Iligan Institute of Technology
of the Mindanao State University
Quality Education for a better Mindanao

# MASTER OF SCIENCE IN MATHEMATICS

## Introduction

The M.S. in Mathematics program is primarily designed to upgrade mathematics training of college teachers in the teaching profession as well as to cater the mathematics needs of those in other profession related to mathematics.

## Objectives

1. Provide one a career in teaching mathematics and prepare him for doctoral work in mathematics.

2. Provide students a good initial know-how in research and motivate them to participate in some research endeavors in mathematics.

## Admission Requirements

1. Must undergo an evaluation test in Advanced Calculus, Algebraic Structures, Finite Mathematics or their equivalents.
2. In case a student has deficiencies, he/she needs to take some undergraduate courses. These courses will be determined by the Department of Mathematics. A passing mark not below 2.5 is required in each of these courses.

## Degree Requirements

1. The MS Mathematics Program requires a minimum of 36 units of course work which include 18 units of three of the four sequential courses, 12 units of mathematics electives and 6 units of thesis work.
2. The masteral thesis should be a contribution to the field. However, in practice, due to the difference in students' capabilities in doing research work, thesis output may either contributory to the field or expository in nature (thesis substitute). In the latter case, the student should take 6 units of math courses other than the required electives and must be of levels higher than the three sequential courses. These substitute courses of 6 units are in a way, preparatory courses for a doctoral program.
3. The student will be required to demonstrate his grasp of fundamentals by taking comprehensive examination in two of the three sequential courses. The comprehensive examination may be repeated once within a span of one year. Failure to pass in the second attempt will mean disqualification from the program. The examination, if needed, may be taken only in areas of failure.

# MASTER OF SCIENCE IN MATHEMATICS (MS MATH)

(LIST OF COURSES BY SEMESTER)

## First Year, First Semester

| Course No. | Course Title | Units | Hrs/Wk | | | Pre-requisite(s) |
|---|---|---|---|---|---|---|
| | | | Lec | Lab | Total | |
| Math 212 | Real Analysis I | 3 | | | | |
| Math 225 | Modern Algebra I | 3 | | | | |
| | Math Elective | 3 | | | | |
| | Total | 9 | | | | |

## First Year, Second Semester

| Course No. | Course Title | Units | Hrs/Wk | | | Pre-requisite(s) |
|---|---|---|---|---|---|---|
| | | | Lec | Lab | Total | |
| Math 213 | Real Analysis II | 3 | | | | Math 212 |
| Math 226N | Modern Algebra II | 3 | | | | Math 225 |
| Math 221 | Linear Algebra I | 3 | | | | |
| | Total | 9 | | | | |

## First Year, Summer

| Course No. | Course Title | Units | Hrs/Wk | | | Pre-requisite(s) |
|---|---|---|---|---|---|---|
| | | | Lec | Lab | Total | |
| | Math Elective | 3 | | | | |
| Math 261 | Topology I | 3 | | | | |
| | Total | 6 | | | | |

## Second Year, First Semester

| Course No. | Course Title | Units | Hrs/Wk | | | Pre-requisite(s) |
|---|---|---|---|---|---|---|
| | | | Lec | Lab | Total | |
| Math 222/ 262 | Linear Algebra II/ Topology II | 3 | | | | Math 221 or 261 |
| | Math Elective | 3 | | | | |
| | Comprehensive Examinations | | | | | |
| | Total | 6 | | | | |

## Second Year, Second Semester

| Course No. | Course Title | Units | Hrs/Wk | | | Pre-requisite(s) |
|---|---|---|---|---|---|---|
| | | | Lec | Lab | Total | |
| Math 300 | Master's Thesis | 6 | | | | |
| | Total | 6 | | | | |

Note: Student should take additional six (6) units of math courses higher than those courses required if the thesis is expository in nature.

**TOTAL NUMBER OF UNITS:** **36** (if thesis is original)
**42** (if thesis is expository)

# CATALOGUE OF COURSES

MATH 212 REAL ANALYSIS I

The real number system; Lévesque measure and integration; differentiation; metric spaces and topological vector spaces; Stone-Weirstrass theorem.

Credit : 3 units
Prerequisite(s) : Instructor's consent

MATH 213 REAL ANALYSIS II

This is a continuation of Real Analysis I. Topics include classical Banach spaces and topics in general measure and integration theory.

Credit : 3 units
Prerequisite(s) : Math 212

MATH 214 INTRODUCTION TO NUMERICAL ANALYSIS

Solution of linear systems; least square approximations, non-linear algebraic equations interpolations and quadrature.

