UNIVERSITY of GUYANA

Title of Programme: **BSc. Degree in Mathematics**

Administrative Oversight: Office of the Vice Chancellor

Academic Department: Department of Mathematics, Physics and Statistics

Date of Commencement: September, 2015

Justification for the programme

Mathematics is indispensable to modern life; with application in all aspects of human endeavour. It enables us to predict the growth of markets, calculate accurate drug doses, effectively use a pressure cooker with accurate timing, and in modern time create 3D- dimensional computer graphics. The demand for personnel skilled in mathematics is high and obvious in most sectors of Guyana national development and also in the Caribbean. The dearth of pure and applied scientists (engineers, etc) in Guyana is a reflection of poor performance of the students in mathematics at the primary and secondary levels. This degree will therefore take students' understanding of the concepts and theories of mathematics – and how they are applied in the real world – to an advanced level, and enhance their career prospects in a huge array of fields. It will enable students develop skills in abstract thinking, conceptualizing problems and constructing models that seek to address issues that confront them individually, and at levels of work group and nationally. And within the context of Open Education; the programme, like others, ensures availability and accessibility of tertiary education especially in the hinterland.

Programme Description

This degree requires 370 credits for graduation in four stages - stage one of 100 credits and the three other stages 90 credits each. Stages 1 and 2 provide the underpinning knowledge and skills needed for more advanced study at Stages 3 and 4.The first two stages introduce key ideas from statistics, algebra, geometry and trigonometry into the students'everyday thinking to build their confidence in learning and using mathematics. Other topics including calculus, vectors, matrices, sequences and functions; data summary, relationship, distribution, hypothesis, estimates, and probability are treated. Differential equations, mechanics and discrete mathematics calculus also form part of the foundation courses. In stages 3 and 4 students continue to develop their mathematical skills and knowledge by exploring new topics and by deepening their understanding of material met previously. They will study both pure and applied mathematics and then branch out by choosing from a range of more advanced modules which currently includes: abstract algebra, complex analysis, graphs and networks, computer algebra, mathematical methods, quantum physics and electromagnetism.

Educational aims

This degree introduces the students to mathematical concepts and thinking, and helps them to develop a mathematical approach. The aims are that the students should achieve:

- familiarity with the essential ideas of pure mathematics (particularly analysis, linear algebra and group theory),
- ability to apply the main tools of applied mathematics (particularly Newtonian mechanics, differential equations, vector calculus, numerical methods and linear algebra),
- ability to model real-world situations and to use mathematics to help develop solutions to practical problems
- ability to follow complex mathematical arguments and to develop mathematical arguments of their own experience of study of mathematics in some breadth and depth
- understanding of some of the more advanced ideas within mathematics
- development of their capability for working with abstract concepts
- ability to communicate mathematical ideas, proofs and conclusions effectively
- ability to work with others on mathematical modelling problems and their validation
- skills necessary to use mathematics in employment, or to progress to further study of mathematics
- ability to use a modern mathematical computer software package in pursuance of the above aims.

  Students will also have the opportunity to develop knowledge of, and the ability to apply, some important concepts and techniques of Statistics.

Learning Outcomes

The learning outcomes of this degree are described in four areas: knowledge and understanding, cognitive skills, practical/ professional skills and key skills.

Knowledge and understanding

On completion of this degree, students will have knowledge and understanding of:

- the elements of linear algebra, analysis and group theory
- the concepts behind the methods of Newtonian mechanics, differential equations, vector calculus, linear algebra and numerical analysis, and be able to model real-world situations using these concepts.
- *pure mathematics*: number theory, combinatorics, geometry, metric spaces, further group theory and analysis
- *applied mathematics*: advanced calculus, fluid mechanics, advanced numerical analysis, methods for partial differential equations, variational principle
- data analysis and statistical methods and be able to model real-world situations using these methods.

Cognitive skills

On completion of this degree, students will have acquired:

- ability in mathematical and statistical manipulation and calculation, using a computer package when appropriate
- ability to assemble relevant information for mathematical and statistical arguments and proofs
- ability to understand and assess mathematical proofs and construct appropriate mathematical proofs of your own
- ability to reason with abstract concepts
- judgement in selecting and applying a wide range of mathematical tools and techniques
- qualitative and quantitative problem-solving skills.

Practical and/or professional skills

On completion of this degree, students will be able to demonstrate the following skills:

- *Application*: apply mathematical and statistical concepts, principles and methods
- *Problem solving*: analyse and evaluate problems (both theoretical and practical) and plan strategies for their solution
- *Information technology*: use information technology with confidence to acquire and present mathematical and statistical knowledge, to model and solve practical problems and to develop mathematical insight
- *Communication*: communicate relevant information accurately and effectively, using a format, structure and style that suit the purpose (including an appropriate presentation)
- *Collaboration*: work collaboratively with others on projects requiring mathematical knowledge and input
- *Independence*: be an independent learner, able to acquire further knowledge with little guidance or support.

Key skills

On completion of the degree, students will be able to demonstrate the following key skills:

Communication

- read and/or listen to documents and discussions having mathematical content, with an appropriate level of understanding
- communicate information having mathematical or statistical content accurately and effectively, using a format, structure and style that suits the purpose (including an appropriate presentation)
- work collaboratively with others on projects requiring mathematical knowledge and input.

Application of number

- exhibit a high level of numeracy, appropriate to a mathematics graduate.

Information technology

- use information technology with confidence to acquire and present mathematical and statistical knowledge, to model and solve practical problems and to develop mathematical insight.

Learning how to learn

- be an independent learner, able to acquire further knowledge with little guidance or support.

Intake
The initial intake will be 50 students. Special consideration will be given to applicants living outside of Region 4 and 6 in Guyana and all school teachers irrespective of where they reside.

Commencement date: September, 2015.

Entry Requirements:
CSEC with passes in Mathematics, English, and 3 other subjects in grades I, II, III; at one setting; or six subjects at two settings. Mature candidates with lesser qualifications would be admitted with the proviso that they pass UG entrance examination.

Duration:
The programme is organized in four (4) stages: and is designed to be completed between 4 to 8 years.

Programme Evaluation and Grading Scheme
The programme will be evaluated through course work of four (4) assignments with a weight of 10% each (total 40%) and final examination with a weight of 60%.

Programme Details

Students are expected to complete 370 credits of studies in four stages to be awarded the degree. This is arranged into 90/100/120 credits per stage.

Stage	UG Course code	OU Course code	Course Title	Credits
1	ENG 1108		Introduction to the Use of English	10
1	ENG 1208		Technical Communication	10
1	MTO1001	MU 123	Discovering Mathematics 1	30
1	MTO1002	MST124	Essential Mathematics 1	30
1	MTO1003	M140	Introducing Statistics	30
				110 credits
2	MTO2001	MST125	Essential Mathematics 2	30
2	MTO2002	M208	Pure Mathematics	60
				90 credits
3	MTO3001	MST 210	Mathematical methods, models and modeling	60
	Any	***one***	***from following three options (60/30 credits)***	
3	MTO 3002	M347	Mathematical Statistics	60
3	MTO 3003	M337	Complex analysis	30
3	MTO 3004	SMT 395	Electromagnetism	30
				90/120 Credits
4	MTO4001	M303	Further Pure Mathematics	60
	Any	***one***	***from following four options***	
4	MTO 4002	M365	Graphs, networks, and design	30
4	MTO 4003	SM358	The Quantum world	30
4	MTO 4004	S382	Astrophysics	30
4	MTO 4005	S383	Linear Statistics Modeling	30
				60/90credits
	Total			**380**

Collaborating Institutions: Ministry of Education and Open University, UK

COST: The cost per year is G$ 2500 (Two thousand and five hundred Guyanese Dollars) per credit.

