Ministry of Education

Identified Competency Focus Areas and Core Courses for Ethiopian Higher Education Institutions' Exit Examination

Program:Bachelor of Science (BSc)in Mathematics

By: MafuzHumer (PhD), Jimma University

August, 2022

Addis Ababa

Ethiopia

TABLE OF CONTENTS

1. Introduction

Mathematics is a fundamental field of study that plays a big role in the development of science, technology, business, computer science and other fields. Themathematics program is designed to enable the graduates to acquire fundamental knowledge, skill and desired attitude so that they will be competent to workin the industry or to teach at secondary school level. The general objective of this program is to train qualified, adaptable, motivated, and responsible Mathematicians who will contribute to the scientific and technological development of Ethiopia. And specific objectives are;

- ✓ Provide an in-depth understanding of the fundamental principles and techniques of Mathematics.
- ✓ Develop mathematical concepts and definitions, and to extend and generalize them to new situations.
- ✓ Progress Mathematical thinking, reasoning and an appreciation of Mathematics as a primary language of science.
- ✓ Make students understand the connections between mathematics and other disciplines, and being able to recognize mathematical ideas embedded in other contexts.
- ✓ Develop the fundamental concepts of mathematical modeling and how to apply mathematics to real-world situations.

Thus, to attain those objectives it is essential that students be equipped with strong mathematics knowledge and skills which enable them to be productive. Meanwhile, it is important to check also whether graduates gained the needed knowledge and skills to fit with the desired market.

Nowadays, the Ethiopian government is giving much more emphasis toquality of education and competence of graduates in Higher Education Institutions (HEI), which needed to prepare exit exam for programsat national level. Exit exam measures the learning outputs of a program and it will help the institutions to work towards quality and competence of their graduates. In addition, exit exam has the following importance;

- ✓ It assesses the basic skills and knowledge of students.
- ✓ It assesses students' overall understanding of their educational experience.
- ✓ It helps institutions to produce skilled and competent manpower for the market.
- ✓ It ensures that first-degree graduates met the graduate profile.

- ✓ It improves the learning outcomes of students and their subsequent labor market performance.
- ✓ It improves quality of education.
- ✓ It can be used as source of information for policy decisions at national level.

This document is prepared to set competencies and identify courses to be included in the exit exam for mathematics program. The courses are selected from among the major or compulsory courses based on the curriculum of BSc.

2. Objectives of the Exit Examination

TheAppliedMathematics exit exam shall have the following objectives

- ✓ To produce skilled and competent manpower to national and international market
- ✓ Assessing students' educational achievement in major areas of Mathematics.
- ✓ Ensuring whether the graduation profile of Mathematics curriculum have achieved at least common standards of knowledge and practical skills
- ✓ Improving public trust and confidence in Applied Mathematics activities of professionals
- ✓ Facilitating the efforts of students to revise the core learning outcomes of the courses covered by the exit examination
- ✓ Ensuring all graduates from HEIs satisfy the requirements of the labor market and employability through the national wide implementation of competency-based exit exam
- ✓ Creating competitive spirit among Mathematics departments in Ethiopia with the aim of encouraging them to give due attention to the national standards

3. Significance of the Document

It is important to set competency areas of the subject matter (program) in order to measure the how much graduates are acquired with skills, knowledge and attitudes. The following shows us the significance or setting competencies and identifying core courses of the program;

- To set competencies that helps to assess the basic skills, knowledge and attitude of graduating students;
- To systematically identify the core courses which will be included the exit exam;

4. Expected Profile of Graduates

A graduate of the program will be able to:

- Acquire fundamental knowledge of mathematics to teach in primary and secondary schools.
- Develop mathematical skills needed in modeling and solving practical problems.
- Apply mathematics to solve real world problems in various application areas such as in industries, economics and health science.
- Develop the knowledge, skills and attitudes necessary to pursue further studies in mathematics and related fields of study.
- Create job opportunities by applying the acquired knowledge and skills.

5. Core Competencies and Learning Outcomes

5.1. Core Competencies

The core competencies of graduates of mathematics in terms knowledge, skill and attitude are;

5.1.1 Knowledge

- ✓ Provide an in-depth understanding of the fundamental principles and techniques of Mathematics.
- ✓ Develop mathematical concepts and definitions, and to extend and generalize them to new situations.

5.1.2 Skills

- ✓ Able to set up mathematical models, formulate algorithm and implement them by using computational methods to real life problems.

- ✓ Exercise the power to self-expression, develop abstract, logical and critical thinking, the ability to reflect critically upon their work, the work of others, and justify the degree of accuracy of their results where appropriate.

5.1.3 Attitude

- ✓ Act in an ethical manner, recognize and be guided by social, professional and ethical issues involved in his/her career in particular and in the community in general.

5.2. Learning Outcomes

The learning outcomes of mathematics BSc program are;

- ✓ A qualified graduate who hasgood knowledge of mathematics to teach at secondary school level or apply mathematics to solve real world problems and problems of his\her country.
- ✓ Responsible Mathematicians who will contribute to the scientific and technological development of Ethiopia.
- ✓ Graduates who can assist and participate in conducting scientific research.
- ✓ Graduates who can demonstrate environmental, social and cultural awareness.
- ✓ Mathematicians who will pursue graduate studies in mathematics and related fields of study.
- ✓ A qualified graduate who thinks critically and reason logically.

