

MASTER OF SCIENCE IN MATHEMATICS

PROGRAM DESCRIPTION

The Master of Science in Mathematics program aims to develop deep and comprehensive understanding of mathematics in various fields such as algebra, analysis, topology and geometry, and its applications to data science and information technology.

Its coursework enables students to delve into both pure and applied mathematics, with its thesis requirement preparing graduates for mathematical research at the doctoral level.

PROGRAM EXPECTED LEARNING OUTCOMES (PELO):

1. Demonstrate advanced knowledge in the field of mathematics and its areas;
2. Use advanced mathematical skills in various fields of specializations;
3. Apply skills in pattern recognition, generalization, abstraction, critical analysis, logical reasoning, synthesis, problem-solving and rigorous argument;
4. Exhibit written and oral skills in communicating mathematical proofs and solutions;
5. Develop research activities towards the advancement of mathematics and allied fields; and
6. Showcase an enhanced perception of the vitality and importance of mathematics in the modern world including the connections between different areas of mathematics, and between mathematics and other disciplines.

PERFORMANCE INDICATORS:

PROGRAM OUTCOMES	PERFORMANCE INDICATORS
Demonstrate advanced knowledge in the field of mathematics and its areas.	<ul style="list-style-type: none">• Undertake an independent study of an unfamiliar topic and present an accurate and in-depth discussion of the results of the investigation both orally and in writing.• Represent a given problem by a mathematical model and use this to obtain a solution to the given problem.

	<ul style="list-style-type: none"> • Discuss extensively and articulate data science and related concepts. • Develop relevant programming abilities. • Demonstrate proficiency with statistical analysis of data. • Develop the ability to build and assess data-based models. • Execute statistical analyses with professional statistical software such as R, Python, SPSS, and SAS. • Demonstrate skill in data management. • Apply data science concepts and methods to solve problems in real-world contexts and will communicate these solutions effectively
Use advanced mathematical skills in various fields of specializations.	<ul style="list-style-type: none"> • Perform appropriate suitable mathematical and statistical computations in data analysis. • Acknowledge scientific and mathematics facts as part everyday life. • Apply scientific advancement in ways that are meaningful to the disciplines. • Submit a paper or thesis that contains proofs of mathematical statements based on rules of logic.

	<ul style="list-style-type: none"> Assess the validity of the mathematical reasoning in the works of others and identify errors and gaps if any. Propose solutions to environmental problems based on interdisciplinary knowledge.
Apply skills in pattern recognition, generalization, abstraction, critical analysis, logical reasoning, synthesis, problem-solving and rigorous argument.	<ul style="list-style-type: none"> Apply the appropriate techniques in solving mathematical problems. Break down a complicated problem into simpler parts. Adapt known methods and tools in solving new problems. Submit a paper or thesis that contains proofs of mathematical statements based on rules of logic. Assess the validity of the mathematical reasoning in the works of others and identify errors and gaps if any. Given a survey expository or research paper is able to recreate proofs and arguments contained in the paper provide examples or give illustrations, and propose generalizations of results.
Exhibit written and oral skills in communicating mathematical proofs and solutions.	<ul style="list-style-type: none"> Demonstrate effective oral and written communication of mathematics concepts and theories.

	<ul style="list-style-type: none"> • Exhibit adequate technical writing and oral communication abilities. • Able to propose conjectures, investigate their truth or falsity, and write rigorous proofs of the investigation. • Given a survey expository or research paper is able to recreate proofs and arguments contained in the paper provide examples or give illustrations, and propose generalizations of results. • Able to prepare a well-written research paper (thesis or special project paper) that organizes and presents a body of mathematical in a detailed. Interesting and original manner. • Able to give an oral presentation of results of the research paper before peers and teaches.
Develop research activities towards the advancement of mathematics and allied fields.	<ul style="list-style-type: none"> • Undertake an independent study of an unfamiliar topic and present an accurate and in-depth discussion of the results of the investigation both orally and in writing. • Represent a given problem by a mathematical model and use this to obtain a solution to the given problem. • Submit a paper or thesis that contains proofs of mathematical statements based on rules of logic.

	<ul style="list-style-type: none"> Assess the validity of the mathematical reasoning in the works of others and identify errors and gaps if any. Able to prepare a well-written research paper (thesis or special project paper) that organizes and presents a body of mathematical in a detailed. Interesting and original manner. Able to give an oral presentation of results of the research paper before peers and teaches.
Showcase an enhanced perception of the vitality and importance of mathematics in the modern world including the connections between different areas of mathematics, and between mathematics and other disciplines.	<ul style="list-style-type: none"> Discuss the mathematical concepts behind well-known solution to real-life problems Discuss important breakthrough in the solution of real-world problems where mathematics played a significant role.