Grading Scheme:

A	100 - 75%
B	74 - 65%
C	64 - 55%
D	54 - 40%
F	39 % & below Fail

Course Outlines

Course Code	ENG 1108
Course Title	Introduction to the Use of English
Number of Credit	10 credits
Programme Stage	One
Mode of delivery	Distance Mode
Co-requisites and Pre-requisites	None
Duration in weeks	Not applicable

Course summary

The Introduction to the Use of English is a foundation course required for students who enter the University of Guyana and are largely from Creole speaking backgrounds. The course introduces students to language as it is used in academic settings and targets the development of reading and writing skills for the tasks required at university. It aims to provide interactive settings for students to develop and increase their language awareness and attain confidence to aim for mastery of oral and written Standard English.

Learning outcomes

At the end of the course the student would increase their:

- language awareness;
- skills in listening/viewing/reading and responding to English used in academic settings;
- critical thinking and level of comprehension of written English;
- skills in writing well-developed essays on topical issues;

Course content:

- Introduction to language in the Guyana context
- Different types of writings
- Rhetorical strategies and paragraphing
- Literal and interpretative meanings
- Higher order level of thinking; analysis, synthesis and evaluation
- Sentence construction.
- Essay writing – topic, thesis , paragraphing, structure and development

Evaluation

Grammar- punctuation, vocabulary, verbs, tenses Evaluation: Course work: Portfolio (5 pieces)
Two tests = 50% Examination: One three-hour written paper = 50%.

Grading Scheme:

A 100 - 75%
B 74 - 65%
C 64 - 55%
D 54 - 40%
F 39 % & below Fail .

Recommended Readings

Bailey, S (2011). *Academic Writing: A Handbook for International Students*. 3rd Ed. Londin: Routledge.
Gillett, A. (2012). *Using English for Academic Purposes: A Guide for Students in Higher Education*, Online at http:www.uefap.com
Lowe, C and Zemliansky, P. (eds) (2009). Writing Spaces: Readings on Writing. Vol. 1 indiana: Parlour Press
Lowe, C and Zemliansky, P. (eds) (2009). Writing Spaces: Readings on Writing. Vol. 2 indiana: Parlour Press

Course Outlines

Course Code	ENG 1208
Course Title	Technical Communication
Number of Credit	10 credits
Programme Stage	One
Mode of delivery	Distance Mode
Co-requisites and Pre-requisites	None
Duration in weeks	Not applicable

Course summary

This course is designed to help students develop the communication skills that are essential for individuals to competently function in a professional, scientific or technical environment. It is intended to develop students' proficiency in writing reports that reflect extensive knowledge and clear understanding of the procedures/methods employed in acquiring and analyzing data.

Learning outcomes

At the end of the course the student would be able to:

- develop an understanding of the fundamental characteristics and functions of technical communication
- apply current conventions and techniques to compose letters, memoranda, e-mail messages and other business correspondence
- engage in various stages of the planning and writing process to produce well-structured, well-written proposals and reports
- appropriately use information from the internet, library databases and other information sources
- increase their communicative competence in the use of English through form- and meaning-focused activities (e.g., language exercises, drama routines, and field excursions).

Course content:

- Introduction to Technical Communication (TC)
- Writing within an Organization: Format & Layout of Business Documents: Letters, Memoranda and Emails
- Writing Summaries
- Planning and Writing Proposals
- Designing and Delivering Oral Presentations
- Planning and Writing Technical Report.

Recommended Readings

1) Boveé, Courtland L. and John V. Thill. *Business Communication Today*. Eighth Edition. New Jersey: Prentice Hall, 2005.
2) Kennedy, Mary L. and Hadley M. Smith. *Reading and Writing in the Academic Community.* New Jersey: Prentice Hall, Inc.,1994
3) Kirszner, Laurine G. and Stephen R. Mandell. *The Holt Handbook.* Fifth Edition. San Diego: Harcourt Brace College, 1999
4) Markel, Mike. *Technical Communication: Situations and Strategies*. Fourth Edition. New York: St. Martin's Press Inc., 1996.
5) *Merriam-Webster's Guide to Business Correspondence*. Second Edition. Massachusetts: Merriam-Webster Inc., 1996.

Evaluation

Coursework: Three (3) assessments = 50%
Examination: One three-hour written paper = 50%

Note: Students MUST obtain a PASS in BOTH Coursework and Examination for successful completion of this course.

Grading Scheme:

A	100 - 75%
B	74 - 65%
C	64 - 55%
D	54 - 40%
F	39 % & below Fail

Course Outlines

Course Code	MTO 1001 (MU 123)
Course Title	Discovering Mathematics
Number of Credit	30
Programme Stage	One
Mode of delivery	Distance Mode
Co-requisites and Pre-requisites	None
Duration in weeks	Not applicable

Course summary

This course is a gentle start to the study of mathematics with no previous knowledge of algebra. It helps students to integrate mathematical ideas into their everyday thinking and build their confidence in using and learning mathematics. It covers statistical, graphical, algebraic, trigonometric and numerical concepts and techniques, and it introduces mathematical modelling. Skills learnt are essential for those who plan to study more mathematics modules, such as Essential mathematics 1. It is also suitable for users of mathematics in other areas, such as computing, science, technology, social science, humanities, business and education.

Learning outcomes:

The course provides opportunities for students to develop and demonstrate the following learning outcomes:

a) Knowledge and understanding:
1. Some key ideas in mathematics, including some statistics, algebra, geometry and trigonometry
2. Basic mathematical vocabulary and notation introduced and developed in the course.
3. A repertoire of mathematical techniques for solving problems.

b) Cognitive skills:
1. Select and use appropriate techniques and strategies for solving problems in a range of everyday and abstract contexts.
2. Be able to interpret results of mathematics in real life situations, checking that results are sensible within the context of the problem.
3. Develop simple mathematical arguments.

c) Key skills:
1. Explain mathematical ideas from the course in writing, using appropriate terminology, notation and style.
2. Develop skills in learning independently – manage study time, learn actively, reflect on progress and plan further learning.
3. Use ICT tools such as the electronic assessment system and online resources for learning.

d) Practical and/or professional skills:
1. Describe problems mathematically.
2. Use a computer to help to investigate and solve a range of mathematical questions and problems.
3. Analyse and comment on the mathematical reasoning of others.
4.

Course Content:

- *Starting point*- Mathematics and the real world problems. Looking at patterns; notations, numbers, rounding off, fractions, mathematical operations, power.
- *Mathematical models*- planning a journey, distance, speed, usimg formula; from words to numbers.
- *Numbers*- real ,integers, working with numbers, ratio, solving practical problems
- *Statistical summaries*- statistical life questions, dealing with data, summarising data- range, mean, percentages, standard deviation, measuring accuracy and precision.
- *Algebra*- Think of a number, bracket, manipulating expressions, equation, relationships- linear, graphs, gradients,
- *Equations and Inequalities.*-Linear, simultaneous equations, graphs and inequalities
- Geometry- angles, areas, perimeters, shapes, and circles.
- *Quadratics*- graphs , models, solving quadratic equations, practical problems and quadratic equations, Asymptotes.

