

Debre Berhan University



College of Natural & Computational Science

Department of Mathematics

Curriculum-PhD in Mathematical Modeling

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Debre Berhan

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Introduction

Since its establishment, Debre Berhan University has launched different undergraduate and post graduate programs based on its mission and vision in particular and the mission and vision of the country in general. The department of mathematics was established in 1999 E.C under the faculty of natural and computational sciences in Debre Berhan University. The department has run undergraduate program (B.Sc program in Mathematics) and postgraduate program (M.Sc in Mathematical Modeling) since its establishment. The M.Sc program in Mathematical Modeling was launched in 2005 E.C.

Expanding its programs further, the department is planning to launch a full-fledged in-house Ph.D program which consists of one specialized program namely Ph.D in Mathematical Modeling. The Ph.D program creates the opportunity for eligible candidates to undertake the Ph.D studies locally in the listed areas of specialization. The Ph.D program exposes candidates to the latest frontier of practical Mathematical knowledge and also provides them with important skills essential to carry out research independently. More over the program will strengthen the research productivity of the department.

This Ph.D program is a pre Ph.D courses and research based program in the above mentioned area of specialization in which candidates are expected to make a significant contribution in the world of science and a new application of mathematics. The pre Ph.D courses constitute highly advanced courses of Mathematical Modeling and are designed to familiarize students with the recent advances in their areas of specialization namely, Mathematical Biology, Mathematical Epidemiology or Mathematical-Bio-Economics.

The Ph.D program is a three year full time study of which one year for pre Ph.D courses and two years for research work. During the first year of the study period students invariably need to become acquainted with state of arts in their chosen area of specialization and will spend some time in preparatory readings , attending lecture courses and presenting seminars. As skill in research, experience of writing a thesis and self confidence with independent work are highly needed in the Ph.D studies therefore the candidates in this program will take an applied research methodology course. Furthermore during the first year of their studies the candidates expected to get opportunities to explore and choose possible areas and topics for their Ph.D research.

The role of Mathematics teachers for all science and technology streams is unavoidable. It is obvious that the universities mostly need applied Mathematics teachers who are capable of teaching Mathematics practically related to the subject matter of different disciplines in different colleges, schools and faculties. For this application of Mathematics, a teacher who teaches “Mathematical Modeling” is very essential. Mathematical Modeling is the branch of Mathematics which helps individuals, governments, businesses organizations, researchers of all physical and social sciences to get insight into problem situations which are arise in our real world. Formulating and building Mathematical Models require study real life cases, work on practical applications and give Mathematical interpretations and analyze the solutions of the real world problems which are actually not covered in the current post graduate curriculum for almost all Mathematics Departments of the universities across the nation. This curriculum is expected to fill this gap. To fill this gap Mathematics Department of DBU has designed this curriculum and decided to open Ph.D program for a specialization of Mathematical Modeling.

Rational

“Of the several kinds of creative activity being promoted in contemporary developments, arguably the most empowering for students is Mathematical Modeling (Galbraith, 1995)”.

Currently Ethiopia has designed and implemented a strategic plan to produce 70% of man power will trained in natural sciences, technology and health care sciences annually. To train such man power in the above mentioned fields, mathematics is a fundamental subject and will play a pivotal role for their development. Especially applied Mathematics is very essential for the development of all these sciences but it is true that almost all Mathematics teachers in the university and colleges are pure mathematics teachers. Therefore there is a shortage of Applied Mathematics teachers in almost all Universities and Colleges across the country. For this the Department of Mathematics opened and run a post graduate program in applied stream especially in “Mathematical Modeling”. With the increasing importance of science and technology, prospects for careers in the mathematical sciences are very good. Mathematical Modeling is important for solving some of the most pressing problems of our time such as new energy resources, climate change, renewable resource management, risk management, epidemiology. To maintain our technological edge;

Mathematical skills will be crucial material. Real world issues pose problems that can be studied by formulating and analyzing mathematical models.

The program welcomes applicants whose primary background of an M.Sc degree in Mathematical Modeling, Differential Equations and Optimization.