Credit : 3 units
Prerequisite(s) : Math 121 and instructor's consent

MATH 214N, 215N NUMERICAL ANALYSIS I, II

Iterative methods of solving equations, linear difference equations, application to solutions of polynomial equations, difference and integral formulas; minimal solution to ordinary differential equation; round-off error bounds

Credit : 3 units
Prerequisite(s) : Numerical Methods

MATH 215 INTRODUCTION TO APPROXIMATION THEORY

Normed linear spaces; convexity; existence and unicity of best approximations; Tchebycheff approximation by polynomial and other related families; least square approximation and related topics; rational approximation.

Credit : 3 units
Prerequisite(s) : Instructor's consent

MATH 216 COMPLEX ANALYSIS I

The complex number system; complex integration and differentiation; Cauchy's theorems; analytic functions and harmonic functions; conformal
mappings; infinite series; singularities; residue theory.

Credit : 3 units
Prerequisite(s) : Math 116 or instructor's consent

MATH 217 COMPLEX ANALYSIS II

This a continuation of Complex Analysis I. Topics include Poison integral formula and its applications; inverse functions; analytic continuation; entire functions; infinite products; Hadamard factorization theorem; families of analytic functions; the prime number theorem.

Credit : 3 units
Prerequisite(s) : Math 216

MATH 218 MEASURE THEORY

Measure spaces; Radon-Nikodym theorem; LP spaces; inner and outer measures; Tonelli's and Fubini's theorems, Daniell integral, mappings of measure spaces; Hear measure; ergodic theory.

Credit : 3 units
Prerequisite(s) : Math 213

MATH 221 LINEAR ALGEBRA I

Vector spaces; basis; subspaces; linear transformations; matrices; systems of linear equations; Hermite normal form; determinants; adjoint; elgenvalues; Hamilton-Cayle theorem; Jordan normal form; linear functional.

Credit : 3 units
Prerequisite(s) : Math 121, Math 116 or instructor’s consent

MATH 222 LINEAR ALGEBRA II

This is a continuation of Linear Algebra I. Topics include linear functionals; bilinear forms; inner product spaces; orthogonal and unitary transformations; Gram - Schmidt orthogonalization process; Linear programming.

Credit : 3 units
Prerequisite(s) : Math 221

MATH 223 LINEAR PROGRAMMING

The simplex method; duality; geometry of linear programs; dual simplex method; parametric programming; integer programming; network analysis including PERT-CPM; algorithms for linear programming; decomposition and upper-bound technique.

Credit : 3 units
Prerequisite(s) : Math 221

MATH 224 NON-LINEAR PROGRAMMING

Properties of convex sets and functions; constrained and unconstrained optimization; Kuhn-Tucker conditions; quadratic programming; convex programming; saddle-point theorems; algorithms for non-linear programming.

Credit : 3 units
Prerequisite(s) : Instructor’s consent

MATH 225 MODERN ALGEBRA I

Groups; permutation groups; Lagrange's theorem; Cayley's theorem;isomorphism theorems; correspondence theorem; Sylow's theorems; Remark-Krull-Schmidt theorem.

Credit : 3 units
Prerequisite(s) : Undergraduate modern algebra course or instructor's Consent

MATH 226N MODERN ALGEBRA II

Rings and ideals; extension fields; Galois theory.

Credit : 3 units
Prerequisite(s) : Math 225

MATH 227 THEORY OF RINGS

Rings and ideals, prime and maximal ideals; nilradical and Jacobson radical, modules projective, injective, flat modules, Rhoetherian and Arthinian rings.

Credit : 3 units
Prerequisite(s) : Math 225

MATH 228 LATTICE THEORY

Partially ordered sets; lattices; complete modular and distributive lattices; applications.

Credit : 3 units
Prerequisite(s) : Undergraduate set theory or instructor's consent.

MATH 229 THEORY OF GROUPS

Abelian groups; finite groups; solvable groups; free groups; infinite abelian groups; group representations.

Credit : 3 units
Prerequisite(s) : Math 225

MATH 230 STATISTICAL METHODS

This is a survey course in basic statistical methods which includes broad topics on frequency distribution; measures of central tendency, dispersion, kurtosis, skewness, association and relationship; sampling and theoretical distributions, estimation; tests of hypothesis; one-way ANOVA and some non-parametric methods

Credit : 3 units
Prerequisite(s) : Instructor's consent

MATH 231 PROBABILITY THEORY

Probability spaces; probability distributions; Random variables; independence; conditional expectation; weak and strong laws of large numbers; moment generating functions; central limit theorem.

Credit : 3 units
Prerequisite(s) : Math 218 or instructor's consent

MATH 232 MATHEMATICAL STATISTICS I

Sampling theory; asymptotic sampling theory for large samples; order statistics; linear statistical estimation; parametric and non-parametric statistical estimation; statistical hypotheses and statistical tests; sequential analysis; decision theory.