- *Statistical pictures*- Plots, histograms, standard variations
- *Trigonometry*- Ratios, angles, circular connections ,equations and identities ,Radians
- *Exponentials,* - family of functions; growing and shrinking, exponential functions
- *Mathematics everywhere*- life examples of application in diverse ways.

Evaluation:

- Four course work assignments - 10% each (40%)
- One final examination (60%)

Grading Scheme:

A 100 - 75%
B 74 - 65%
C 64 - 55%
D 54 - 40%
F 39 % & below Fail

Recommended texts:
All recommended text and reading materials will be provided to students and a tablet computer as part of the tuition

Course Outlines

Course Code	MTO1002(MST124)
Course Title	Essential Mathematics 1
Number of Credit	30
Programme Stage	One
Mode of delivery	Distance Mode
Co-requisites and Pre-requisites	None
Duration in weeks	Not applicable

Course summary

This key introductory course provides a broad and enjoyable foundation for university-level mathematics, but requires some prior knowledge. It teaches the essential ideas and techniques that underpin university-level study in mathematics and mathematical subjects such as physics, engineering and economics; and it uses mathematical software to solve problems. The students will develop skills in communicating results and defining problems.

Learning outcomes:

Successful study of this course would enable students develop skills in:

- expressing problems in mathematical language
- using mathematical techniques to find solutions to problems
- communicating mathematical ideas clearly and succinctly.

Course Content:

The content includes the following topics:

- *Functions*: these provide a means of representing situations where one quantity depends on another.
- *Trigonometry*: revision of the relationships between the angles and side lengths of triangles, and the definitions of the trigonometric functions sine, cosine and tangent for angles of any size..
- *Vectors*: these are quantities that have both a size and a direction.
- *Calculus*: one of the most important and widely applicable topics in mathematics. It is concerned with quantities that change continuously, such as the distance travelled by, and the speed of, a moving object..
- *Matrices*: these are arrays of numbers, which can be manipulated mathematically in various ways. They're used extensively in both pure mathematics and mathematical applications.
- *Sequences*: deal with how to work with some commonly occurring types of number sequences, such as those in which each number is obtained by multiplying the previous number by a constant.
- *Complex numbers*: these form an intriguing set of numbers that includes all the usual numbers, and also many `imaginary' numbers, such as the square root of minus one. They have many uses in applied and pure mathematics.

Evaluation:

- Four course work assignments - 10% each (40%)
- One final examination (60%)

Grading Scheme:

A 100 - 75%
B 74 - 65%
C 64 - 55%
D 54 - 40%
F 39 % & below Fail

Recommended texts:
All recommended text and reading materials will be provided to students and a tablet computer as part of the tuition

Course Outlines

Course Code	MTO 1003 (M140)
Course Title	Introducing Statistics
Number of Credit	30
Programme Stage	One
Mode of delivery	Distance Mode
Co-requisites and Pre-requisites	None
Duration in weeks	Not applicable

.

Course summary

Today, more than ever, statistics is part of our lives. This key introductory module will enable students to learn how to use basic statistical tools and quantitative methods that are useful in business, government, industry, medicine, the economy, and most academic subjects. Topics covered include: summarizing data; examining relationships; randomness and sampling distributions; probability; testing hypotheses; and estimation. Using data from a range of applications, students will learn practical statistical techniques and fundamental principles, as well as using software and a calculator to analyse data. The skills introduced will be ideal if students plan to study more mathematics modules or if they encounter data in another subject or their daily life.

Learning outcomes:

The module provides opportunities for students to develop and demonstrate the following learning outcomes:

KNOWLEDGE AND UNDERSTANDING:

- Demonstrate knowledge and understanding of some key ideas on statistics.
- Demonstrate knowledge and understanding of basic statistical vocabulary and notation introduced and developed in the study units.
- Demonstrate knowledge and understanding of a repertoire of statistical techniques for analysing data..

COGNITIVE SKILLS:

- Select and use appropriate techniques and strategies for analysing data in a range of everyday contexts.
- Interpret statistics in real-life situations, providing answers in a non technical format.
- Develop simple statistical arguments.

KEY SKILLS:

- Explain statistical ideas form the study units in writing, using appropriate terminology, notation and style.
- Develop skills in learning independently – manage study times, learn actively, reflect on progress and plan further learning
- Use ICT tools such as the electronic assessment system and online resources for learning.

PRACTICAL AND/OR PROFESSIONAL SKILLS:

- Describe questions about data statistically
- Use a computer to analyse data.
- Analyse and comment on statistical analyses

Course Content:

Introduction –Data sources primary and secondary, discrete and continuous data, manipulation, cleaning, data. Stem and Leaf plot.

Prices- Location Mean and media, weighted means, using summation notation; Measures of spread- range, quartiles, interquartile range.

Earnings- Sources of data on earnings, possible influences on earnings, basic comparison of men's and women's earnings via ratios. Standard deviation, Skewness Left and right skewness, numerical measure of skewness Computer Work

Surveys- Introduction to surveys, Random sampling, properties of simple random sampling, systematic random sampling; patterns in samples;population values and sample values, effect of sample size; More sampling methods ,Types of error, stratified random sampling, cluster sampling, quota sampling.

Relationships- Linked data, scatterplots; Interpretation of scatterplots Linear/nonlinear, positive/negative relationships, weak/strong relationships; Lines on plots; Least Squares Line Using the Least Squares Line; Residuals, prediction, extrapolation.

Truancy- Probability, Binomial Distribution; Testing hypotheses; Confidence intervals

Class Size -Sampling distribution of a mean., One-sample z-test Two-sided and one-sided z-test.

Reading Aloud - Contingency tables; null and alternative hypotheses - chi-square test for independence.,

School league tables- Strength of association; Quantifying relationships*;* Population regression parameters, Confidence intervals for parameters, Test for zero slope; Measuring association; correlation coefficient, Test for zero correlation.

Experiments- experiments and statistics*;* The t-test*;* one-sample t-test, matched pairs t-test; analysis of variance

Evaluation:

- Four course work assignments - 10% each (40%)
- One final examination (60%)

Grading Scheme:

A 100 - 75%
B 74 - 65%
C 64 - 55%
D 54 - 40%
F 39 % & below Fail

Recommended texts:
All recommended text and reading materials will be provided to students and a tablet computer as part of the tuition

Course Outlines

Course Code	MTO2001 (MST125)
Course Title	Essential Mathematics 2
Number of Credit	30
Programme Stage	Two
Mode of delivery	Distance Mode
Co-requisites and Pre-requisites	None
Duration in weeks	Not applicable

Course summary

Essential mathematics 2 builds on the concepts and techniques in Essential mathematics 1 (MST124) to provide a complete foundation for higher-level mathematics studies. Students ' ll be introduced to a broad range of enjoyable and essential topics, such as proof, differential equations, mechanics and discrete mathematics, as well as extending your knowledge of calculus and its applications. They 'll use mathematical software, and learn how to typeset mathematics. To study this module the students should have a sound knowledge of relevant mathematics as provided by Essential mathematics 1, in particular basic calculus.