Resource Profile

Staff profile

The academic staff profile of the department encompasses 35 mathematicians whose academic levels ranges from graduate assistant to well experienced professors. Among the current academic staff members of the department the following can be actively engaged in the Ph.D program.

Home Staff

S. No	Name	Academic Rank	Specialization	Address
1	Dr. A.N Mohammed	Professor	Mathematical Modeling	DBU
2	Dr. TemesgenTibebu	Associate Professor	Mathematical Modeling	DBU

Cooperative Staffs

S. No	Name	Academic Rank	Specialization	Addresses
1	Dr. TsegayeGedife	Assistant Professor	Differential Equations	AAU
2	Dr. TadesseAbdi	Assistant Professor	Differential Equations	AAU
3	DR. GenanawGofe	Assistant Professor	Numerical Analysis	JU
4	Dr. AlemayehuShiferaw	Assistant Professor	Numerical Analysis	JU
5	Dr. DawitMelese	Assistant Professor	Mathematical Modeling	WU
6	Dr. ShieferawFeyissa	Assistant Professor	Mathematical Modeling	ASTU

Physical facility

Each office of the academic staff has computer facility connected with the internet. The department has well organized computer laboratory which has 15 internet connected computers, lecture hall and seminar library for the Ph.D candidates.

Objectives

The objectives of the Ph.D program in Mathematical Modeling are:

- To produce well qualified researchers in the Applied Mathematics
- To produce trained man power in Applied Mathematics for higher educational institution

Graduate Profile

After completing the Ph.D degree in Mathematical Modeling the graduates are able to:

- Teach practical applications of Mathematics by building a model for some phenomenon of different disciplines in physical sciences, life sciences, health care sciences and technology of undergraduate and post graduate programs.
- Carry independent research in their field of specialization
- Conduct a group research with different departments in physical sciences , life sciences, technology and health care sciences
- Develop mathematical models that help individuals, government policy makers, researchers, engineers, businesses organizations to solve real world problems.
- Produce papers, journals and articles in the national and international publishers and give valuable contribution to the world of science.
- Supervise and advise the research of graduate students.

Admission requirements

Academic requirements

Applicants who meet the following requirements will be eligible for admission to the Ph.D program in Mathematical Modeling.

- i. Has a M.Sc degree in Mathematical Modeling, Differential Equations and Optimization with
 - A Cumulative Grade Point Average, CGPA at least 3.00
 - Rating of at least “*Good*” in M.Sc thesis or a grade of at least **B** in seminar or project course
- ii. Two recommendation letters from former academic instructors of the applicants
- iii. Identify the area of their specialization
- iv. Identify their advisor from the department academic staff and
- v. Present the advisor consent and recommendation to the department.
- vi. Meet the general University graduate admission requirements.
- vii. Have sponsor or self-support to cover her/his tuition fees.

Non Academic requirements

- i. All other university wide non- academic requirements for admission to Ph.D programs in Debre Berhan University
- ii. If the number of applicants who have satisfied the admission requirements is beyond the department intake capacity, then selection of applicants shall be carried out of 100% of which
 - CGPA of their M.Sc program 30%
 - Written Entrance examination 50%
 - Oral Entrance examination 10%
 - Assessment of Recommendation letters 10%

Duration of study

- The Ph.D program will be for four years.
- Extension of duration of the study beyond four years may be permitted by the Department Graduate Committee, DGC if a candidate shows she/he was unable to complete the studies within the first semester of the four years and the extension is recommended by the candidate Ph.D advisor/s.

- In any case the maximum duration of the Ph.D program is five years in accordance with the senate legislation. A candidate who cannot complete the Ph.D studies within the expected duration is considered for dismissal.

Pre Ph.D course work and Thesis

- A Ph.D candidate is required to take a minimum of 19 credit hours of course work.
- A candidate of Ph.D must pass each of the required courses with a grade of at least B.
- If a candidate scored below the stipulated grade in any of the required course, she/her is permitted to repeat the examination/s once.
- A candidate who fails to attain the stipulated grade at her/his second attempt shall be dismissed from the program.

