 | 3 |
| | | | | ACF1000(1) | Accounting for Financial Decision Making | 3+0 | 3 |
| | | | | ACF1002(1) | Principles of Finance | 3+0 | 3 |

**YEAR 2**

| Semester 1 | | | | Semester 2 | | | |
|---|---|---|---|---|---|---|---|
| **Code** | **Module Name** | **Hrs/Wk L+P** | **Credits** | **Code** | **Module Name** | **Hrs/Wk L+P** | **Credits** |
| **CORE** | | | | **CORE** | | | |
| MA2101(3) | Numerical Analysis I | 3+0 | 3 | MA2201(3) | Linear Algebra | 3+0 | 3 |
| MA2102(3) | Mathematical Methods I | 3+0 | 3 | MA2202(3) | Linear Programming | 3+0 | 3 |
| MA2103(3) | Mathematical Statistics | 3+0 | 3 | MA2203(3) | Linear Regression Analysis | 3+0 | 3 |
| MA2106(3) | Risk Analysis I | 3+0 | 3 | MA2206(3) | Fixed Income Analysis | 3+0 | 3 |
| DFA2002Y(3) | Corporate Finance | 3+0 | 6 | | | | |
| **NOTE: AT LEAST TWO ELECTIVES FROM:** | | | | | | | |
| DFA2012Y(3) | Portfolio Theory & Fixed Income Securities | 3+0 | 6 | MA2006(3) | Alternative Investments | 3+0 | 3 |
| | | | | MA2009(3) | Actuarial Mathematics | 3+0 | 3 |

**and /or any other year 2 module offered by the 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** | | | |
| MA3000(5) | Project | - | 7 | MA3201(5) | Applied Probability | 3+0 | 3 |
| MA3104(5) | Risk Analysis II | 3+0 | 3 | MA3204(5) | Stochastic Calculus | 3+0 | 3 |
| MA3105(5) | Financial Derivatives | 3+0 | 3 | | | | |
| **NOTE: AT LEAST THREE ELECTIVES FROM (of which six(6) credits from finance modules):** | | | | | | | |
| MA3011(5) | Time Series Analysis | 3+0 | 3 | MA3018(5) | Discrete Time Finance | 3+0 | 3 |
| MA3017(5) | Mathematics for Economics | 3+0 | 3 | MA3005(5) | Statistical Methods for Finance | 3+0 | 3 |
| DFA3006Y(5) | International Finance | 3+0 | 6 | | | | |

**and /or any other year 3 module offered by the department.**

## Note:

1. ***Electives may be offered in either semester 1 or 2 & not all electives may be on offer.***

2. ***Students opting for BSc (Hons) Mathematics with Finance should register for ACF 1000(1) and ACF1002(1) as electives in Year I.***

## 10. Outline Syllabus

**PQ: Pre requirement***(must follow module & sit for exams)*
**MR: Minimum requirement** *(must have the required number of credits)*

## Core Modules

**MA1101(1) - Mathematical Techniques I**
Differentiation/Integration, Differential Equations, Hyperbolic Functions, Partial Differentiation, Double Integration

**MA1102(1) - Mathematical Analysis I**
The real numbers, Sequences, Infinite series, Limits

**MA1103(1) - Applied Mathematics I**
Statics, System of particles, Dynamics

**MA1104(1) - Algebra**
Set Theory, Equivalence Relations & Classes, Groups, Subgroups and Homomorphism, Rings & Fields

**MA1105(1) - Probability & Statistics**
Elementary Probability, Random Variables, Discrete and Continuous Probability Distributions, The Central Limit Theorem (CLT), Estimation, Testing of Hypothesis, Non-parametric Methods. Categorical Data Analysis

**MA1106Y(1) - Tools for Scientific Reporting**
Word Processing, Spreadsheets, VBA, Latex

**MA1201(1) - Mathematical Techniques II**
Matrix Algebra and Solution of Linear Systems. Column/Row Space, Eigen values, Vector Analysis, Change of Variables/ Triple Integration.