Learning outcomes:

1. Knowledge and understanding skills

The student will:

- Understand some properties of different types of numbers, modular arithmetic, conics, hyperbolic functions, simple geometric transformations and eigenvalues/eigenvectors.
- Understand the basic principles of mathematical proof.
- Understand and apply the ideas behind some mathematical methods, including those applicable to recurrence sequences, curve-sketching and first-order differential equations.
- Understand and work with basic ideas in modelling forces and motion.

2. Cognitive skills

The students will:

- choose appropriate strategies for problem solving, in both practical and abstract contexts.
- use moderately complicated mathematical techniques.
- understand texts involving moderately complicated mathematics

3. Key skills

The students will:

- work fluently and accurately with some standard mathematical techniques, in particular those of basic calculus
- use the techniques of mathematics to model and solve simple mechanical problems.
- communicate mathematics effectively in writing.
- use a mathematics computer package
- study independently.

4. 4. Practical and/or Professional skills:

They will:

- think logically about problems and apply relevant techniques, including use of a computer, to a variety of situations

- work on tasks independently, and manage time.

Course Content:

- Introduction - topics include vectors, differentiation and integration
- Congruencies : division algorithm, consequences, properties of consequences
- Modular arithmetic - addition, multiplication, inverse, Euclid's Algorithm, Solving linear equation in Zn
- Rational and real numbers
- Conics: what it is and application to science
- Conics in standard position-Ellipse, hyperbola, parabola
- Dinectrix property , eccentricity
- Quadratic curves and translating conics
- Parametrising conics
- Statics: Newton's laws, modeling, systems of particles.
- Iteration : sequence, population model, Newton- Raphson method
- Geometric transformation- planes, rotations, reflection, linear transformation, inverse and composite transformation
- Mathematical language and proof. Why proofs?, variable proposition, theorem s, lemmas, hypotheses, corollaries
- Types of proofs- direct, contradictions, contraposition ,induction
- Further calculus- curve sketching, integration hyperbolic functions
- Differentiation Application with computer-direction fields, Euler's method.
- Dynamics: kinematics, vector, motion of particles
- Eigenvalues: calculation, 2 X2 matrices.
- Combinatorics- counting, The golden ratio, Fibonacci numbers, Linear second –order recurrence sequences.
-

Evaluation:

- Four course work assignments - 10% each (40%)
- One final examination (60%)

Grading Scheme:

A 100 - 75%
B 74 - 65%
C 64 - 55%
D 54 - 40%
F 39 % & below Fail

Recommended texts:
All recommended text and reading materials will be provided to students and a tablet computer as part of the tuition

Course outlines

Course Code	MTO2002 (M 208)
Course Title	Pure Mathematics
Number of Credit	60
Programme Stage	Two
Mode of delivery	Distance Mode
Co-requisites and Pre-requisites	None
Duration in weeks	Not applicable

Course summary

This course introduces the students to pure mathematics - one of the oldest creative human activities. Pure mathematics explores how numbers, shapes and systems can be combined in finite and infinite dimensions and processes. Specifically, this module deals with group theory, linear algebra, mathematical analysis. Group Theory explores sets of mathematical objects that can be combined – such as numbers, which can be added or multiplied, or rotations and reflections of a shape, which can be performed in succession. Linear Algebra explores 2- and 3-dimensional space and systems of linear equations, and develops themes arising from the links between these topics. Analysis, the foundation of calculus, covers operations such as differentiation and integration, arising from infinite limiting processes. To study this course, students should have a sound knowledge of relevant mathematics at level 1 of this programme.

Learning outcomes:

The course provides opportunities for students to develop and demonstrate the following learning outcomes:

a) Knowledge and understanding.

Students will understand:

- the basic elements of group theory;
- the basic elements of linear algebra;
- the basic elements of real analysis;
- notions of mathematical proof and rigour;
- notation, representations and conventions associated with these topics at level 2.

b) Cognitive skills. Students will:

- assemble relevant information for proofs;
- choose appropriate strategies for problem solving;
- produce coherent, convincing arguments appropriate to the level;
- assimilate complex mathematical ideas and arguments.

c) Key skills. Students will demonstrate:

- the ability to organise study time, to study independently, exploit feedback and meet deadlines;
- the ability to communicate solutions to problems clearly and coherently, using appropriate technical language.

d) Practical and/or professional skills. Students will demonstrate:

- thinking abstractly, using abstract ideas and notation;
- precision in technical description and computation.

Course Content:
Introduction

Real functions and graphs
Mathematical language and proof
Number systems

Group Theory A

Symmetry

Groups and subgroups-Cyclic groups - Isomorphisms - Groups from modular arithmetic. Permutations- Even and odd permutations - Conjugacy in Sn - Cayley's Theorem Normal subgroups - Quotient groups - Groups of small order

Linear Algebra

Vectors and conics- Coordinate geometry; Conics - Properties of conics; Linear equations and matrices ;Simultaneous equations; Determinants; Vector spaces; Linear transformations; Eigenvectors - Eigenvalues and eigenvectors - Conics and quadrics transformation, and applications to conics and quadric surfaces.

Analysis A

Numbers-Real numbers – Inequalities: Sequences- Null, Convergent, Divergent; Series Continuity- continuous functions - Inverse functions

Group Theory B

Conjugacy- Conjugate element, Normal subgroups, symmetry groups; Isomorphisms and homomorphisms - Properties of Images and kernels; Group actions -What is a group action? - Orbits and stabilizers.

Analysis B

Limits- Defining exponential functions - Shrinking polygons - Limits of functions - Asymptotic behaviour of functions; Differentiation- Rules, Rolle's Theorem - The Mean Value Theorem . Integration- Riemann integral, Inequalities, sequences; Power series-Taylor's Theorem - Convergence of power series.

Evaluation:

- Four course work assignments - 10% each (40%)
- One final examination (60%)

Grading Scheme:

A 100 - 75%
B 74 - 65%
C 64 - 55%
D 54 - 40%
F 39 % & below Fail

Recommended texts:

All recommended text and reading materials will be provided to students and a tablet computer as part of the tuition

Course Outlines

Course Code	MTO3001 (MST210)
Course Title	Mathematical methods, models and modeling.
Number of Credit	60
Programme Stage	Three
Mode of delivery	Distance Mode
Co-requisites and Pre-requisites	None
Duration in weeks	Not applicable

Course description

The course is concerned with how to solve real problems by finding out how they are transformed into mathematical models and learning the methods of solution. This module covers classical mechanical models as well as some non-mechanical models such as population dynamics; and methods including vector algebra, differential equations, calculus (including several variables and vector calculus), matrices, methods for three-dimensional problems, and numerical methods. Teaching is supported and enhanced by use of a computer algebra package. This module is essential for higher level study of applied mathematics. To study this module student 'll need a sound knowledge of mathematics as developed in *Essential mathematics 1* (MST124) and *Essential mathematics 2* (MST125) or equivalent.

Learning outcomes:

The course provides opportunities for students to develop and demonstrate the following learning outcomes.

(a) Knowledge and understanding

- Meet and use some of the fundamental partial differential equations of applied mathematics, including the wave equation and the diffusion equation.
- Meet partial differential equations in various different contexts, and apply a variety of methods for their solution, including separation of variables, Fourier series and Fourier transforms.
- Model physical problems using random walks which involve concepts of probability and statistics.
- Formulate and solve variational problems.
- Apply variational principles to derive the Euler–Lagrange equation.