COURSE DESCRIPTIONS

I. Basic Courses

APM1101 Fundamental Concepts of Mathematics

This course covers sets, principles of logic, methods of proof, relations, functions, integers, binary operations, complex numbers, matrices and matrix operations, and an introduction to mathematical systems.

Prerequisite : *None*
Credits : *Three (3) units*
Number of hours : *54 hours*

APM1129 Advanced Calculus 1

This course provides an introduction to mathematical analysis beyond the calculus series. It includes the real number system, point set topology, limits and continuity, the derivatives, multivariable differential calculus, implicit functions and extremum problems.

Prerequisite : *APM1123 - Calculus 3*
Credits : *Three (3) units*
Number of hours : *54 hours*

II. Required Courses

Modern Algebra I

This course is an introduction to abstract algebra and the study of groups. Topics include isomorphism theorems for groups, group actions, Sylow theorems and applications, subrings, ideals and quotient rings, integral domains and fields, Euclidean rings, PIDs and UFDs.

Prerequisite : *None*
Credits : *Three (3) units*
Number of hours : *54 hours*

Linear Algebra

This course deals with the study of linear algebra and matrix theory. Topics include vector spaces, linear transformations, eigenvalues and eigenvectors, diagonalizability, inner product spaces and an introduction to the theory of canonical forms for matrices and linear transformations.

Prerequisite : *None*
Credits : *Three (3) units*
Number of hours : *54 hours*

Real Analysis I

This course deals with the study of theory of functions in real variables. Topics include measure and measure theory, measurable functions, Lebesgue theory of integration and differentiation.

Prerequisite : *None*
Credits : *Three (3) units*
Number of hours : *54 hours*

Complex Analysis

This course covers with the study of theory of functions in complex variables. Topics include complex number system, differentiability, elementary functions, contour integration, sequences and series, local theory, residue theory and harmonic functions.

Prerequisite : *None*
Credits : *Three (3) units*
Number of hours : *54 hours*

III. Electives and Cognates

Modern Algebra II

This course is an advanced course on modern algebra. Topics include modules, fields and characteristic of fields, extensions and irreducible polynomials and Galois theory.

Prerequisite : *Modern Algebra I*
Credits : *Three (3) units*
Number of hours : *54 hours*

Geometric Crystallography

This course deals with the study of Isometries, frieze groups, crystallographic groups, lattices and invariant sublattices, finite groups of isometries, geometric and arithmetic crystal classes.

Prerequisite : *Modern Algebra I*
Credits : *Three (3) units*
Number of hours : *54 hours*

Combinatorial Mathematics

This course deals with the study of permutations and combinations, generating functions, principle of inclusion and exclusion, recurrence relations, occupancy, matrices of zeros and ones, partitions, orthogonal Latin squares, and combinatorial designs.

Prerequisite : *None*
Credits : *Three (3) units*
Number of hours : *54 hours*

Discrete Mathematics

This is an advanced course on basic structures and algorithms, induction and counting, discrete probability and relations, and graphs and trees.

Prerequisite : *None*
Credits : *Three (3) units*
Number of hours : *54 hours*

Graph Theory

This course covers the advanced study of graphs. Topics include graphs and isomorphism, trees and forest, colouring and flows, and Hamilton cycles.

Prerequisite : *None*
Credits : *Three (3) units*
Number of hours : *54 hours*

Approximation Theory

This course covers Taylor's theorem, Weierstrass approximation theorem, approximation in Hilbert spaces, Fourier Series and Fourier transform, direct and inverse theorems, algebraic and trigonometric interpolation, Whittaker-Shannon sampling theory, wavelet analysis.

Prerequisite : *Real Analysis I*
Credits : *Three (3) units*
Number of hours : *54 hours*

Functional Analysis

This course deals with the study of linear operators, linear functionals, topological linear spaces, normed spaces, Hilbert spaces, functional equations, Radon measures, distributive and linear partial differential equations, and spectral analysis.

Prerequisite : *Real Analysis I*
Credits : *Three (3) units*
Number of hours : *54 hours*

Numerical Analysis

This is an advanced course on Floating point representation, condition numbers, iterative methods for solving systems of linear and nonlinear equations, numerical integration, numerical linear algebra.

Prerequisite : *Real Analysis I*
Credits : *Three (3) units*
Number of hours : *54 hours*

Numerical Optimization

This course deals with the study of deterministic descent type methods, stochastic optimization methods, numerical implementation.

Prerequisite : *Numerical Analysis*
Credits : *Three (3) units*
Number of hours : *54 hours*

Partial Differential Equations

This course deals with the study of equations involving partial derivatives. Topics include partial differential equations of the first and second order, Green's function and boundary value problems.