6. Categorized Courses into Themes

The selected courses in the above section can be categorized into the following four themes.

No.	Category Name	List of courses in the category
Theme I	Analysis	Calculus I
		Calculus II
		Calculus of Function of Complex Variables
		Calculus of Function of Several Variables
Theme II	Numerical Analysis/	Numerical Analysis I
		Linear Optimization

	Optimization	Mathematical Modeling
Theme III	Differential Equations	Ordinary Differential Equations
		Partial Differential Equations
		Financial Mathematics I
Theme IV	Algebra	Modern Algebra I
		Linear Algebra I
		Number Theory

Table 1: Categorized courses into themes.

7. Courses to be Included in the Exam

Courses that will be included in the exit exam for mathematics program are identified based on the following;

- ✓ Relevance of the course to measure the three learning domains.
- ✓ Relevance of the course to measure the three competencies of graduates.
- ✓ Major (or compulsory)courses of the program.

The following courses are identified to be included in exit exam.

No.	Course Name	Course Cr. hrs	Description
1	Modern Algebra I	3	This course deals with topics: Groups, isomorphism theorem, permutations group, direct product, direct sum of abelian groups, group action, rings, polynomial rings, PID and UFD and field and field extensions.
2	Calculus I	4	This course introduces the basic concepts of limit, continuity, differentiation, integration, and some of their applications.
3	Calculus II	4	This course covers inverse functions, derivatives of inverse functions, techniques of integration focusing on trigonometric substitution and partial fractions, Trapezoidal

			rule and Simpson's rule, arc length, indeterminate forms, sequences, series and power series.
4	Linear Algebra I	3	This course covers vectors, lines and planes, vector spaces, matrices, system of linear equations, determinants, eigenvalues and eigenvectors, and linear transformations.
5	Number Theory	3	This course covers algebraic structure of integers, basic notions of divisibility theory, Diophantine equations, theory of congruence and equations over finite rings, decimal representations of rational numbers, continued fractions, and quadratic extension of rational numbers.
6	Numerical Analysis I	3	This course covers basic concepts in error estimation, solutions of non-linear equations, solutions of system of linear equations and non-linear equations, finite differences, numerical interpolations, numerical differentiation and numerical integration.
7	Linear Optimization	3	This course deals with linear programming, geometric and simplex methods, duality theory and further variations of the simplex method, sensitivity analysis, interior point methods, transportation problems, and theory of games.
8	Ordinary Differential Equation	4	This course covers basic definitions and terminology, preliminary theory of first and higher order linear ordinary differential equations (ODEs), method of solutions and their applications, series solution, Laplace transform, and systems of first order linear differential equations.
9	Calculus of Function of Complex Variables	4	The course mainly covers the complex number system, complex differentiability, analytic functions, conformal mappings, complex integration Cauchy's theorem, Cauchy integral formula, power series representations of analytic functions, Laurent series, residue theorem, evaluation of definite integrals, and Mobius transformation.
10	Partial	3	This course discusses basic concepts of partial differential

	Differential Equations		equations (PDE), some techniques of solutions of first order PDE, Fourier series, second order PDE and analytical methods of solutions.
11	Calculus of Functions of Several variables	4	This course covers review of vector algebra, vector valued functions, functions of several variables, their derivatives and integrals with applications, and calculus of vector fields: Green's theorem, line and surface integrals, Stoke's theorem, and Divergence theorem.
12	Mathematical Modeling	3	This course covers basic concepts and methods in modeling, dimensional analysis, graphical methods and applications, approximation and testing, Eulerian and Lagrangian modeling, consecutive equations, applications (population growth model, interacting species, traffic flow, diffusion and population models, etc)
13	Financial Mathematics I	3	This course rigorously discusses the basic concepts of Financial Mathematics which are useful for Financial Markets. Hence, to reach in to its goal the course contains the basic units of financial markets such as basic finance, probability spaces, random variables, options and arbitrage, Discrete-Time Portfolio Processes and expectations.

Table 1: Selected courses to be included in exit exam.

8. Conclusion

In summary, courses to be included in the exit exam have been identified and competencies have been set for first degree mathematics BSc program. Thirteen courses have been selected from among 23 courses that are major for BSc program.

Appendix:

List of Major courses for BSc mathematics program;

1. Fundamental Concepts of Geometry
2. Transformation Geometry
3. Fundamental Concepts of Algebra
4. Linear Algebra I
5. Linear algebra II
6. Number Theory
7. Modern Algebra I
8. Introduction to Combinatorics and Graph Theory
9. Numerical Analysis I
10. Introduction to Mathematical Software
11. Linear Optimization
12. Calculus I
13. Calculus II
14. Calculus of Function of Several Variables
15. Calculus of Function of Complex Variables
16. Advanced Calculus of One Variable
17. Introduction to Topology
18. Financial Mathematics I
19. Ordinary Differential Equations
20. Partial Differential Equations
21. Mathematical Modeling
22. Introduction to Research Methods
23. Undergraduate Mathematics Research/Undergraduate Research Project

Evaluators:

1. AbebeMulugeta (MSc), DebreMarkos University
2. MesfinBogale (MSc), Dilla University
3. GetachewAdamu (PhD), Bahir Dar University
4. AntenehAlemu (PhD), Woldia University
5. DenekewAlemayehu (MSc), Hawassa University
6. NateaHunde (PhD), ASTU
7. Dawit Solomon (PhD), Kotebe University of Education