Credit : 3 units
Prerequisite(s) : Math 231

MATH 233 MATHEMATICAL STATISTICS II

Linear regression and correlation; multiple regression; polynomial regression; analysis of variance; fixed-effect model; random effects model; randomized block designs; factorial experiments.

Credit : 3 units
Prerequisite(s) : Math 232

MATH 234 INTEGER PROGRAMMING AND COMBINATORIAL OPTIMIZATION

Applications of integer programming; converging and primal cutting plane algorithms; branch-bound methods; transportation problem; application of graph theory and mathematical programming.

Credit : 3 units
Prerequisite(s) : Instructor's consent

MATH 235 INTRODUCTION TO STOCHASTIC PROCESSES

Markov chains, their basic theorems and applications; renewal theory; branching processes; queuing theory; birth and death processes; branching processes; Poison processes.

Credit : 3 units
Prerequisite(s) : Math 231 or Instructor's consent

MATH 236 CATEGORY THEORY

Categories, functions; natural transformations; representable functions and limits of diagrams; adjoint functions and limits of diagrams; adjoint function; Abelian and homological categories.

Credit : 3 units
Prerequisite(s) : Undergraduate set theory and Math 226 or instructor's consent

MATH 242 APPLIED DYNAMIC PROGRAMMING

Deterministic dynamic programming; probabilistic dynamic programming; applications of dynamic programming forward and backward recursion; continuous state dynamic programming; multiple state variables.

Credit : 3 units
Prerequisite(s) : Math 223

MATH 243 QUEUING THEORY

Stochastic models of waiting lines and related systems, classification of queuing; designs; parametric description of queues; optimal control of queues; applications

Credit : 3 units
Prerequisite(s) : Math 235 or instructor's consent

MATH 244 NUMERICAL LINEAR ALGEBRA

Computer aspects with linear algebra; linear equation and matrices, direct and iterative methods, eigenvalues and eigenvectors with matrices, error analysis

Credit : 3 units
Prerequisite(s) : Linear Algebra

MATH 250 MODERN GEOMETRY

Skewfields and fields; permutation groups; classical projective planes; dual spaces and homogeneous coordinates; cross ratio; polarities; conics; elementary properties of projective and affine planes; duality principles; coordination of projective and affine planes.

Credit : 3 units
Prerequisite(s) : Math 221

MATH 251 ORDINARY DIFFERENTIAL EQUATIONS

Existence, uniqueness, and dependence theorems; linear systems; stability of non-linear systems; perturbation of periodic solutions; Poincare-Bendixson theory; equations in Banach space.

Credit : 3 units
Prerequisite(s) : Math 221 & Math 212 or instructor's consent

MATH 252 PARTIAL DIFFERENTIAL EQUATIONS

Existence and uniqueness theory in partial differential equations; generalized solutions and convergence of approximate solutions to partial differential systems; elliptic, hypo-elliptic, and hyperbolic operators.

Credit : 3 units
Prerequisite(s) : Math 221 & Math 212 or instructor's consent

MATH 253 NUMERICAL SOLUTIONS TO ORDINARY DIFFERENTIAL EQUATIONS

Numerical solution to initial value problems by Runge Kutta methods, general one-step methods and multi-step methods; analysis of truncation error; discretization error and rounding error; stability of multi-step methods; numerical solution of boundary and eigenvalue problems by initial value problem techniques and finite difference methods

Credit : 3 units
Prerequisite(s) : Math 214n

MATH 255 INTRODUCTION TO DYNAMICAL SYSTEMS

Discrete dynamical systems: orbit analysis, bifurcations, symbolic analysis, chaos, fractals; continuous dynamical systems: trajectories of ordinary differential equations, Poincare-Bendixon Theory

Credit : 3 units
Prerequisite(s) : Math 81 and Csc 11 or equivalent

MATH 256 INTRODUCTION TO FRACTAL GEOMETRY

Metric topology, complete metric spaces, Hausdorf metric, shift maps, iterative function systems, fractal sets, Hausdorf measure and Hausdorf dimension, Cantor sets and Cantor functions, Sierpinski carpets, Koch curves, Peano space-filling curves, introduction to fractal measures.

Credit : 3 units
Prerequisite(s) : Math 112 and Csc11 or equivalent

MATH 257 NUMERICAL SOLUTIONS TO PARTIAL DIFFERENTIAL EQUATION

Numerical solution with hyperbolic, parabolic and elliptic equations by finite difference methods; iterative methods for solving elliptic equations, discretization and round-off errors; implicit and explicit methods for parabolic and hyperbolic systems, the method of characteristics, the concept of stability for initial value problems

Credit : 3 units
Prerequisite(s) : Math 215n

MATH 261 TOPOLOGY I

Topological spaces; continuous functions, product spaces and quotient spaces; convergence structures (nets and filters); separation axioms and countability properties; connectedness; metrizable spaces.