(b) Cognitive skills

- Select and apply appropriate techniques to solve problems in a range of contexts.
- Develop an ability to analyse problems and identify key mathematical features.
- Produce coherent and convincing arguments in order to solve problems.

(c) Key skills

- Improve own distance-learning skills.
- Organise study time and work independently.
- Make effective use of feedback and meet deadlines.
- Communicate solutions to problems clearly and coherently, using appropriate mathematical language.

(d) Practical and/or professional skills

- Be able to abstract the mathematical model that underpins a real-world problem.
- Be able to select and apply appropriate methods to solve a range of practical problems.

Course Content:

- Introduction- numbers, ,measurement, accuracy, functions, complex numbers, differentiation and integration
- First-order and second –order differential equations
- Vector algebra and statistics
- Dynamics and modeling motions in two and three dimensions
- Matrices and determinants
- Systems of differential equations
- Functions of several variables
- MSXR209 modelling
- Oscillators and energy
- Forcing, damping and resonance
- Normal modes
- Modelling with non-linear differential equation
- Fourier series
- Partial differential equations
- Scalar and vector fields
- Vector calculus

- Multiple integrals
- Systems of particles
- Circular motion
- Rotating bodies and angular momentum.
-

Evaluation:

- Four course work assignments - 10% each (40%)
- One final examination (60%)

Grading Scheme:

A 100 - 75%
B 74 - 65%
C 64 - 55%
D 54 - 40%
E 39 % & below Fail

Recommended texts:
All recommended text and reading materials will be provided to students and a tablet computer as part of the tuition

Course Outlines

Course Code	MTO 3002 (M 347)
Course Title	Mathematical Statistics
Number of Credit	60
Programme Stage	Three
Mode of delivery	Distance Mode
Co-requisites and Pre-requisites	None
Duration in weeks	Not applicable

Course summary

This module provides students with the mathematical underpinning for statistical method. Students will gain a thorough grounding in mathematical statistics, together with generic skills. They will study distribution theory, leading on to the theory of statistical inference developed under both classical and Bayesian approaches. In the classical case, they will focus on maximum likelihood estimation; and also explore the development of these ideas in the context of linear modeling (regression and extensions). To study this module, students should have a sound knowledge of basic statistical ideas and competence in calculus, algebra and matrices, as provided by the appropriate courses at the foundation level of the programme.

Learning outcomes

The course provides opportunities for students to develop and demonstrate the following learning outcomes.

KNOWLEDGE AND UNDERSTANDING: The students will show understanding of:

- the mathematical background to a variety of major statistical methods
- basic distribution theory
- the mathematical basis of classical methods of statistical inference, especially that based on the likelihood
- the mathematical basis of Bayesian methods of statistical inference
- the above ideas in the context of linear and generalised linear modelling

COGNITIVE SKILLS: The students will be able to:

- carry out mathematical and statistical manipulations and calculations
- construct appropriate mathematical and statistical arguments of your own
- apply mathematical arguments in statistical contexts
- create appropriate statistical models and draw justifiable inferences
- develop skills of reasoning with abstract concepts
- enhance quantitative problem-solving skills

KEY SKILLS: The students will be able to demonstrate how to:

- use information technology with confidence to acquire and present statistical knowledge
- interpret and communicate solutions to statistical problems clearly and coherently
- use appropriate statistical language
- be an independent learner, able to acquire further knowledge with little guidance or support

PRACTICAL AND/OR PROFESSIONAL SKILLS: The student will be able to:

- understand and employ statistical concepts, principles and methods
- analyse and evaluate problems and plan strategies for their solution
- provide theoretical arguments in support of statistical methodology
- do the above at a level suitable to be of professional or practical use to a statistician or other numerate scientist

Course content

The course content is organized into five blocks, as stated below.

Block 1. Introduction:
A brief review of some basic concepts in previous mathematics modules. E**.g.** Quantitative and categorical variables; Basic probability, Normal, Bernoulli, binomial, Poisson distributions; Central limit theorem Calculus, including Taylor series Matrices
Basic Ideas of Statistical Inference; Basic Ideas of Statistical Inference; Basics of Bayesian inference; Sufficiency; factorization theorem: Basic Distribution Theory

Block 2: Classical Inference
Estimation, Confidence Intervals and Hypothesis Testing, Likelihood Asymptotics and Modified Likelihood.

Block 3: Bayesian Inference
Prior to Posterior, treatment of Bayesian inference, Markov Chain Monte Carlo

Block 4: Linear Modelling
Linear regression, Multiple regression, Generalised linear modeling- the distribution theory of how chi-square, t and F distributions arise.

Block 5: Miscellaneous Topics
Distribution Theory- Proof of Central Limit Theorem Transformation of random variables ,quintiles' unimodality, measures of skewness, etc.
Decision theory- Pay-off function, Risk function, Decision trees etc
Kernel Smoothing- Introduction to, and definition of, kernel density estimation, Basic asymptotic theory; bias/variance tradeoff

Evaluation:
- Four course work assignments - 10% each (40%)
- One final examination (60%)

Grading Scheme:
A 100 - 75%
B 74 - 65%
C 64 - 55%
D 54 - 40%
F 39 % & below Fail

Recommended texts:
All recommended text and reading materials will be provided to students and a tablet computer as part of the tuition importance of theory and analysis in solving practical problems.

Course Outlines

Course Code	MTO3003 (M337)
Course Title	Complex analysis
Number of Credit	30
Programme Stage	Three
Mode of delivery	Distance Mode
Co-requisites and Pre-requisites	None
Duration in weeks	Not applicable

Course summary.

This module develops the theory of functions of a complex variable, emphasizing their geometric properties and indicating some applications. *Introduction* covers complex numbers; complex functions; sequences and continuity; and differentiation of complex functions. *Representation formulas* cover integration of complex functions; Cauchy's theorem and Cauchy's integral formula; Taylor series; and Laurent series. *Calculus of residues* covers residue calculus; winding number and the location of zeros of complex functions; analytic continuation; Euler's gamma function and Riemann's zeta function. Finally, *Applications* covers conformal mappings; fluid flows; complex analytic dynamics; Julia sets; and the Mandelbrot set. Students need a sound knowledge of differentiation and integration of real functions for this module.

Learning outcomes:

The course provides opportunities for students to develop and demonstrate the following learning outcomes.

a) Knowledge and understanding of:

1. core definitions, conventions, notations, results and techniques in complex analysis at level 3, including;
2. complex numbers, types of sets of complex numbers;
3. complex functions, differentiation, integration, analytical continuation, and series in the complex plane;
4. the relevant abstract theory including the theorems of Cauchy, Liouville, Rouché; the Open Mapping Theorem; winding number;
5. the calculus of residues and its applications;
6. other applications including finding extrema, estimates, the locations of zeros;
7. applying the methods of complex analysis to the gamma function, conformal mappings, fluid flow and the Mandelbrot set.

b) Cognitive skills, to be able to:

1. assimilate complex mathematical ideas and arguments;
2. develop abstract logical thinking;
3. develop ability to interpret functions geometrically;
4. develop mathematical intuition;
5. represent mathematical statements in a formal and unambiguous way;
6. assemble relevant information for proofs and solutions;
7. produce coherent, convincing arguments appropriate to the level;
8. choose appropriate strategies for problem solving;
9. apply combinations of relevant techniques and procedures within complex analysis;
10. apply methods of complex analysis, in particular, to conformal mappings, fluid flow and the Mandelbrot set.

c) Key skills, to enhance the student's ability to:

1. communicate effectively in writing about the subject (using precise notations and coherent logical arguments);
2. combine several techniques to solve abstract and applied mathematical problems;
3. improve own learning and performance (e.g. develop the capacity to learn considerable quantities of abstract material in depth within fixed timescales, and monitoring own learning and study patterns).

d) Practical and/or professional skills:

1. apply the principles, concepts and techniques of complex analysis to other relevant disciplines.

