

Bachelor's Degree Program in Mathematics

Goals and Associated Outcomes

Goal 1: Graduates will have acquired a firm foundation of knowledge of fundamental mathematical concepts, methods, language, and modes of reasoning sufficient to support further academic work or careers in fields that require mathematical understanding.

Outcomes: The student exhibits the ability to:

- (a) Use important definitions and results correctly.
- (b) Apply mathematical results and procedures to concrete problems.
- (c) Generate straightforward extensions of mathematical procedures and results.
- (d) Analyze quantitative data using appropriate mathematical tools.
- (e) Use mathematical software to investigate and solve problems.
- (f) Identify logical errors in mathematical arguments.
- (g) Prove immediate consequences of basic theorems.

Goal 2: Graduates will be able to communicate mathematical ideas and results clearly and with appropriate precision, both orally and in writing.

Outcomes: The student exhibits the ability to:

- (a) Use mathematical notation and terminology correctly.
- (b) Organize computations and proofs clearly and logically.
- (c) Explain the reasoning that supports solutions to mathematical problems.

Goal 3: Graduates will have acquired sufficient mathematical background and experience to use the professional literature to progress further on their own.

Outcomes: The student exhibits the ability to:

- (a) Use the professional literature (journal articles, articles available on the web, higher-level textbooks, etc.) to write a paper on a mathematical topic not covered in formal study.

Overview

Our principal assessment tool is our capstone course, MTH 495 (Senior Seminar), in which students are required to write and present a paper on a mathematical topic not covered in previous formal study. We also collect work from one 200-level course and one 300-level course, MTH 288 (Linear Algebra) and MTH 301 (Introduction to Applied Mathematics). Thus, we will have samples of most majors' work at three stages of their undergraduate careers. Each spring these samples are evaluated against the specified outcomes by the department's Undergraduate Assessment Committee. The Chair is actively involved, the Associate Chair

chaired the Undergraduate Assessment Committee this year, and a report is made to the Undergraduate Program Committee (UPC).

Goals and Outcomes

Early attempts at departmental self-assessment of the undergraduate program lacked measurable outcomes and were excessively complex. The present collection above was developed in Fall 2002 using input from the UPC and open meetings and agreed to by the entire department. They have served us well and have not been changed since then.

Research Methods

For MTH 288, we collect all of the final exams from the Fall Semester each year and evaluate each with a 5 point rubric on Goal 1, Outcomes a and b, and Goal 2, Outcomes a, b, and c. This instrument has not been modified. The checksheet and scoring rubric are attached.

For MTH 301, we collect the major projects from the Fall Semester each year and evaluate each with a 5 point rubric on Goal 1, Outcomes a, b, d, and e, and Goal 2, Outcomes a, b, and c. This instrument has been modified since last year as recommended by the Office of Assessment. The change consists in switching from a 6 point rubric to a 5 point rubric that is consistent with the one used for MTH 288. The checksheet and scoring rubric are attached. In addition, the oral presentations are now assessed, as recommended by the Office of Assessment. The assessment is done by the course instructor and a copy of the checklist is attached.

For MTH 495, we collect the course papers from the Fall Semester each year and evaluate each with a 9 point rubric that covers all of Goals 1, 2, and 3 above with each of their Outcomes. This instrument is unchanged from last year; a copy of this checklist is attached. The only change is that the oral presentations are now assessed, as recommended by the Office of Assessment. The assessment is done by the course instructor and a copy of the checklist is attached.

One indirect method the chair used in the past was exit interviews for graduating math majors. We were told several years ago and again last year by the outside consultant that this was not a valid approach, so exit interviews are no longer scheduled. A new chair took office July 1, 2006, and is considering exit interviews and hopes to implement them next year.

Findings

For MTH 288, the average score for the 13 students was 14.2, and the maximum possible score is 20. This is vastly lower than the 18.5 average last year and vastly higher than the 11.42 average of the previous year. These differences are explained by the nature of the final exam. Two years ago, the final exam was given in class, and last year the exam was take home. This year, the exam had two parts, one take home and one in class. The assessors this year all noticed a large difference in the quality of the work on the two parts of the final exam, and felt that the in class exam was the better assessment tool.