Credit : 3 units
Prerequisite(s) : Undergraduate courses in set theory & advanced calculus or intructor's consent

MATH 262 TOPOLOGY II

This is a continuation of Topology I. Topics include completeness, connectedness, uniform spaces, proximity spaces.

Credit : 3 units
Prerequisite(s) : Math 261

MATH 263 INTRODUCTION TO ALGEBRAIC TOPOLOGY

The homotopy relation; the fundamental group and higher homotopy groups; complexes, polytapes and their homology groups; cohomology; Lofschatz's fixed-point theorem; the Brouwer fixed-point theorem, mappings of spheres.

Credit : 3 units
Prerequisite(s) : Math 262, Math 225 & instructor's consent

MATH 264 INTRODUCTION TO DIFFERENTIAL TOPOLOGY

Differentiatable manifolds; tangent bundles; vector fields; differential forms; selected topics.

Credit : 3 units
Prerequisite(s) : Math 262, Math 213, & Math 221

MATH 265 THEORY OF PROXIMITY SPACES

Proximity spaces, compactifications; clusters and grills; uniform spaces; generalized uniform structures.

Credit : 3 units
Prerequisite(s) : Topology II

MATH 266 ALGEBRAIC TOPOLOGY

Homology and cohomology theories; homotopy theory, and applications.

Credit : 3 units
Prerequisite(s) : Introduction to Algebraic Topology

MATH 270 COMBINATORIAL MATHEMATICS

Permutations and combinations; generating functions; principles of inclusion and exclusion; recurrence relations; matrices of zeros and ones; partition function.

Credit : 3 units
Prerequisite(s) : Math 225 Instructor's consent

MATH 275 GRAPH THEORY

Graphs and associated matrices; oriented graphs and kernels; domination and independence; matching theory; groups and graphs.

Credit : 3 units
Prerequisite(s) : Math 221 and Math 225 or Instructor’s consent

MATH 276 THEORY OF HYPERGRAPHS

Conformal and representable graphs; sums and products of hyper graphs; cycles; symmetry; regularity and colorability or hypergraphs.

Credit : 3 units
Prerequisite(s) : Math 275

MATH 277 FINITE GRAPHS AND NETWORKS

Basic graph theory and applications to optional path problems; flows in networks; combinatorial problems.

Credit : 3 units
Prerequisite(s) : Math 275

MATH 281 FUNCTIONAL ANALYSIS I

Topological vector spaces; Banach spaces; Hilbert spaces; Hanh-Banach theorem; duality; linear bounded operators; spectral theory.

Credit : 3 units
Prerequisite(s) : Math 213 or instructor's consent

MATH 282 FUNCTIONAL ANALYSIS II

This is a continuation of Functional Analysis I. Topics include distributions and Fourier transforms; unbound operators.

Credit : 3 units
Prerequisite(s) : Math 281

MATH 284 COMPUTER MODELLING AND SIMULATION

Techniques for computer modeling and simulation, inputs, driving function, errors, outputs, interactive simulation as applied to physical system and analysis performance, queuing models and discrete event simulation introduced via problem solving approach to enable the student to apply the techniques in real life situations.

Credit : 3 units
Prerequisite(s) : Programming and Numerical Methods

MATH 290 SEMINAR IN ANALYSIS
Credit : 3 units
Prerequisite(s) : Instructor's consent

MATH 291 SEMINAR IN FUNCTIONAL ANALYSIS

Credit : 3 units
Prerequisite(s) : Instructor's consent

MATH 292 SEMINAR IN ALGEBRA
Credit : 3 units
Prerequisite(s) : Instructor's consent

MATH 293 SEMINAR IN PROBABILITY THEORY AND MATHEMATICAL STATISTICS

Credit : 3 units
Prerequisite(s) : Instructor's consent

MATH 294 SEMINAR IN GRAPH THEORY / COMBINATORICS
Credit : 3 units
Prerequisite(s) : Instructor's consent

MATH 295 SEMINAR IN APPLIED MATHEMATICS
Credit : 3 units
Prerequisite(s) : Instructor's consent

MATH 296 SEMINAR IN TOPOLOGY

Credit : 3 units
Prerequisite(s) : Instructor's consent

MATH 297 SEMINAR ON SELECTED TOPICS

Credit : 3 units
Prerequisite(s) : Instructor's consent

MATH 298 INDEPENDENT STUDY

Credit : 3 units
Prerequisite(s) : Adviser's consent

MATH 300 MASTER'S THESIS

Credit : 6 units