Course Content:

The course deals with how the ideas of calculus are applied to the functions of a complex variable; that is complex analysis.

The topics treated broadly include:

- determination of the sums of many infinite series
- evaluation of many improper integrals
- finding the zeros of polynomial functions
- the distribution of large prime numbers
- model on how fluid flows past an aerofoil
- generation of fractal sets and the Mandelbrot set.

Evaluation:

- Four course work assignments - 10% each (40%)
- One final examination (60%)

Grading Scheme:

A 100 - 75%
B 74 - 65%
C 64 - 55%
D 54 - 40%
F 39 % & below Fail

Recommended texts:

All recommended text and reading materials will be provided to students and a tablet computer as part of the tuition

Course Outlines

Course Code	MTO 3004 (SMT395)
Course Title	Electromagnetism
Number of Credit	30
Programme Stage	Three
Mode of delivery	Distance Mode
Co-requisites and Pre-requisites	None
Duration in weeks	Not applicable

Course summary

The course aims to give students a detailed understanding of the theory of electromagnetism, and to show how this theory can be encapsulated in Maxwell's four equations and the Lorentz force equation. It will show that electromagnetism explains a wide range of physical phenomena, from the behaviour of light to the electrical and magnetic properties of materials, and that it has a broad range of applications, including many of technological relevance and of relevance to astrophysics and planetary science. Students studying the course will learn to appreciate the value of using advanced mathematical techniques (such as vector calculus) to describe aspects of the physical world, and they will practice using these techniques to find quantitative answers to problems

Learning outcomes:

This course provides opportunities for students to develop and demonstrate knowledge and understanding, qualities, skills and other attributes in the following four areas.

Knowledge and understanding of
1 underlying concepts, principles, laws, equations, relationships and applications of electromagnetism;
2 terms, conventions and units of measurement appropriate to electromagnetism;
3 the language and the techniques of mathematics that are used in electromagnetism
4 techniques for solving problems in electromagnetism;
5 how electromagnetic theory can be applied to a variety of situations;
6 the central role of Maxwell's equations and the Lorentz force law, and how they are used to make quantitative predictions and solve problems;
7 some of the limits of current knowledge in the field of electromagnetism.

Cognitive skills- They will be able to
1 use and apply knowledge and understanding of essential facts, concepts, principles and laws of electromagnetism to model a range of physical systems and to solve a variety of problems, in both familiar and unfamiliar situations;

2 use mathematical language and techniques, and mathematical and physical models, to understand phenomena and solve problems in electromagnetism;
exploit symmetry to tackle three-dimensional problems, choose appropriate approximations that lead to tractable solutions to problems, and visualize complex three-dimensional situations, for example, by the construction, or interpretation, of appropriately labelled diagrams;

3 evaluate information from a range of sources and make sound judgements, which take account of theories and concepts of electromagnetism.

Professional skill- Students will be able to
1 manage your own learning and time, and be able to learn independently so that you can continue your personal and professional development after completing the module.

Key skills – In addition students will be able to:

1- locate, receive and respond to a variety of information sources (e.g. textual, numerical, graphical, video and computer-based);

2 - communicate scientific information accurately and effectively, using appropriate combinations of written text, symbols, equations and numbers, graphs and diagrams, in a style that is suitable for the purpose and for the audience; communication may be in the form of a scientific essay, a shorter piece of writing, or appropriately presented solutions to problems, and must make correct use of scientific and mathematical notation;

3 - perform complex calculations, with appropriate use of physical units;

4 - improve your own learning and future performance by reflecting on past performance.

Course Content:

- Electric forces and fields
- Gauss's law
- Magnetic forces and fields
- Ampere's law
- Electrostatic potential
- Electromagnetic inclusion
- Maxwell's triumph
- Foundations of electromagnetism
- Electric fields in materials
- Magnetic fields in materials
- Electrostatic fields calculation
- Magnetic field calculation
- Forces on charge particles
- Resistance and induction
- Electromagnetic energy
- Superconductivity
- Special relativity and electromagnetism
- Electromagnetic waves in empty space
- Generation of electromagnetic waves
- Dielectric :reflection and refraction
- Dielectric: dispersion and absorption
- Conductor: absorption and reflection
- Plasma.

Evaluation:

- Four course work assignments - 10% each (40%)
- One final examination (60%)

Grading Scheme:

A 100 - 75%
B 74 - 65%
C 64 - 55%
D 54 - 40%
F 39 % & below Fail

Recommended texts:

All recommended text and reading materials will be provided to students and a tablet computer as part of the tuition

Course Outlines

Course Code	MTO 4001 (M303)
Course Title	Further Pure Mathematics
Number of Credit	60
Programme Stage	Four
Mode of delivery	Distance Mode
Co-requisites and Pre-requisites	None
Duration in weeks	Not applicable

Course summary

This course gives the students a broad overview of topics that are important in the modern development and theory of mathematics. It introduces them to number theory; the algebraic theory of rings and fields; and the theory of distance or metrics for mathematical objects. They will also further develop their understanding of group theory and real analysis, as introduced in Pure mathematics (????).In addition, they will look at how these ideas are applied to cryptography and fractals. To study this module the students should have a sound knowledge of relevant mathematics, including group theory, linear algebra, convergence of real sequences and continuity of real functions, provided by the appropriate foundation level 1 study.

Learning outcomes:

The course provides opportunities for students to develop and demonstrate the following learning outcomes:

KNOWLEDGE AND UNDERSTANDING:

The students will have understanding of:

- core definitions, results and techniques in elementary number theory, including congruence arithmetic, continued fractions and some classic Diophantine equations
- the main ideas of metric spaces (including metrics, continuity, completeness, open, closed, connected and compact sets)
- core definitions, results and techniques in group theory up to and including the Sylow
- theorems core definitions, results and techniques in elementary rings and fields, including unique factorisation, polynomial rings and finite fields

COGNITIVE SKILLS:

- choose appropriate strategies for problem solving;
- assemble relevant information for proofs
- produce coherent, convincing arguments appropriate to the level;
- apply complex methods and algorithms;
- assimilate complex mathematical ideas and arguments;
- develop abstract logical thinking;

KEY SKILLS

- communicate effectively in writing about the subject;
- improve own learning and performance (e.g. ability to organise study time, to study independently, exploit feedback, to meet deadlines

PRACTICAL AND/OR PROFESSIONAL SKILLS:

- think logically about problems and apply relevant techniques to a variety of situations.

Course content:

The course covers three major areas of number theory, algebra and metric spaces; organized in six books each containing four chapters. The topics covered in broad term include the following.

Numbers I - .Introduction to Number Theory. Foundations, Prime Numbers, Congruences and Fermat's and Wilson's Theorem.

Group Theory - Classification, Finite Groups and Sylow's Theorems. This will consolidate and build on the group theory studied at level one. On completion students should understand the structure of finite Abelian groups and be able to use the Sylow Theorems to analyse the structure of appropriate finite groups.