Supportive courses and seminars

- A Ph.D student is required to attend and present in department seminars credited 2 Hrs.
- To ensure that the Ph.D program remains current and up to standard, the Department Graduate Committee will organize compact courses for Ph.D students on current areas of research or on new developing knowledge in applied and pure mathematics at least once per year for at least two weeks with no credit.
- Leading researchers or professors from abroad will be invited to offer such compact courses.
- The Department Graduate Committee will use the recommendation of Ph.D advisors to select the topic and the professor for each compact course.
- If the Ph.D student has co-advisor in abroad, she/he is required to stay three to six months at a university or research institute abroad during which the

candidate spends the time at the external institution working on her/his research and may attend relevant advanced courses.

- If a student needs to stay at the external institution beyond six months, the student must send a written request and recommendation from her/his advisor to the DGC. The DGC may allow the extension for duration of at most six months.

Course Code

All compulsory courses and thesis in this program are coded where a code starts with prefix “Math” followed by three digits. The three digits denote the following

- The first digit 7 to 9 represents the year of the program
- The middle digit represents the following subject areas
 - 0 = Optimal Control
 - 1 = Selected Topics in Differential Equations
 - 2 = Advanced Numerical Solutions of Differential Equations
 - 3 = Advanced Mathematical Modeling
 - 4 = Applied Research Methodology
 - 5 = Mathematical Biology
 - 6 = Mathematical Epidemiology
 - 7 = Mathematical Bio Economics
 - 8 = Seminar
 - 9 = Thesis
- The last digit represents type of semester that 1 for first and 2 for second semester.

Course Required

Compulsory Courses

Code	Course Title	Cr. Hrs
Math 711	Selected Topics in Differential Equations	3
Math 721	Advanced Numerical Analysis of Differential Equations	3
Math 731	Advanced Mathematical Modeling	3
Math 741	Applied Research Methodology	2
Math 702	Optimal Control	3
Math 782	Seminar	2
Math *9*	Ph.D Thesis	6

Specialization Courses

Code	Course Title	Cr. Hrs
Math 752	Mathematical Biology	3
Math 762	Mathematical Epidemiology	3
Math 772	Mathematical Bio Economics	3

Course Schedule

Semester	Year I		
	Course Title	Course Code	Credits
I	Selected Topics in Differential Equations	Math 711	3
	Advanced Numerical Analysis of Differential Equations	Math 721	3
	Advanced Mathematical Modeling	Math 731	3
	Applied Research Methodology	Math 741	2
	Total credit hrs		11
II	Optimal Control	Math 702	3
	*** Area of Specialization ***	Math 7*2	3
	Seminar	Math 782	2
	Total credit hrs		8

Year II & III			
Semester	Course Title	Course Code	Credits/ Semester
I & II	Ph.D Thesis	Math *9*	6
	Total Credit Hrs/semester		6

Delivery Methods	Active Lecture and Active learning	
Performance Evaluation	Continuous Assessment& presentation	60%
	Final examination	40%
	Maximum marks	100%

Course Description

Selected topics on revision for numerical analysis, numerical solution of ordinary differential equations: iteration method, bisection method, secant method, Newton Raphson method, Picard’s method, Runge-Kutta method, numerical solution of partial differential equation: finite difference method, finite element method.

Course Name..... Advanced Mathematical Modeling

Course Code..... Math 731

Credit Hours3 Hrs

Text Book.....Mathematical Modeling for the Life Sciences, Jacques Istas

Delivery Methods	Active Lecture and Active learning	
Performance Evaluation	Continuous Assessment& presentation& presentation	60%
	Final examination	40%
	Maximum marks	100%

Course Description

The focus of this course is to give an overview of the mathematical techniques that are commonly used in practice, and illustrate the modeling procedure through some model examples. The basic notion of mathematical models focus on model construction, analysis and application and students will learn how to develop and use mathematical models of real-world systems.