**MA1202(1) - Mathematical Analysis II (PQ: MA 1102(1))**
Continuity of Functions, Intermediate-Value Theorem, Differentiable Functions, Rolle's Theorem, Mean value Theorem, Taylor's Theorem, Riemann Integration, Integral Mean Value Theorem, Improper Integrals.

**MA1203(1) - Computer Applications in Mathematics**
Introduction to C++, Introduction to Mathematica, Symbolic Calculations, Scientific Visualisation.

**MA2101(3) - Numerical Analysis I (PQ: MA 1101(1))**
Floating Point Computations. Interpolation, Solution of Linear Equations. Direct and Iterative Methods, Solution of Non-linear Equations. Numerical Differentiation. Numerical Integration.

**MA2102(3) - Mathematical Methods I (PQ: MA 1201(1))**
Review of first- and second-order ODEs, Fourier series, First and Second-order Partial Differential Equations, Laplace and Fourier transforms.

**MA2103(3) - Mathematical Statistics (PQ: MA 1105(1))**
Axiomatic approach to Probability, Bayes' Theorem, Bivariate Random Variables, Mathematical Expectations, Generating functions, Limit theorems, Probability Distributions.

**MA2106(3) - Risk Analysis I (PQ: MA 1101(1))**
Risk Analysis, Expected Utility and Stochastic Dominance, The Mean-Variance Criterion, Two Fund Theorem, Capital Asset Pricing Model (CAPM).

**DFA 2002Y(3) – Corporate Finance**
Present values and wealth; Risk and return; Capital budgeting and risk; Market Equilibrium: CAPM and APT: Theory and empirical test; Correlation structure of Security Returns; EMH and its implications in Corporate Financing; Capital Structure and Cost of Capital: Theory, Empirical Evidence and Applications; Leasing; The Dividend Policy: Theory, Empirical Evidence and Applications; Gilt-edged securities: Interest rate theory and pricing of bonds; Introduction to Options; Introduction to Financial Futures; Multinational Finance; Hedging Strategies; Mergers, Acquisition and Restructuring: Theory and empirical evidence; Treasury Management

**MA2201(3) - Linear Algebra(PQ: MA1104(1))**
Vector spaces. Subspaces .Linear dependence and independence. Basis and dimension. Linear transformations. Change of bases. Eigenvalues and eigenvectors. Invariant subspaces. Quadratic forms.

**MA2202(3) - Linear Programming (PQ: MA1201(1))**
Linear Programming Problems, Integer Programming, Network Problems

**MA2203(3) - Linear Regression Analysis (PQ: MA1105(1))**
Simple Linear Regression. Multiple Linear Regression. Model Adequacy checking. Transformations to correct Model inadequacy. Polynomial regression models Variable selection and model building

**MA2206(3) - Fixed Income Analysis (PQ: MA1101(1))**
Types of Bonds, Pricing of Bonds and Fixed Income securities, Bond Price Volatility, Risk Management using Fixed Income Derivatives and Credit Derivatives, Mortgage backed Securities and Analysis.

**MA3000(5) - Project (MR: CPA > 45% & at least 42 credits from Maths Core Modules)**
Project work on a topic approved by the Department of Mathematics.

**MA3104(5) - Risk Analysis II (PQ: MA2106(3))**
Market Risk, Credit Risk, VaR models, Garch, Variance Covariance, Historical and Monte Carlo Models for Calculating VaR. Credit Risk Models. Greeks.

**MA3105(5) – Financial Derivatives**
Forward and Futures, Call and put options, Put-call parity, Hedging, Types of bonds, Swaps, Swaptions, Interest rate Derivative Instruments..