For MTH 301, the average score for the 12 projects was 20.8, and the maximum possible score is 28. This is somewhat higher than the 18.8 average (adjusted to be consistent with the current rubric) of the previous year. The students were required to use the Writing

Center this year, which may account for the improvement. The average score of the 25 students on the oral presentations was 47.0 with a maximum of 50.

For MTH 495, the average score for the 22 students was 6.98, and the maximum possible score is 9. This is significantly lower than the 7.91 average of the previous year. The difference may be accounted for by two factors. First, we had some very poor students this year, and three of them received grades of F in the course. Second, we had several honors students take an honors version of this course; they were not included in the assessment and would obviously have raised the average. The average score of the 21 students on the oral presentations was 30 with a maximum of 35; only the questions graded numerically were used to arrive at these scores.

Review

For MTH 288, the data were analyzed in the Spring Semester, 2007, by a three-person committee with input from the Chair. Each committee member evaluated each final exam.

For MTH 301, the written projects were analyzed in the Spring Semester, 2007, by a three-person committee with input from the Chair. Each committee member evaluated each project. The oral presentations were assessed by the course instructor.

For MTH 495, the written projects were analyzed in the Spring Semester, 2007, by a three-person committee with input from the Chair. Each committee member evaluated each course paper. The oral presentations were assessed by the course instructor.

Results of each of these three components are reviewed by the Chair, Associate Chair, and UPC Chair, as well as members of the UPC. This year, there was substantial discussion in two department meetings on what we've learned and how we can improve our courses as a result of our assessment results.

Actions

When we began with assessment in the late 1990's, we used just the capstone course, MTH 495, which had been in place for several years. But experience then showed that it would be desirable to have samples of majors' work from earlier in their academic careers; hence the current version. MTH 167, 168, 181, and 182 (Precalculus Mathematics I and II, Calculus I and II) are currently undergoing a major revision. The changes will be phased in at the rate of one course per semester, beginning with MTH 167 in Fall, 2007. All homework assignments, tests, and grading will be done uniformly both from one section to another and from one term to another. We anticipate adding an assessment method to one or more of these courses at some future time

For MTH 288, generally speaking, the process is working well and the students are performing. We determined, on the basis of the vast difference on student performance on in class and take home tests, to make the final exam entirely in class. In order to give students more writing practice, the number of lab reports in this course will also be increased.

For MTH 301, the projects are well aligned with the goals and objectives desired. We will continue to require a first draft and will also refer all students to the CSU Writing Center for both the draft and the final report. We also expect to incorporate more preparation for writing mathematics in at least one of our 200 level courses, after the mathematics major program undergoes a major revision; work on this revision has begun.

For MTH 495, improvement is evident, especially over the papers from several years ago. The instructor this year required that all projects be submitted electronically and used the University's plagiarism checking software; this will continue in the future.

Our experience in MTH 495 indicates that many of our students do not know how to write a paper at this level and have difficulty understanding what is expected of them. To remedy this, MTH 495 is being phased out and replaced by two new courses: MTH 396, Junior Seminar, and MTH 496, Senior Project. Catalog copy for these courses follows.

MTH 396 Junior Seminar (2-0-2). Prerequisites: MTH 182; three of MTH 220, MTH 281, MTH 286 and MTH 288, all grade C or better; or departmental approval. Weekly meetings introduce students to a wide range of mathematical topics and also include workshops on various aspects of writing cogent and well-formulated technical reports in mathematics.

A primary goal of this course is to prepare the student for MTH 496 Senior Project. Successful completion of the course requires the student having an approved topic and supervisor for MTH 496.

MTH 496 Senior Project (4-0-4). Prerequisites: MTH 396 (grade of S) and at least two other mathematics courses numbered 300 or above, or departmental approval. Prerequisite or corequisite: At least one other mathematics course numbered 400 or above, or departmental approval. Working individually with a faculty supervisor, each student will read papers in technical journals, make an oral presentation, and write a technical report. (Writing)

Student Name _____

MTH 288 Assessment

Goal	Outcome		4 Excellent	3 Good	2 Satisfactory	1 Almost Satisfactory	0 Unsatisfactory
1	a	The student exhibits the ability to use important definitions and results correctly.					
1	b	The student exhibits the ability to apply mathematical results and procedures to concrete problems.					
2	a	The student exhibits the ability to use mathematical notation and terminology correctly.					
2	b	The student exhibits the ability to organize computations and proofs clearly and logically.					
2	c	The student exhibits the ability to explain the reasoning that supports solutions to mathematical problems.					