Prerequisite : *None*
Credits : *Three (3) units*
Number of hours : *54 hours*

General Topology

This course is an introduction to topology. Topics include topological spaces and metric spaces, theory of convergence, bases, axioms of countability, subspaces, homeomorphisms.

Prerequisite : *None*
Credits : *Three (3) units*
Number of hours : *54 hours*

Algebraic Topology

This course deals with the study of homotopy, fundamental group, singular homology, simplicial complexes, degree and fixed point theorems.

Prerequisite : *General Topology*
Credits : *Three (3) units*
Number of hours : *54 hours*

Algebraic Geometry

This course covers the study of the general projective space. Topics include collineation and correlations in a projective space, algebraic manifolds and plane curves, and quadratic transformation of systems of plane curves.

Prerequisite : *None*
Credits : *Three (3) units*
Number of hours : *54 hours*

Differential Geometry

This course deals with the study of classical theory of curves and surfaces. Topics include mappings of surfaces, differential structures and Lie groups and frame bundles.

Prerequisite : *None*
Credits : *Three (3) units*
Number of hours : *54 hours*

Hyperbolic Geometry

This course covers the study of Moebius transformations, hyperbolic plane and hyperbolic metric, geometry of geodesics, hyperbolic trigonometry, groups of isometries on the hyperbolic plane.

Prerequisite : *Modern Geometry*
Credits : *Three (3) units*
Number of hours : *54 hours*

Linear Programming

This is an advanced course in optimization. Topics include the simplex method, duality, geometry of linear programs, parametric programming, decomposition and upper-bounded variables.

Prerequisite : *None*
Credits : *Three (3) units*
Number of hours : *54 hours*

Mathematical Biology

This is an advanced course on applications of mathematics in biological models. Topics include Continuous and discrete population models for single species, models for interacting populations, evolutionary models, dynamics of infectious diseases, Biological oscillators and switches, perturbed and coupled oscillators, reaction diffusion, enzyme kinetics, chemotaxis, circadian systems models, coupled cell networks.

Prerequisite : *None*
Credits : *Three (3) units*
Number of hours : *54 hours*

Mathematical Finance

This course covers the study of binomial asset pricing model, vanilla options, exotic options, American options, arbitrage probabilities, profit and loss, stochastic interest rates.

Prerequisite : *None*
Credits : *Three (3) units*
Number of hours : *54 hours*

Mathematical Statistics

This is an advanced course on probability and statistics. Topics include Descriptive statistics, probability and probability distributions, sampling theory, estimation and test of hypothesis, linear correlation and regression analysis.

Prerequisite : *None*
Credits : *Three (3) units*
Number of hours : *54 hours*

Nonlinear Programming

This course deals with the study of the properties of convex sets and functions, unconstrained optimization, Kuhn- Tucker Theorem, Lagrange multipliers, saddle-point theorems and algorithms.

Prerequisite : *None*
Credits : *Three (3) units*
Number of hours : *54 hours*

Advanced Operating Systems and Networking

This course deals with the advanced topics and research issues in computer and operating systems. Topics include distributed systems and languages, networking, security, and protection, real-time and embedded systems, modeling and analysis, principles and implementations of operating systems and networking.

Prerequisite : *None*
Credits : *Three (3) units*
Number of hours : *54 hours*

Advanced Database Systems

This course deals with the study of the core and advanced principles and techniques of data and information management. Topics include processing and optimization of declarative queries, transactions, crash recovery, data stream systems, web data management, information integration, and introduction to data mining.

Prerequisite : *Advanced Operating Systems and Networking*
Credits : *Three (3) units*
Number of hours : *54 hours*

Advanced Systems Design and Implementation

This is an advanced course in systems analysis and design with focus on the key stages of the systems development life cycle including planning, analysis, and design.

Prerequisite : *Advanced Database Systems*
Credits : *Three (3) units*
Number of hours : *54 hours*

Technology and Project Management

This course is an introduction to the basic processes of project management for instructional design projects. Topics include organizational issues, methods of planning, and techniques for managing the business and creative processes that determine the success of a project.

Prerequisite : *Advanced Systems Design and Implementation*
Credits : *Three (3) units*
Number of hours : *54 hours*

Data Warehousing and Management

This course explores various techniques in designing data warehouses and creating data integration workflows as well as providing organizational perspective about data warehouse development which includes gaining conceptual background about maturity models, architectures, multidimensional models, and management practices.