Numbers II - Ring and Polynomials, Fermat's Last Theorem and Unique Factorisation with some applications to Number Theory.Multiplicative Functions, Quadratic and Reciprocity.

Metric spaces I - Introduction to Metric Spaces; -Distance and Continuity, Metric Spaces, Metric Spaces and Continuity 2, Open and Closed Sets.

Rings and Fields - Rings and Homomorphisms, Fields and Polynomials, Fields and Geometry and Public Key Cryptography; Rings derived from polynomials and the concept of prime ideals. The fields units will introduce fields and discuss how to construct fields of fractions and field extensions as well as investigating ruler and compass constructions. The unit on cryptography will include some applications of finite fields.

Metric Spaces II - Connectedness, Compactness, Completeness and Fractals.

Evaluation:

- Four course work assignments - 10% each (40%)
- One final examination (60%)

Grading Scheme:

A 100 - 75%
B 74 - 65%
C 64 - 55%
D 54 - 40%
F 39 % & below Fail

Recommended texts:
All recommended text and reading materials will be provided to students and a tablet computer as part of the tuition importance of theory and analysis in solving practical problems.

Course Outlines

Course Code	MTO 4002(M365)
Course Title	Graphs, networks and design
Number of Credit	30
Programme Stage	Four
Mode of delivery	Distance Mode
Co-requisites and Pre-requisites	None
Duration in weeks	Not applicable

Course summary

This module is about using ideas from discrete mathematics to model problems, and representing these ideas through diagrams. The word 'graphs' refers to diagrams consisting of points joined by lines. These points may correspond to chemical atoms, towns, electrical terminals or anything that can be connected in pairs. The lines may be chemical bonds, roads, wires or other connections. The main topics of mathematical interest are graphs and digraphs; network flows; block designs; geometry; codes; and mathematical modelling. Application areas covered include communications; structures and mechanisms; electrical networks; transport systems; social networks; and computer science.

Learning outcomes:

Intended learning outcomes

The course provides opportunities for students to develop and demonstrate the following learning outcomes

1. Knowledge and understanding of:

    - the classification of combinatorial problems as existence, construction, enumeration and optimisation;
    - basic elements of graph theory, including traversability, trees, planarity and colouring;
    - basic elements of network analysis, including network flows, optimal paths, assignment and transportation problems, and applications to physical networks;
    - basic elements of design, including geometric design, kinematic design, the design of codes and the design of experiments.

2. Cognitive skills, to be able to:

    - assimilate combinatorial ideas and arguments in the three main areas of the course;
    - develop abstract logical thinking and mathematical intuition;
    - represent mathematical statements in a clear and concise way;
    - choose appropriate problem solving strategies to solve a wide range of problems;
    - apply combinatorial algorithms, in particular to problems involving graphs and networks;
    - apply relevant techniques and procedures with the three main areas of the course;
    - use computer software to solve a range of combinatorial problems and to carry out algorithms;
    - model practical situations by a graph or network, in simple cases.

3. Key skills:

    - communicate effectively in writing about the subject (using appropriate diagrams and technical language);
    - improve own learning and performance (e.g. ability to organise study time, to study independently, exploit feedback, to meet deadlines);
    - use computer software (e.g. to explore graphs and solve algorithmic problems).

4. Practical and/or professional skills:

    - apply the principles, concepts and techniques of graph and network modelling to relevant practical problems;
    - apply a systematic approach to design problems in geometric design, kinematic design, the design of codes and the design of experiment

Course Content:

The module is divided into three related areas: graphs, networks and design. The *Introduction* introduces two themes of the module, combinatorics and mathematical modelling, and illustrates them with examples from the three areas.

Graphs and diagraphs - nature of graphs and uses in genetics, ecology and music. Eulerian and Hamiltonian graphs.

Network flow- Finding maximum amount of a commodity passing through two points. Algorithm and solution to problems.

Geometric design- two dimensional patterns, construction and properties of regular, semi-regular tilting.

Trees- branching processes, decision-making procedures and molecules representations

Optimal paths- critical path planning

Kinematic Design- mechanical design of table lamps, robots manipulators, space –frame structures.

Planarity and colouring- drawing a graph in a plan without crosses; use of colours.

Assignment and transportation- warehousing and problems of system-management model

Design of codes- redundant information- cyclic and Hamming codes.

Graphs and computing- use of graph in computing

Physical network- electrical network and water flow through pipes

Block design-as applicable to agriculture and soil variation.

Evaluation:

- Four course work assignments - 10% each (40%)
- One final examination (60%)

Grading Scheme:

A 100 - 75%
B 74 - 65%
C 64 - 55%
D 54 - 40%
F 39 % & below Fail

Recommended texts:

All recommended text and reading materials will be provided to students and a tablet computer as part of the tuition

Course Outlines

Course Code	MTO4003(SM358)
Course Title	The Quantum world
Number of Credit	30
Programme Stage	Four
Mode of delivery	Distance Mode
Co-requisites and Pre-requisites	None
Duration in weeks	Not applicable

Course summary

The course provides a secure grounding in the physical principles, mathematical techniques and interpretation of quantum mechanics. Key ideas include: wave mechanics, interference, linear algebra, the uncertainty principle, measurement probabilities, entanglement, perturbation theory, identical particles and the exclusion principle. The course strongly emphasises applications of the basic theory to applied physics, chemistry and technology. The course will also survey recent evidence that tests and confirms the validity of quantum mechanics.

Learning outcomes:

1. Knowledge and understanding:

On completion of this course, you will have acquired knowledge and understanding of:

1. the fundamental principles and methods of quantum mechanics;
2. terms and notation appropriate to quantum mechanics;
3. language and techniques of mathematics used in quantum mechanics;
4. standard interpretations of quantum mechanics, including issues related to entanglement;
5. ways in which quantum mechanics is applied to real physical systems.

2. Cognitive skills:

On completion of this course, you will be able to:

1. use and apply the concepts and formalism of quantum mechanics;
2. interpret phenomena from a quantum mechanical perspective;
3. use appropriate mathematical language and techniques to understand quantum mechanical phenomena and to solve problems in quantum mechanics;
4. make appropriate approximations when using quantum mechanics to model real systems;
5. critically evaluate the extent to which aspects of quantum mechanics have been tested by experiment.

3. Key skills:

The student will have the ability to**:**

1. locate, receive and use a variety of sources of information (textual, tabular, equations, diagrams, audio-visual and computer-based);
2. study effectively by acquiring general skills from specific worked examples and exercises;
3. communicate complex information accurately and unambiguously via written work with appropriate use of notation, units, equations and diagrams

Course Content:

- The Quantum revolution
- Schrodinge's equation and wave function
- Particles in boxes
- The Heisenberg uncertainty principle
- Simple harmonic oscillators
- Waves packets and motions
- Scattering and tunneling
- Introduction to angular momentum
- Spin angular momentum
- Many-particle system s and indistinguishability
- Entanglement and the EPR "paradox"
- Quantum information
- Angular momentum
- The Hydrogen atom
- Time independent approximation

- Hydrogen-like systems
- Many-electron atoms
- Diatomic molecules
- Solids
- Light and matter.