Total: _____

Rater: _____

Assessment Rubric MTH 288

Item 1. Excellent Gives a complete, clear, coherent, and unambiguous response.

Good Gives a fairly complete response that is reasonably clear.

Satisfactory Conveys the basic idea but the wording is imprecise or muddled, and parts of the statement may be omitted.

Almost satisfactory conveys the basic idea but makes minor errors or major omissions; wording is difficult to understand

Unsatisfactory Shows no understanding of the statement, or shows no comprehension of the need for precision.

Item 2. Excellent Applies the correct result or procedure correctly, with a full and precise explanation of why this applies.

Good Applies the correct result or procedure correctly or with minor errors, with some explanation as to why this applies.

Satisfactory Applies the correct result or procedure correctly or with minor errors, but leaves parts of the solution out; inadequate explanation as to why this applies.

Almost satisfactory Begins to apply the correct result or procedure, but with major errors or with significant parts of the problem unsolved; little or no useful explanation as to why this applies.

Unsatisfactory Applies the correct result or procedure with several major errors, or attempts to apply results or procedures that are not applicable.

Item 3. Excellent Writes in a manner suitable for a textbook or written report.

Good Writes in an understandable manner but with minor technical flaws or omissions.

Satisfactory Writes in a muddled but understandable way, may include unnecessary symbols or other confusing material.

Almost satisfactory Has some knowledge of the notation and terminology, but could not be understood by someone who did not already know the solution.

Unsatisfactory Misuses terminology and notation, shows little or no knowledge of syntax

Item 4. Excellent Gives a complete, clear, coherent, and unambiguous response. Shows all necessary steps in the correct order.

Good Gives a fairly complete response that is reasonably clear.

Some necessary steps may be omitted and unnecessary steps may be included.

Satisfactory Gives an understandable response that is generally correct. Parts of the response may be muddled or irrelevant.

Almost satisfactory Gives a response that could not be understood by someone who did not already know the solution. Parts of the response may be muddled, incorrect, or irrelevant.

Unsatisfactory Has major errors in computation and/or logic, or has no understanding of the problem.

Item 5. Excellent Gives a complete, clear, logical, coherent, correct, and unambiguous response.

Good Gives a fairly complete response that is reasonably clear . Any omissions are minor.

Satisfactory Gives a fairly complete response that is reasonably clear, but parts may be muddled. Any omissions are minor.

Almost satisfactory Gives a fairly complete response that is generally muddled, and could not be understood by someone who did not already know the solution. Shows incomplete knowledge of the solution, and there may be a major omission.

Unsatisfactory The reasoning contains a major logical error, or is irrelevant to the problem, or just incorrect.

MTH 301 Presentation Evaluation

Title: _____

Presenters: _____

Title	Yes	No			
Introduction	Yes	No			
Conclusions	Yes	No			
Mathematical Correctness	1	2	3	4	5
Defines all terms used	Yes	No			
Mathematical arguments/proofs	1	2	3	4	5
Examples	1	2	3	4	5
Language	1	2	3	4	5
Organization	1	2	3	4	5
Clarity of exposition	1	2	3	4	5
Visibility	Adequate		Inadequate		
Design (colors, text/graphics)	1	2	3	4	5
Peer interaction (answer questions)	1	2	3	4	5

Each Yes or Adequate is equivalent to 2 points. So the maximum score is 50 points.

Comments: _____

Scoring Rubric for MTH 301 Projects

Goal 1 Outcomes:

Use important definitions and results correctly.

4=Excellent– Uses appropriate terms and results in a complete, clear, coherent manner. Presents strong supporting arguments with diagrams as needed.

3=Good – Gives a fairly complete response that is reasonably clear and may include an appropriate diagram.

2=Satisfactory –Completes the project, but the explanation may not be clearly tied to appropriate results. Diagrams may be inappropriate or unclear.

1=Almost Satisfactory – Fails to show complete understanding of ideas. May omit significant connections to math results.

0=Unsatisfactory – Fails to make connections to necessary ideas or results. Shows little understanding of problem situation. Drawings misrepresent the problem situation.