Prerequisite : *None*
Credits : *Three (3) units*
Number of hours : *54 hours*

Exploratory Data Analysis

This course covers the essential techniques needed to summarize data. This summary is often needed as a prerequisite for data modeling, and assists in developing more sophisticated models. In this course, the students will be introduced to techniques needed to formulate and improve hypothesis statements, along with R programming skills and other similar plotting systems needed to present the gist of the data in graphical or numerical formats. This will help uncover relationships where later experiments and analysis can focus on. The student will also learn relevant statistical techniques that are needed to visualize more complicated data sets, especially those including multiple variables.

Prerequisite : *None*
Credits : *Three (3) units*
Number of hours : *54 hours*

Data Visualization and Storytelling

The course covers the techniques needed for the accurate and effective visualization and presentation of data. Topics include knowing how to determine the focus of the data and

understanding the reason behind its accumulation, and advances to the skills needed to transfer this understanding to written, visual, and oral presentations.

Prerequisite : *Data Warehousing and Management*
Credits : *Three (3) units*
Number of hours : *54 hours*

Big Data and Predictive Analysis

In this course, students will be introduced to the concept of using big data as a tool to solve real-world problems, and analytical techniques for effective predictive modeling.

Prerequisite : *Exploratory Data Analysis*
Data Visualization and Storytelling
Credits : *Three (3) units*
Number of hours : *54 hours*

Cloud Computing

This course explores various architectural cloud computing models including Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), and Business Process as a Service (BPaaS), the different ways in which clouds can be deployed (public, private, hybrid, and community clouds, and audit approaches which examines the threats and security implications.

Prerequisite : *Exploratory Data Analysis*
Data Visualization and Storytelling
Credits : *Three (3) units*
Number of hours : *54 hours*

Machine Learning

This course serves as an introduction to the concepts of machine, along with the underlying statistical processes. Topics include neural networks, pattern recognition, kernels, support vector machines, and related concepts.

Prerequisite : *Data Warehousing and Management*
Exploratory Data Analysis
Credits : *Three (3) units*
Number of hours : *54 hours*

IV. Thesis

Graduate Seminar

This course is intended to provide graduate students exposure to a variety of topics in various fields and areas of specialization.

Prerequisite : *None*
Credits : *Three (3) units*
Number of hours : *54 hours*

Thesis 1

The course provides opportunities for students to conduct research proposal on mathematics or a statistics topic, or a combination of either mathematics or statistics and information technology topics that builds on areas covered by the core and elective courses. An oral presentation is required in this course.

Prerequisite : *Comprehensive Examination*
Credits : *Three (3) units*
Number of hours : *54 hours*

Thesis 2

The course serves as the second and final part of the students' research. Students are guided to finish their thesis write-up and orally presenting a defensible result of their research work.

Prerequisite : *Thesis 1*
Credits : *Three (3) units*
Number of hours : *54 hours*

MASTER OF SCIENCE IN MATHEMATICS

Effective Academic Year 2022 - 2023

FIRST YEAR				
First Semester				
Course Code	Course Title	LEC	LAB	Prerequisites
	Modern Algebra I	3		
	Linear Algebra	3		
	Real Analysis 1	3		
	Elective (Allied)	3		
	Total Units	12		
Second Semester				
Course Code	Course Title	LEC	LAB	Prerequisites
	Complex Analysis	3		
	Elective (Topology / Geometry)	3		
	Elective (Allied)	3		
	Elective (Analysis / Algebra)	3		
	Total Units	12		
SECOND YEAR				
First Semester				
Course Code	Course Title	LEC	LAB	Prerequisites
	Elective (Allied)	3		
	Graduate Seminar	3		
	Thesis 1	3		
	Total Units	9		
Second Semester				
Course Code	Course Title	LEC	LAB	Prerequisites
	Thesis 2	3		
	Total Units	3		

MASTER OF SCIENCE IN MATHEMATICS				
CHED'S MASTER OF SCIENCE IN MATHEMATICS MINIMUM REQUIREMENT		FEU'S MASTER OF SCIENCE IN MATHEMATICS CURRICULUM PROGRAM		
I. Bridging Courses	0			0
			Fundamental Concepts of Mathematics	0
			Advanced Calculus	0
II. REQUIRED COURSES	15			15
Modern Algebra I	3		Modern Algebra I	3
Linear Algebra	3		Linear Algebra	3
Real Analysis I	3		Real Analysis I	3
Complex Analysis	3		Complex Analysis	3
Topology / Geometry Elective	3		Topology / Geometry Elective	3
III. ELECTIVES	12			12
Elective 1	3		Elective 1	3
Elective 2	3		Elective 2	3
Elective 3	3		Elective 3	3
Elective 4	3		Elective 4	3
IV. COGNATES	0			0
V. THESIS	6			9
Thesis 1	3		Thesis 1	3
Thesis 2	3		Thesis 2	3
			Graduate Seminar	3
TOTAL UNITS	33			36