An outlines of the course are:

Basic concepts of mathematical modeling, Dimensional analysis, non-dimensionalization and re-parametrisation Dynamical systems, Population dynamics: Single species models: simple growth model, logistic model, spruce bud worm model, harvesting model, interacting population models: prey predator model, competition model, and mutualism/symbiosis model, Routh-Hurwitz Criteria, Different Types of Functional Responses.

Course Name..... Applied Research Methodology

Course Code..... Math 741

Credit Hours2 Hrs

Delivery Methods.....Active Lecture and Active learning

Performance Evaluation	Continuous Assessment & presentation	60%
	Final examination	40%
	Maximum marks	100%

Course Description

Applied Research methods: Types of research: applied/action research and pure/basic research. Developing research proposals, writing articles for publication: identifying research problems and developing hypothesis, Constructing objectives and develop methods/materials: study site and

Teaching Methodology

The teaching and learning of the compulsory courses will mainly follow the approaches listed below.

Lecture, Discussion and Problem solving:

Mathematics subjects are characterized by the need for high degree of concept and abstract thinking within the learning process. This poses considerable challenges to learners unless adequately supported by instructors. Therefore, for each of the compulsory courses, 3 hours per week shall be allocated during which subject area expert offers face-to-face lecture, facilitates discussions and guides problem solving in classroom.

Independent and Active learning:

In order to assist students develop their own skills; instructors of each course will plan appropriate tasks that provide students with opportunities to independently learn by themselves. These tasks shall be adequately challenging and will be carefully identified by the instructors of the courses so as, on the one hand, the learning help students to master the concepts in the course and, on the other hand, it gives the learners experience and confidence to take on similar challenges in the future. These tasks will include, among other things, such as reading assignments and analysis on selected topics, modeling and solving of complex practical problems, review and analysis of relevant articles published currently on reputable journals, and writing reports. The instructors will evaluate the reports and provide feedbacks.

Assessment and evaluation

- Instructor of each compulsory course will plan method of assessments and decides on type and values of assignments, projects, written reports and examinations based on the specific nature of the course.
- Instructor of a compulsory courses check and evaluates each and every assignment, project, written report, examination and provides feedback.
- Every student will obtain a letter grade that reflects his/her achievement in every compulsory course. The letter grades and their values are in accordance with the general grading rules of Debre Berhan University for graduate courses.
- Thesis and dissertation are evaluated and rated in accordance with the senate legislation of Debre Berhan University.

Qualifying for PhD candidacy

Qualifying criteria

A student is required to satisfy all the following conditions within 18 months of admission to qualify for PhD candidacy and to be eligible to write the doctoral dissertation.

- a. A PhD student must successfully complete all the required courses with a grade of at least B. If a candidate fails in his first attempt he/she is permitted to repeat the qualifying examination only once.
- b. A PhD student must take comprehensive qualifying examination approved by the DGC and administered at the beginning of the second year. A student who scored 75% and above will qualify to pursue his/her study.
- c. A PhD student must identify the topic of dissertation in consultation with his/her supervisor and submit a research proposal to the supervisor.
- d. A PhD student must be enrolled at the beginning of every semester subject to approval of the DGC. The DGC shall require the progress report of the student and recommendation of the student's supervisor(s) at the beginning of every academic year to approval the enrollment of the student.

Failure to meet qualifying criteria

A student who fails to fulfill the qualifying criteria condition (a) shall be dismissed from the PhD program.

Graduation requirements

Every candidate for PhD degree must fulfill the following requirements for graduation.

Completion of course, seminar and preliminary thesis work

A candidate must successfully complete the mandatory 11 credit hours course works with a grade of at least B.

Doctoral research

Research requirement

- Dissertation or Thesis, Math *9* ,is a requirement for the PhD program
- A PhD candidate must carry out original research in his/her field of specialization, the result will be presented as a doctoral dissertation subject to careful scrutiny by a board of examiners.
- The dissertation must satisfy the general requirements stipulated by the CGS of DBU.
- At least one article from the doctoral research of the candidate must have been published or accepted for publication in a scientific journal

OR

- The dissertation must get a strong attestation from the external examiner for its originality before the date of defense is fixed.
- The dissertation shall be the candidate's own account of his/her research and shall be accompanied by a declaration to this effect signed by the candidate.