**MA3201(5) - Applied Probability(PQ: MA2103(3))**
Conditional Expectation. Law of Total Expectation. Generating Functions. Branching Processes Discrete Time Markov Chains. Continuous Time Markov Chains. The Poisson Process

**MA3204 (5) – Stochastic Calculus (PQ: MA2103(3))**
Measure and Integration, Brownian Motion and Weiner Processes, Probability Theory and Conditional Expectations, Stochastic Differential Equations, Ito's Lemma, Risk Neutrality and the Girsanov's Theorem, Martingale Pricing Applications to Option Pricing and Term Structure Models.

## Elective Modules

**ACF1000(1) - Accounting For Financial Decision Making**

The Role of Accounting Information; Recording and Summarising Transactions; Accounting Concepts & Preparing Final Accounts; Adjustments to Final Accounts; Capital v/s Revenue Expenditure; Bank Reconciliation Statement; Accounting

Ratios; Accounting for Internal Decision Making Techniques; Elements of Cost; Costing Methods & Techniques; Decision Making Techniques; Accounting for Manufacturers; Budgeting.

**ACF1002(1) - Principles of Finance**
Description of the Financial System; Capital Markets; An Analysis of the Mechanisms of the Financial System in the Economy: Theory and Current Statistics; Time value of money; Capital Budgeting: an introduction; Valuation of Financial Assets; Bond Analysis: an introduction; Risk, Return and Diversification; Efficient Market Hypothesis; Multinational Finance: an introduction.

**MA1001(1) - Financial Mathematics**
Time Value of Money. Bonds and Term Structure.

**MA1002(1) - Applied Mathematics II (PQ: MA1103(1))**
Rigid bodies. Moments of Inertia. Generalised coordinates.

**MA1003(1) - Descriptive Statistics**
Characteristics of data, Data collection, Data presentation, Univariate data, Covariance and correlation, Index Numbers.

**MA1004(1) - Simulation Modeling and Analysis**
Basic Simulation Modeling, Random-Number Generators, Generating Random Variates, Output Data Analysis for a Single System, Variance Reduction Techniques, Use of a simulation software.

**MA2006(3) – Alternative Investments**
Open and closed end funds, Exchange traded funds, Real estate, Valuation, Commodities

**MA2009 (5) – Actuarial Mathematics**
Survival Models, Life Tables, Life Insurance, Life Annuities, Benefit Premiums and Reserves, Multiple Life Functions and Decrement Tables, Markov Chains, Poisson Processes.

**DFA2012Y(3) – Portfolio Theory And Fixed Income Securities**
Types Of Securities; The Mauritian Fund Management Industry; The Global Fund Management Industry; Price Volatility Characteristics Of Fixed Income Securities; Bond Rating; Bond Strategy; Immunization Strategies; Global Bond Portfolio Management; Portfolio Theory, Portfolio Selection; Fundamental Analysis; Technical Analysis; Implications Of The Emh; Active V/S Passive Strategy, Asset Allocation (Strategic Asset Allocation; Tactical Asset Allocation); Managed Portfolio, Performance Measurement; Ethics In Finance; Applied Portfolio Models Using Excel.

**MA3005(5) - Statistical Methods for Finance (PQ: MA2203(3))**
Statistical properties of returns, Regression analysis applications to pricing models, Multivariate analysis with applications in Markowitz's portfolio management, Volatilities, Nonparametric methods with applications to option pricing and interest rate markets, Portfolio optimization and the Capital Asset Pricing Model.

**MA3011(5) - Time Series Analysis (PQ: MA2203(3))**
Time Series Data. Forecasting Accuracy. Moving Averages. Decomposition Methods, Exponential Smoothing Models. State Space Models, ARIMA Models. Model Identification and Forecasting.

**MA3017(5) – Mathematics for Economics**
Serial Correlation, heteroskedasticity, multicollinearity, Autoregressive-moving average processes, Non-stationary time series models, unit root tests, vector autoregressive models, Causality, Variance Decomposition, Cointegration analysis, Impulse response analysis.