Evaluation:

- Four course work assignments at 10% each (40%)
- One final examination (60%)

Grading Scheme:

A 100 - 75%
B 74 - 65%
C 64 - 55%
D 54 - 40%
F 39 % & below Fail

Recommended texts: All recommended text and reading materials will be provided to students and a tablet computer as part of the tuition

Course Outlines

Course Code	MTO4004 (S382)
Course Title	Astrophysics
Number of Credit	30
Programme Stage	Four
Mode of delivery	Distance Mode
Co-requisites and Pre-requisites	None
Duration in weeks	Not applicable

Course summary

This course focuses on the astrophysics of stars and exoplanets – examining their properties, structure, evolution and the physical processes that occur within them. Virtual Learning Environment (VLE) and internet-based resources are used throughout the course. Students 'll experience real, collaborative astrophysical research, online with a small group of other students, to acquire, reduce, analyse and interpret data.

Learning outcomes:

The course provides opportunities for students to develop and demonstrate the following learning outcomes:

1.Knowledge and understanding.

The students will be able to demonstrate the knowledge and understanding of:

- The terminology used to describe the properties and behaviour of extrasolar planets and isolated stars.
- Basic concepts of hydrodynamics, thermodynamics, plasma physics, quantum physics and nuclear physics that are of relevance to astrophysics.
- The properties of stars at different stages of their evolution – how they form, what happens to them as they age and what becomes of them when they die.
- The physical processes that sustain the energy output of stars during each stage of their evolution and drive the progression from one stage to the next.
- The relationship between different stages of stellar evolution and the production of the chemical elements.
- The principles underlying the astronomical techniques used in the observational work carried out.
- The scientific background to the observational work carried out.
- The methods used in the detection and characterisation of exoplanets, in particular the properties revealed by exoplanet transits.
- The astrophysics of planets as revealed by the known population of transiting exoplanets.
- The scientific examination of the question "is life unique to Earth?" in the context of exoplanet research.

2. Cognitive skills.

The student will :

- manipulate numbers, algebraic symbols and mathematical functions in equations of relevance to astrophysics.
- apply the techniques of differentiation and integration and manipulate differential equations which are of relevance to astrophysics.
- derive and manipulate quantitative theoretical models of physical processes and to derive physical estimates.
- demonstrate the interplay between modelling and observation or experiment
- critically evaluate arguments and data and formulate judgements in accordance with astrophysical theories and concepts.
- pursue disciplined abstract reasoning

Course Content:

- Structure and evolution of stars
- Formation of stars
- Growth, age and death of stars

- Physical processes and energy sustenance of each growth stage
- Stellar evolution and production of chemical elements
- Local home-based practical project
- Extra-solar planets
- Detection and charcterisation of extra-planets
- Host stars- properties, their planets, orbits, selection, quantification
- Models for the formation, structure, and evolution of planets.
- Answer to the question- ‘ Is life unique to Earth?”

Evaluation:

- Four course work assignments - 10% each (40%)
- One final examination (60%)

Grading Scheme:

A 100 - 75%
B 74 - 65%
C 64 - 55%
D 54 - 40%
F 39 % & below Fail

Recommended texts:
All recommended text and reading materials will be provided to students and a tablet computer as part of the tuition

Course Outlines

Course Code	MTO4005 (S383)
Course Title	Linear Statistical Modeling.
Number of Credit	30
Programme Stage	Four
Mode of delivery	Distance Mode
Co-requisites and Pre-requisites	None
Duration in weeks	Not applicable

Course summary

This course covers statistical modelling where a response variable depends on one or several explanatory variables: such as how well patients respond to a treatment, given their age and disease severity; or how different strains of rice compare when grown in various conditions. Taking a practical approach, students will use real problems and data to stimulate analyses and their interpretation. Statistical tools are introduced, and use of the statistical software package, GenStat (supplied) is taught. Students need a reasonable understanding of basic statistical ideas, as provide statistics modules learnt earlier in the programme. Students will learn to use the most important methods of analysing data – a skill that too few people have.

Learning outcomes

This course provides opportunities for students to develop and demonstrate knowledge and understanding, qualities, skills and other attributes in the following areas.

Knowledge and understanding:

- General ideas of modelling statistical data where there is a univariate response.
- Normal linear models (including analysis of variance, multiple regression and enhanced knowledge of simple regression).
- Basic and some intermediate ideas of experimental design, in a linear modelling context.
- Basic and some intermediate ideas of generalized linear modelling (including logistic, Poisson and gamma regression and loglinear models for contingency tables as special cases).
- Residual and influence diagnostics for linear and generalized linear models.
- The role, use and limitations of statistical software in statistical modelling.
- Enhanced appreciation of the setting and breadth of application of Statistics in today's world.
- Limited specific aspects of the history and development of generalized linear modelling.

Cognitive skills:

- Ability to formulate data analysis problems in a linear or generalized linear modelling framework.
- Ability to interpret and critically evaluate the outcomes of statistical data analysis in terms of the real-world problem from which the data arose.
- Ability to comment critically on choice of experimental design in simple situations.
- Ability to use a modern statistical software package (in particular, Genstat) to analyse data using linear and generalized linear models (including data exploration and the use of diagnostics).
- Enhanced ability for critical quantitative thinking.

3. Key skills:

- Ability to organise study time, to study independently, exploit feedback, to meet deadlines.
- Ability to communicate statistical ideas clearly and coherently, using appropriate technical and non-technical language.
- Ability to communicate solutions to problems and the outcomes of statistical data analyses clearly and coherently, and to comment critically on reports of statistical analyses, using appropriate technical language.

Practical and/or professional skills:

- Practical skills in statistical computing for linear and generalized linear modelling.

Course content

Introduction: definition of linearity, review of scatter plots, box plots and contingency tables.

Review of statistical concepts: revision of the statistical prerequisities required for the course.

Introduction to GenStat: introduction to the software used in this course, GenStat. This includes producing basic graphical output, numerical summaries and calculations of quantiles and probabilities from standard distributions.

Linear regression with one explanatory variable: simple linear regression including fitting using GenStat, making inferences, calculating confidence and prediction intervals, transformations, comparing slopes and correlations.

One-way analysis of variance*:* completely randomized block experiments, description of the one-way ANOVA model, testing for equality of means, planned comparisons, contrasts and unplanned comparisons.

Multiple linear regressions: description of the multiple linear regression model, choosing explanatory variables, parallels with cases with one explanatory variable, using indicator variables to compare regression lines and to do analysis of variance.

The analysis of factorial experiments: main effects and interactions, two-way ANOVA, more than two factors, using regression, factorial ANOVA without replication.

Experiments with blocking: description of blocking, Latin squares, incomplete block designs, split plot designs, confounding and designing experiments

Binary regression**:** the logistic function, the logistic regression model, using logistic regression.

What are generalized linear models**?** Poisson regression, the generalized linear model, inference for GLMs, GLM applications.

Diagnostic checking: leverage, the Cook statistic, residuals for GLMs, detection of observations with high leverage or influence in GLMs and recommended use of diagnostics.

Log linear models for contingency tables: two-way contingency tables, sampling models, log linear models in practice, links between logistic and log linear models

Further data analyses**:** data analysis involving GLMs, analysis of covariance, offsets, over dispersion

Evaluation:

- Four course work assignments - 10% each (40%)
- One final examination (60%)

Grading Scheme:

A 100 - 75%
B 74 - 65%
C 64 - 55%
D 54 - 40%
F 39 % & below Fail

Recommended texts:
All recommended text and reading materials will be provided to students and a tablet computer as part of the tuition.