Submission of dissertation

- Dissertation shall be submitted to the department, along with the recommendation of the adviser(s), at least three months before the envisaged date of defense.
- a. Upon receipt of a dissertation, the DGC appoints a four person board of Examiners, including the advisor and the chairperson of the department, subject to an approval by Academic Commission (AC) of the faculty of Natural and computational science .One of the members of the board must be an external examiner from other higher education institution in Ethiopia or abroad who has academic rank of at least associate professor. The chairperson of the department shall chair the board and is a non-voting member. In case the chairperson is the candidate's supervisor or required to be a voting member, the DGC shall assign a non –voting chairperson for the board.
- b. The chairperson of the department shall send the dissertation to every examiner for evaluation immediately after the approval of the board of Examiners by the AC.
- c. If an article from the doctoral research of the candidate has been published or accepted for publication on a reputable journal , the chairperson shall fix the date of defense within two months of formation of the board of Examiners, subject to approval of DGC.
- d. If an article from the doctoral research of the candidate has not been published or not accepted for publication on a reputable journal, the chairperson of the department shall request the external examiner to send back his/her evaluation and recommendation on its originality before fixing a date for the defense .If the recommendation of the external examiner is positive, the chairperson will fix the date of the defense within a month from the date of receiving the recommendation subject to approval by the DGC.
- e. However if the recommendation of the external examiner the dissertation not to be sufficiently original ,then the chairperson provides the feedback to the student and his/her PhD advisers (s) and suspends all arrangements that have taken place as a consequence of submission of the dissertation until another upgrade dissertation is submitted by the candidate . The chairperson communicates this to the DGC and AC.

Dissertation presentation and defense

- a. A candidate for the PhD degree undergo an open and public oral examination of his/ her dissertation by the candidate for 30 to 45 minutes followed by answering questions from the Board of Examiners for 45 to 60 minutes.
- b. After the defense, the examining Board decides either to accept or reject the dissertation.
- c. A dissertation that is defended and accepted shall be rated “Excellent ”, “Very-Good”, “Good” or “Satisfactory”. A rejected thesis shall be rated “Fail”.

University-wide general graduation requirements

In condition to the graduation requirements and rules stated above every university-wide requirement, regulations and procedures for submission and defense of a PhD dissertation spelled out in the senate legislation of DBU shall apply. The duties and responsibilities of the Board of examiners in general and that of external examiner in particular shall be according with the senate Legislation of DBU.

Degree nomenclature

A candidate, who fulfills the requirements laid down in this curriculum and whose research, study and examination results are judged to be of sufficient merit, shall be awarded the degree of

“Doctor of Philosophy in Mathematical Modeling”

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Quality assurance

- All requirements stated in this curriculum are essential for the quality of the PhD program. Hence, all participants including students, instructors, advisers, subject area leaders, and the DGC are responsible to observe the fulfillment of these requirements .In particular, the DGC shall routinely monitor the quality of the PhD program and ensure the fulfillment of all requirements specified in this curriculum.
- PhD adviser(s) appraise their student’s progress and their own performance at the end of each semester and determine the next effective course of actions.
- PhD adviser(s) and subject area leaders(s) routinely and actively observe the teaching , learning and research activities in the PhD program of the department, benchmark activities and outcomes of similar programs elsewhere, evaluate the level of the department’s PhD program as compared to the benchmarked PhD programs and take necessary measures or forward recommendation to the DGC to maintain the quality of the program.
- The DGC will continuously monitor the teaching learning activities in the PhD program and documents
 - Students’ progress reports
 - Reports on program appraisals
 - External examiners’ reports
 - Staff and student feedbacks
 - Report from any relevant external bodies.

These will be used as input for a full review and upgrading of the PhD program to be undertaken every four years.

References

1. Ph.D in Mathematics Curriculum, Hawasa University, Ethiopia.
2. Ph.D in Mathematics Curriculum Andhra University, India.
3. Ph.D in Mathematics Curriculum, Addis Ababa University, Ethiopia.