**MA3018(5) - Discrete Time Finance (PQ: MA1101(1))**
Binomial and Trinomial Tree model, Fundamental Theorems of Asset Pricing in a multi-period setting, Equity Price Modelling, Term structure Modelling.

**DFA 3006Y(5) - International Finance**
The International Monetary System; Using Balance of Payments Data; The Foreign Exchange Market; International Parity Conditions; Foreign Currency Options; Measuring and managing foreign exchange exposure; Internal and external techniques of exposure management; Interest rate exposure; Capital and Ownership structure; Global cost of capital; Capital markets and other sources of funding for the global firm; Corporate strategy and Foreign Investment Decisions; Taxation issues; Political Risk Management; Managing Multinational Operations; Working Capital Management; Import and Export Financing; Issues in International Finance.

## OTHER MODULES OFFERED BY DEPARTMENT OF MATHEMATICS

**MA2001(3) - Group Theory (PQ: MA1104(1))**
Cyclic, Isomorphism theorems. Permutation groups. Automorphism of groups. Symmetric and Alternating groups. Dihedral Groups,Sylow theorems.

**MA2002(3) - Discrete Mathematics (PQ: MA1104(1))**
Fundamental Principles of counting, Generating Functions, Asymptotic bounds, Recurrence relations, Graph Theory and Applications

**MA2005(3) – Mathematical Methods II (PQ: MA2102(3))**
Method of Characteristics. Boundary value problems. Green's functions. Integral equations.

**MA2104(3) - Complex Analysis (PQ: MA 1202(1))**
Complex-valued functions, Cauchy-Riemann equations, Holomorphic and harmonic functions, Complex Integration, Cauchy's Theorem, Cauchy's Integral Formulas, Complex Series, Taylor and Laurent Theorems, Laurent Expansions, Cauchy's Residue Theorem, Residue Calculus.

**MA2105(3) - Metric Spaces (PQ: MA 1202(1))**
Metric Spaces. Open and closed sets, Equivalent metrics, Continuity, Convergence and Completeness, Compactness.

**MA2204(3) - Numerical Analysis II (PQ: MA 1101)**
Initial Value Problems. Basic Methods. Consistency, Zero-Stability and Convergence Runge-Kutta Methods. Explicit and Implicit RK Methods. Order Conditions and Butcher Trees. Collocation RK methods. Linear Multistep Methods. Adams Bashforth and Adams-Moulton Methods. Characteristic Polynomials. Nystrom Methods.

**MA2205(3) – Numerical Linear Algebra (PQ: MA1104(1))**
Matrix Multiplication Problems, Vector and matrix norms. Householder and Givens transformations QR factorisation. Least-Squares problem. Eigenvalue problem. Power method and Rayleigh quotient iteration Householder deflation.

**MA3001(5) - Operational Research (PQ: MA 2202(3))**
Decision theory. Inventory. Network Flows.

**MA3003(5) - Numerical Solution Of Pdes (PQ: MA 2101(3))**
Fourier Transforms. Semi-Discrete Fourier Transforms. Well-Posed Problems, Hyperbolic Problems. Method of Characteristics, Numerical Schemes for Hyperbolic Problems. Consistency, Stability and Convergence Parabolic Equations. The Heat Equation and Crank-Nicolson Scheme. Higher Order Discretisations Elliptic Equations. Iterative Solution Methods

**MA3004(5) - Optimisation (PQ: MA 2101(3))**

Nonlinear Programming. Unconstrained Problems. Newton's Method, Multivariable Calculus, Gradient Algorithms. Quasi-Newton and Conjugate Gradient Methods

**MA3010(5) – Mathematical Modelling (PQ: MA 2202(3))**
Introduction to modelling; Model analysis: Applications

**MA3101(5) - Measure and Integral (PQ: MA 1202(1))**
Lebesgue measure on a real line. Measurable functions. The Lebesgue integral on the real line .Convergence theorems. Lebesgue probability space. Cumulative distribution function.