Apply mathematical results and procedures to concrete problems.

4=Excellent – Uses appropriate mathematical/statistical results and procedures to the problem at hand. Includes a full and precise explanation of why these apply.

3=Good – Uses necessary approaches but the project is lacking some important characteristic. Does identify the most important aspects of the problem.

2=Satisfactory – Completes project with appropriate procedures but contains 0 or more errors or omissions involving the translation from the concrete to the theoretical.

1=Almost Satisfactory – Completes project but could not answer one of the major questions of interest. Shows some signs of understanding but errors/omissions make the project not satisfactory.

0=Unsatisfactory – Completes project with incorrect or inappropriate results or fails to indicate where information is appropriate to problem.

Analyze quantitative data using appropriate mathematical tools.

4=Excellent – Uses the correct methodology to answer the questions of interest. If any assumptions are necessary for analysis, those are clearly stated. Student also produces the appropriate graphics for the questions of interest.

3=Good – Student uses appropriate methodology to answer questions of interest, but the paper is lacking in some important characteristic. This may include not stating assumptions or not including appropriate graphics.

2=Satisfactory – Student completes project with appropriate methodology, but contains 0 or more errors/omissions involving the statement of assumptions or inclusion of appropriate graphs.

1=Almost Satisfactory – Student did not apply the correct methodology to answer one of the major questions of interest. Student could be consistent in making the mistake

throughout paper. Student does the appropriate steps for their chosen methodology, and it is well-described, but flawed from the beginning.

0=Unsatisfactory – Student completes project with inappropriate or incorrect methodology in more than one instance or shows incoherent approach to questions of interest. Student does not seem to grasp the correct way in which to conduct the needed analysis. Student does not include the assumptions or graphs appropriate for the questions of interest.

Use mathematical software to investigate and solve problems

4=Excellent – Uses software appropriately to answer the questions of interest. Provides documented results from the analysis with the appropriate interpretation of the output. Student does not include meaningless output that is not needed to answer the questions of interest. Student uses the software correctly to label graphics with necessary information.

3=Good – Uses software appropriately, but fails to provide complete documentation or fails to label all graphs sufficiently. The student did successfully interpret the results correctly.

2=Satisfactory – Student used software appropriately, but failed to understand what was needed as adequate documentation of the results. Student has almost provided enough information to justify conclusions, but sufficient omissions occur to warrant concern.

1=Almost Satisfactory – Student shows inappropriate or incorrect use of software to complete the project. The student shows some signs of understanding what is needed to complete the project, but sufficient errors/omissions or wrong interpretation of results make the project not satisfactory.

0=Unsatisfactory – Student completes project with inappropriate or incorrect results of software or incoherent approach to questions of interest. Necessary output and/or graphs are missing in or wrong interpretation for output are given in almost all cases.

Goal 2 Outcomes:

Uses mathematical notation and terminology correctly:

4=Excellent – Student uses proper notation throughout the paper. Student creates his own notation correctly as needed.

3=Good – Student makes only one flaw with notation in paper. May have that same flaw occurring throughout paper, but it is essentially one misunderstanding of the notation.

2= Satisfactory – Student makes only a minor number of mistakes/omissions with regard to notation.

1=Almost Satisfactory – Student shows a problem with notation. There are too frequent misuses of notation to warrant satisfactory.

0= Unsatisfactory – Students shows a complete misunderstanding of notation or student has no understanding of notation to the point that the paper is unreadable.

Organizes computations and proofs clearly and logically

(This outcome adapted for projects rather than proofs).

4=Excellent – Student submits a professional looking report that is well-organized and very easy to read. The paper provides adequate introduction. In addition, the reader can understand the inquiry of interest and the results of the analysis without having read the assignment page. This category also includes style elements so that there are not inappropriate page breaks or non-consistent font usage.

3=Good – Student makes only minor errors in the presentation of their project. Minor errors could include a minor page break problem, a minor font issue. Student may have forgotten to clearly state goals or background effectively enough so that the reader can understand the inquiry without the assignment sheet.

2=Satisfactory – Student fails to make the project clear enough for the reader to understand. This may entail failing to include an adequate introduction or just providing enough written information to make the purpose or the results of the analysis clear.

