Assessment Report: B.S. in Mathematics-Applied Mathematics Option
Learning Outcomes Academic Year 2015-2016

M 441-Numerical Linear Algebra and Optimization

Assessment Coordinator: Tianyu Zhang

This report summarizes an assessment of M441 with regard to the Applied Mathematics Option. The learning outcome and rubric are listed below.

Outcome 1: Use rigorous mathematical reasoning or computations to establish fundamental applied mathematics concepts.

There were 17 students in the fall 2015 M441 section 1 class that finished and received a letter grade. Out of these 9 students were Applied Math or Mathematics majors. For the assessment two problems of the final exam were used. More specifically, problem 1 was designed to test the comprehensive understanding of some fundamental concepts in numerical linear algebra such as vector and matrix norm, orthogonal projection, condition number and inverse matrix. Problem 7 was designed to test the computational skills by calculating the LU factorization of a matrix with partial pivoting.

Results:

	Exceptional	Acceptable	Marginal	Unacceptable
Computational skills	6	1	1	1
Mathematical reasoning	1	4	3	1
Overall	4	3	1	1

The overall outcome of the assessment was positive. In the future, more emphasis should be place on rigorous mathematical reasoning and establishing fundamental applied mathematics concepts.

M 442- Numerical Solution and Differential Equations

Assessment Coordinator: Tianyu Zhang

This report summarizes an assessment of M441 with regard to the Applied Mathematics Option. The learning outcome and rubric are listed below.

Outcome 4: Demonstrate a working knowledge of the technological tools needed to solve problems from applied mathematics.

There were 18 students in the spring 2016 M442 class that finished and received a letter grade. Out of these 14 students were Applied Math or Mathematics majors. For the assessment two problems of the final exam were used. More specifically, problem 1 was designed to test the understanding of some fundamental concepts in numerical solution to differential equations such as convergence, consistency, stability, stiff problems and linear multistep methods. Problem 2 was designed to test the computational skills by calculating the general and particular solutions of a linear difference equation.

Results:

	Exceptional	Acceptable	Marginal	Unacceptable
Computational skills	9	4	1	0
Mathematical reasoning	4	7	1	2
Overall	5	6	2	1

The overall outcome of the assessment was positive. In the future, more emphasis should be placed on rigorous mathematical reasoning and establishing fundamental applied mathematics concepts.

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Program Learning Outcomes

Students should demonstrate the ability to:

1) Use rigorous mathematical reasoning or computations to establish fundamental applied mathematics concepts.
2) Set up mathematical models and critically interpret their results.
3) Select and implement an appropriate mathematical technique needed to analyze and validate a mathematical model.
4) Demonstrate a working knowledge of the technological tools needed to solve problems from applied mathematics.

Curriculum Map and Assessment Schedule

	Outcomes				Assessment Schedule
	1	2	3	4	
M 386, Software Applications in Mathematics			X	X	Odd spring semesters
M 430, Mathematical Biology		X			Odd spring semesters
M 441, Numerical Linear Algebra and Optimization	X			X	Odd fall semesters
M 442 Numerical Solution of Differential Equations				X	Even spring semesters
M 450, Applied Mathematics I	X		X		Every 4th fall, begins F13
M 451, Applied Mathematics II	X	X			Every 4th spring, begins S14
M 454, Introduction to Dynamical Systems I	X				Every 4th fall, begins F14
M 455, Introduction to Dynamical Systems II	X				Every 4th spring, begins S15

Rubric

Learning Outcome	Unacceptable	Marginal	Acceptable	Excellent
1) *Use rigorous mathematical reasoning or computations to establish fundamental applied mathematics concepts.*	The work is not correct and complete because either concepts are used improperly or key ideas are missing or the organization is unlikely to work even if a few more ideas were inserted.	The work is not correct and complete because one or two significant ideas are missing, but the terms are properly defined and the work shows a type of organization that might well work if the right ideas were inserted in the proper places. Also, the work is "marginal" if most of the work is leading toward a correct argument, but a false statement is inserted.	The work is almost correct with relevant concepts used and ideas that could work, but not well-organized, for example, with some steps out of order, or with something relatively minor incomplete.	The work is fully correct and complete, with the relevant concepts properly employed and ideas that work, and the steps well-organized into a proper sequence
2) *Set up mathematical models and critically interpret their results.*	If the work is not correct and complete because either there are fundamental gaps in understanding of the underlying scientific principles or in the understanding of the appropriate technique and its implementation.	The work is not correct and complete because one or two significant ideas are missing, but the majority of the ingredients are present.	The work is almost correct with relevant scientific concepts and mathematical techniques that could work, but not well-organized, with a minor omission, misunderstanding, or inadequate choice of mathematical technique.	The work is fully correct and complete, with the complete understanding of the scientific principles of the modeled problem and with employment of the appropriate mathematical techniques.
3) *Select and implement an appropriate mathematical technique needed to analyze and validate a mathematical model.*	The work is not correct and complete because either there are fundamental gaps in understanding of the underlying mathematical assumptions or in the understanding of the appropriate technique and its implementation.	The work is not correct and complete because one or two significant components of the analysis or of the implementation are missing, but the majority of the ingredients are present.	The work is almost correct with relevant assumptions addressed and the correct algorithm chosen with an implementation that could work, but is implemented with a minor misunderstanding of a technique or a minor error in other elements of the computations.	The work is fully correct and complete, with a full understanding of the underlying mathematical assumptions that deem a particular mathematical technique applicable to a given model and with an appropriate knowledge of the main principles and techniques related to the implementation of a particular form of analysis, mathematical or numerical.
4) *Evaluate a working knowledge of the technological tools needed to solve problems from applied mathematics. Student work will be evaluated against four criteria:* *a. A choice of the appropriate software for a given problem.* *b. A proper implementation of the software.* *c. Proper documentation.* *d. Presentation and the output of results.*	If less than half of the criteria are completed.	If at least half of the criteria are completed.	If three of the above are adequately addressed.	If all four criteria are adequately addressed.

Threshold

At least half of the majors in each of the courses are assessed as "excellent" or "acceptable" for all the learning outcomes.