**MA3102(5) - Fluid Dynamics I (PQ: MA 2102(3))**
Kinematics and Dynamics of simple flows. Irrotational and rotational flows. Complex potential. Theorems of Milne-Thomson and Blasius.

**MA3202(5) - Functional Analysis (PQ: MA 2105(3))**
Normed vector spaces. Banach spaces. Finite dimensional spaces. The Hilbert space. Linear operators. Fundamental theorem for normed and Banach spaces. Principle of uniform boundedness. Dual spaces. Strong and weak convergence

## STATISTICS

**MA2004(3) - Computational Statistics (PQ: MA1105(1))**
Exploratory data analysis, Monte Carlo methods for inferential statistics, Data partitioning, Probability density estimation, Markov Chain Monte Carlo Methods, Use of a programming languages - R or MATLAB or any other relevant software.

**MA2007(3) - Survival Analysis (PQ: MA1105(3))**
Concepts and techniques used in the analysis of time to event data, including censoring, hazard rates, estimation of survival curves, parametric & nonparametric models, use of regression techniques and diagnostics.

**MA2008(3) - Statistical Quality Control (PQ: MA1105(3))**
Properties, designs and application of control charts, Shewhart charts, straight moving average chart, cumulative sum chart, exponentially weighted moving average chart, basic concepts of acceptance sampling, single, multiple and sequential sampling by attributes, variable sampling.

**MA2107(3) - Survey Methodology (PQ: MA1105(1))**
Planning surveys, Questionnaire design, Inference and error in surveys, Target populations, Sampling frames and coverage error, Sample design and sampling errors, Methods of data collection, Nonresponse in sample surveys, Probability proportion to size with and without replacement sampling, Sample size determination, Case problems including market research.

**MA2207(3) - Design and Analysis of Experiments (PQ: MA2107(3))**
Experimental designs, analysis of one-way and two way layout data, multiple comparisons, factorial designs, $2^k$-factorial designs, blocking and confounding, fractional factorial design and nested designs.

**MA3002(5) - Longitudinal Data Analysis (PQ: MA2203(3))**
Introduction to longitudinal studies, exploring longitudinal data, analysis of variance for repeated measures, general linear models for longitudinal data, growth curves, models for covariance structure, generalized linear models for longitudinal discrete data.

**MA3012(5) - Geostatistics (PQ: MA 2103(3))**
Exploratory spatial data analysis, Sample data set: Spatial continuity, Random function models for spatial data, Point Estimation, Ordinary and block Kriging, Applications using softwares. (At least one of R, Surfer, ArcGIS).

**MA3013(5) - Statistical Data Mining (PQ: MA2103(3))**
Data Preprocessing, Data Warehousing, Patterns and Associations, Classification, Cluster Analysis, Non-linear models.

**MA3014(5) - Categorical Data Analysis (PQ: MA 2203(3))**

Categorical response data and contingency tables, Framework of generalised linear models, Logistic regression, Multicategory Logit model, Loglinear models for contingency tables.

**MA3015(5) - Bayesian Statistics (PQ: MA2103(3))**
Bayesian principles such as subjective probability, Bayesian inference and decision making, the likelihood principle, predictivism and numerical methods of approximating posterior distributions. Models and applications including univariate and multivariate regression models, the general linear model and Bayesian classification. Case studies.

**MA3016(5) - Game Theory (PQ: MA2103(3))**
Impartial Combinatorial Games. Two-Person Zero-Sum Games. Two-Person General-Sum Games. Games in Coalitional Form.

**MA3103(5) - Generalised Linear Models (PQ: MA2203(3))**
Generalised linear models; the exponential family, the linear predictor, link functions, analysis of deviance, parameter estimation, deviance residuals, Model choice, fitting and validation.

**MA3203(5) - Multivariate Analysis (PQ: MA2103(3))**
Multidimensional random variables, Multivariate Normal Distribution. Wishart Distribution. Hottelings T2. Multivariate Analysis of Variance. Principal Components Discriminant Analysis.