1=Almost Satisfactory – Student fails to make project clear to reader and also fails to make the project well-organized and professional looking. The project may include large blocks of unused white space, or several fonts.

0=Unsatisfactory – The project is not professional or complete or the project is organized so poorly, that it is unreadable. The project may not be clearly understood without the original assignment sheet.

Explains the reasoning that supports solutions to mathematical problems

4=Excellent – Student gives a complete interpretation of the results that is correct and appropriate for the questions of interest. Student use clear and concise language to describe the results of the test and the summary is thorough.

3=Good – Students give the correct interpretation, but reasoning is not complete. Student may also not include a thorough summary. This may occur when student gives bare-bones answers to questions and does not give complete answers.

2=Satisfactory – Student gives correct interpretations in most cases, but may slip for one or two questions. Student may also give proper interpretations, but then not give sufficient explanations or a complete summary to the project.

1=Almost Satisfactory – Student makes sufficient mistakes concerning interpreting results and making conclusions to warrant unsatisfactory. The student is clearly understanding the proper techniques to use, but then does not know to successfully interpret the results. Student does not include a sufficient summary to the project.

0=Unsatisfactory – Student clearly does not understand how to successfully interpret output. Student fails to give correct conclusions or fails to provide a summary at the end.

Student Name _____

Check sheet for Projects in MTH 301

Goal 1 Outcomes:

a)	Uses important definitions and results correctly	4	3	2	1	0
b)	Applies mathematical results and procedures to concrete problems	4	3	2	1	0
d)	Analyze Quantitative Data using appropriate mathematical tools (Applies proper methodology)	4	3	2	1	0
e)	Uses mathematical software to investigate and solve problems (Uses software correctly and labels graphs correctly)	4	3	2	1	0

Goal 2 Outcomes:

a)	Uses mathematical notation and terminology correctly	4	3	2	1	0
b)	Organizes computations and proofs clearly and logically (Layout and professionalism of projects)	4	3	2	1	0
c)	Explains the reasoning that supports solutions to mathematical problems (Gives correct conclusions and provides thorough summary)	4	3	2	1	0

TOTAL _____

Grader _____

Student Name _____

Math 495 Senior Seminar Project Checklist

Mark each question from 1-9 (9 being best) or with NA when it does not apply to the project at hand. At the end, take the average of the non-NA scores. This is the overall evaluation for the project.

1. Organizes project well with main results clearly stated _____
2. Includes crucial definitions and background information _____
3. Uses important definitions and/or results correctly _____
4. Analyzes information well _____
5. Uses mathematical language and symbols appropriately _____
6. Uses mathematical techniques well _____
7. Uses mathematics appropriate for the problem _____
8. Uses software appropriate for the problem _____
9. Formulates appropriate and convincing conclusions _____
10. Explains the problem and work clearly _____
11. Displays a knowledge of literature on the subject _____
12. Displays an in-depth analysis of the problem or area _____

Overall Score _____

A score of 7-9 rates the project as **High**; 4-6 as **Medium**; and 1-3 as **Low**.

High represents a project displaying a complete response to the problem set forth. The general analysis and write-up should be correct, clear and coherent, communicating the problem and the relevant mathematics effectively to the intended audience. The project should display an understanding of the ideas and processes involved and, where appropriate, should contain examples and/or counterexamples.

Medium represents a complete solution to the problem set forth, but the explanation may be unclear in places, there may be minor mathematical mistakes or understanding of the underlying concepts or techniques may not be displayed in a convincing manner. In general, however, the analysis and conclusions are correct.

Low represents either a lack of solution of the problem set forth or an explanation which lacks coherence and/or clarity. There may be gross mathematical errors or errors in analysis and conclusions which do not (or apparently do not) follow from the analysis.

Rater: _____

Math 495 Presentation evaluation

Title: _____

Presenter: _____

Title	Yes No
Introduction	Yes No
Conclusions	Yes No
Mathematical Correctness	0 1 2 3 4 5
Defines all terms used	Yes No
Mathematical arguments/proofs	0 1 2 3 4 5
Examples	0 1 2 3 4 5
Language	0 1 2 3 4 5
Organization	0 1 2 3 4 5
Clarity of exposition	0 1 2 3 4 5
Visibility:	Adequate Inadequate
Design (colors, text/graphics)	0 1 2 3 4 5

Comments: