DOCTOR OF PHILOSOPHY (PhD)
IN APPLIED MATHEMATICS
Program

Graduate School
and
Institute of Mathematical Sciences and Physics
College of Arts and Sciences
University of the Philippines Los Baños (UPLB)

BACKGROUND

The global trend in applied research necessitates the use of mathematical approaches. The Ph.D. Applied Mathematics in UPLB, the first doctorate degree program in applied mathematics in the Philippines, is an interdisciplinary program that focuses on the study and creation of mathematical and computational methods to solve complex problems in various fields and industries. The goal is to produce graduates who are innovative problem solvers, combining advanced-level mathematical science and domain knowledge to help address local and global issues and challenges. This program seeks to contribute to the existing pool of experts in the field of Mathematics who are competent not only in theory but also in the use of these theories in obtaining predictions and quantitative prescriptions for complex problems.

As one of the National Centers of Excellence in the Basic Sciences, the Institute of Mathematical Sciences and Physics (IMSP) is committed to the advancement of science and technology, application of science and technology in the service of the people, and strengthening and broadening the national capability to train scientific leaders and conduct research. Consistent with this vision, the Ph.D. Applied Mathematics program aims to produce graduates who will lead and direct scientific and technological activities in private industry, government, academe, and the civil society. This is also coherent with UPLB's mission and development goals concerning the important role of the basic sciences in interdisciplinary studies.

The Ph.D. Applied Mathematics program is structured to emphasize interconnections between theory and application. The core courses on mathematical modeling of dynamical systems and advanced techniques in numerical analysis focus on the two major concerns of Applied Mathematics, namely, modeling and computing aspects. In these courses, the students will be trained in formulating innovative and multifaceted solutions to complex interdisciplinary problems, which will involve data analytics and informatics as well as design and future thinking. Two-thirds of the required units of coursework are devoted to major courses and electives. This allows freedom and flexibility in selecting courses in more specialized and trailblazing areas of applied mathematics and the application fields.

It is essential for graduates of the Ph.D. Applied Mathematics program to be proficient in mathematics and, at the same time, have in-depth knowledge of areas of application. The Research and Development Internship provides an opportunity for students to expand and diversify their knowledge, skills, values, professional linkages, and collaboration networks beyond what the academia can offer. The Ph.D. Applied Mathematics in UPLB is the first mathematics-related doctorate program that requires industry and practice-based research and development internship. Internships can be done (locally or abroad) in knowledge-intensive or research institutes, government agencies, non-government organizations, or industries.

Ph.D. Applied Mathematics graduates can work in academic and research institutions as educators or researchers in colleges and universities. They can also be

employed as scientists in government laboratories, research institutions, knowledge management agencies, and consulting firms. With growing interests in data mining and analytics, graduates of this program can also be data scientists working in e-commerce, business intelligence, bioinformatics and genomics, or management engineering. Financial service and investment management firms can also hire Ph.D. Applied Mathematics graduates as financial analysts who will use sophisticated math models and computational methods to support investment decisions, manage risks, develop and price new securities, and optimize operations. Engineering (computer, electronics, chemical, electrical, industrial) research organizations will also be interested in the modeling and computational strengths of Ph.D. Applied Mathematics graduates to rationalize the design and analysis of existing and new materials in fields like electronics and nanotechnology. With the emergence of ecological and environmental problems affecting the whole population, those who have the modeling and numerical knowledge can be tapped to apply quantitative techniques in the management of ocean fisheries, insect population growth, and spread of infection under various immunization protocols. Computer information and software firms can also employ graduates of Ph.D. Applied Mathematics program as analysts or head of R&D operations. Transportation and communication service providers can also take in Ph.D. Applied Mathematics graduates as consultants for efficient and effective delivery of services. Social enterprises can also hire these graduates to study social networks affecting their success or failure, and to simulate the dynamics and behavior of communities.

Graduates of the Ph.D. Applied Mathematics program must have the ability to do independent, original, and multidisciplinary researches which will be exhibited in their dissertation. The Ph.D. program seeks to address specific present and future needs of science, technology, and society, to wit:

- Biomathematics to formulate quantitative solutions to the problems in biology, agriculture, biotechnology, environmental science, and medicine with the aid of data science;
- Complex Systems Modeling to analyze interactions and trends in dynamic, physical, and social systems at different scales;
- Financial Mathematics to manage the risks in human societies, businesses, natural environment, and agricultural economy;
- Data Science and Numerical Mathematics to approximate solutions to the problems in the natural, social, and engineering sciences using modern technologies and algorithms in machine learning and artificial intelligence;
- Partial Differential Equations to model properties of composite materials, and the evolution of the dynamics in spatio-temporal systems; and
- Quantitative Management and Decision Science to optimize the use of natural resources and design efficient processes and operations in various industries.

BRIEF DESCRIPTION OF THE PROGRAM

Program Outcomes (POs)

The Ph.D. Applied Mathematics program aims to produce graduates who are able to:

a. demonstrate the knowledge and skills at the most advanced level at the frontier of a field;
b. use independent and original thinking skills needed in complex multidisciplinary research resulting in the creation of new methods or practice;
c. apply knowledge and skills in highly advanced contexts, and in the development and testing of new theories and new solutions to resolve complex and abstract issues;
d. make an authoritative and expert judgment in the management of research or organization;
e. demonstrate ethical and professional behavior in the practice of the profession and the creation of new ideas or processes;
f. discuss critically the foundations and philosophy of applied mathematics, advanced mathematical theories, methods, and applications;
g. communicate the results of the independent, original, and multidisciplinary researches that seek innovative and effective quantitative solutions to relevant complex problems;
h. engage actively in curricular development and research in applied mathematics;
i. lead in the mentorship and development of future experts in the mathematical sciences;
j. demonstrate leadership in multidisciplinary environments as an applied mathematics practitioner; and
k. provide scholarly and technical quantitative expertise in addressing national issues and development challenges.

Program Structure

The Ph.D. Applied Mathematics has two core courses that focus on the two major concerns of Applied Mathematics--modeling and computing. The other required course concentrates on an experiential course--the Research and Development Internship, the first of its kind in a mathematical doctorate program in the country. Two-thirds of the required coursework is devoted to major courses and electives which can be taken from specialized fields of mathematics, applied mathematics, and application areas.

Component	***Number of units***
Core Courses	6
Major Courses	6
Research and Development Internship	3
Elective Courses	12
Graduate Seminar	1
Dissertation	12
Total number of units:	**40**

Total no. of years: 3 years (full-time), 4 years (part-time)

Admission Requirements

In addition to the admission requirements of the UPLB Graduate School (https://www.uplbgraduateschool.org/prospective-students/admission), an applicant for admission into the Ph.D. Applied Mathematics program must have

a. completed a Master's degree in Mathematics/Applied Mathematics or related fields (with a background in analysis and linear algebra) from any recognized institution of higher learning;
b. submitted a research plan related to the Ph.D. Applied Mathematics program; and
c. passed a panel oral examination.

General Requirements for Graduation

Graduation from the Ph.D. Applied Mathematics program shall require the following University requirements:

a. Completion of the twenty-seven (27) units of coursework, one (1) unit of graduate seminar, and twelve units (12) units of dissertation;
b. Passing the Qualifying and Comprehensive Exams;
c. Satisfaction of the external review;
d. Submission of the dissertation manuscript;
e. Submission of two (2) preprint articles based on the dissertation; and
f. Acceptance for publication of a paper based on the dissertation.

Policies on retention, transfer/shifting, and other rules and regulations are specified in the UPLB Graduate School Manual (https://www.uplbgraduateschool.org/current-students/gs-policies-rules--regulations).

CURRICULUM

Year 1

First Semester			Second Semester		
Course Code	**Course Title**	**Units**	**Course Code**	**Course Title**	**Units**
AMAT 310	Dynamic Systems Modeling	3		Major Course	3
AMAT 350	Advanced Numerical Analysis	3		Elective Course	3
	Major Course	3		Elective Course	3
	Elective Course	3		Elective Course	3
	Total	**12**		**Total**	**12**
Qualifying exam to be scheduled after the first semester.					
TOTAL					**24**

Year 2

First Semester			Second Semester		
Course Code	**Course Title**	**Units**	**Course Code**	**Course Title**	**Units**
AMAT 398	Research and Development Internship*	3	AMAT 400	Dissertation	4
AMAT 399	Graduate Seminar*	1			
	Total	**4**		**Total**	**4**
Comprehensive exam to be scheduled after completing satisfactorily all the courses (except AMAT 400) prescribed in the approved plan of coursework, and prior to the start of the dissertation.					
TOTAL					**8**

* can be taken during the Midyear prior to Year 2

Year 3

First Semester			Second Semester		
Course Code	**Course Title**	**Units**	**Course Code**	**Course Title**	**Units**
AMAT 400	Dissertation	4	AMAT 400	Dissertation	4
	Total	**4**		**Total**	**4**
TOTAL					**8**

Schematic diagram showing the progression of courses

First Year		*Second Year*		*Third Year*	
First Semester	***Second Semester***	***First Semester***	***Second Semester***	***First Semester***	***Second Semester***
AMAT 310 (Core) AMAT 350 (Core) Major Elective Qualifying exam to be scheduled after the first semester.	Major Elective Elective Elective	AMAT 398 (Required) AMAT 399 (Seminar) Comprehensive exam to be scheduled after completing satisfactorily all the courses (except AMAT 400) prescribed in the approved plan of coursework, and prior to the start of the dissertation.	AMAT 400 (Thesis)	AMAT 400 (Thesis)	AMAT 400 (Thesis)

DESCRIPTION OF REQUIRED COURSES

Course code: AMAT 310
Course title: Dynamic Systems Modeling
Course description: Deterministic and stochastic modeling of temporal and spatial evolution of dynamic systems
Course credit: 3 units
Course prerequisite: COI
Semester offered: 1,2

Course code: AMAT 350
Course title: Advanced Numerical Analysis
Course description: Theory and applications of numerical analysis
Course credit: 3 units
Course prerequisite: COI
Semester offered: 1,2

Course code: AMAT 398
Course title: Research and Development Internship
Course credit: 3 units
Course stipulation: The student should have passed the 12 units of core and major courses
Number of hours: Minimum of 200 hours
Semester offered: 1,2,M

Course code: AMAT 399
Course title: Graduate Seminar
Course credit: 1 unit
Course prerequisite: COI
Semester offered: 1,2,M

Course code: AMAT 400
Course title: PhD Dissertation
Course credit: 12 units
Course prerequisite: COI
Semester offered: 1,2,M

LIST OF POSSIBLE MAJOR COURSES (*6 units*)

Course Code	Course Title	Semester Offered	Units	Prerequisites
AMAT 360	Convex Optimization	1	3	COI
AMAT 361	Optimal Control	2	3	COI
AMAT 391	Special Topics	1,2	1-3	COI
AMAT 215	Mathematical Theory of Choice and Games	2	3	AMAT 105 or MATH 120 or COI
AMAT 250	Numerical Simulation	2	3	COI
AMAT 255	Mathematical Data Science	2	3	COI
AMAT 266	Deterministic Mathematical Decision Models	1	3	AMAT 160 or COI
AMAT 267	Probabilistic Mathematical Decision Models	2	3	AMAT 160 or COI
AMAT 277	Mathematical Finance	1	3	COI
AMAT 280	Biomathematics	1	3	None
MATH 211	Abstract Algebra	1	3	MATH 111
MATH 213	Theory of Matrices	1	3	MATH 120 or COI
MATH 215	Coding Theory and Cryptography	1	3	MATH 111
MATH 217	Algebraic Combinatorics	2	3	MATH 211
MATH 220	Algebraic Geometry	1	3	MATH 211
MATH 222	Finite Geometries	2	3	MATH 211
MATH 225	Topology	2	3	MATH 101
MATH 230	Real Analysis	1	3	MATH 155
MATH 231	Complex Analysis	2	3	MATH 155
MATH 235	Functional Analysis	2	3	MATH 213

MATH 243	Graph Theory and Applications	2	3	None
MATH 252	Theory of Partial Differential Equations	1	3	MATH 151 or COI
MATH 281	Measure-Theoretic Probability and Stochastic Processes	2	3	MATH 182 or COI

Visit the IMSP website for more details: https://imsp.cas.uplb.edu.ph/graduate-courses-2.

ELECTIVE COURSES (*12 units*)

Elective courses can be chosen from various application areas (e.g., Agriculture, Agribusiness Management and Economics, Agricultural and Biosystems Engineering, Biology, Chemical Engineering, Communication, Computer Science, Development Management and Governance, Economics, Environmental Science, Forestry, Management and Entrepreneurship, Mathematics and Applied Mathematics, Statistics, Veterinary Medicine), as approved by the advisory committee.

Visit the Graduate School website for the list of possible electives (it is recommended to contact the department or institute offering the course for the updated information): https://www.uplbgraduateschool.org/academic-programs/academic-programs.

SAMPLE OF PLAN OF STUDY FOR MAJOR AND ELECTIVE COURSES

Research Area: Development Studies

Major courses: AMAT 267: Probabilistic Mathematical Decision Models
AMAT 391: Special Topics

Elective courses: CED 365: Rural Institutions
DVST 301: Development Theories and Frameworks
DVST 303: Mixed Methods Research for Development Studies
STAT 363: Sampling Theory of Surveys

Research Area: Microfinance

Major courses: AMAT 277: Mathematical Finance
AMAT 391: Special Topics

Elective courses: AECO 230: Advanced Agricultural Finance
DMG 230: Microfinance, Micro-insurance and Development
DMG 231: Governance of Microfinance Institutions
MGT 215: Financial Management

Research Area: Computing

Major courses:	AMAT 360: Convex Optimization
	AMAT 391: Special Topics
Elective courses:	CMSC 250: Scientific Computing
	CMSC 341: Advanced Theory of Computation
	CMSC 342: Computational Complexity Theory
	STAT 250: Multivariate Statistical Models

Research Area: Biomathematics (Genetics)

Major courses:	AMAT 280: Biomathematics
	AMAT 361: Optimal Control
Elective courses:	BIO 235: Evolutionary Genetics
	BIO 236: Developmental Genetics
	BIO 255/AGR 255: Population Genetics
	AGR 256: Quantitative Genetics