Course Assessment Report
Washtenaw Community College

Discipline	Course Number	Title
Mathematics	197	MTH 197 08/24/2023- Linear Algebra
College	**Division**	**Department**
Math, Science and Engineering Tech	Math, Science and Engineering Tech	Math & Engineering Studies
Faculty Preparer		Lawrence David
Date of Last Filed Assessment Report		11/04/2021

I. Review previous assessment reports submitted for this course and provide the following information.

1. Was this course previously assessed and if so, when?

   Yes

   Yes, August 2021.

2. Briefly describe the results of previous assessment report(s).

   The standard of success was met for all Student Learning Outcomes (SLOs). Changes were made based on previous assessment reports, and the evidence suggested they were effective.

3. Briefly describe the Action Plan/Intended Changes from the previous report(s), when and how changes were implemented.

   Intended changes, that were implemented in the following syllabus review, were to change the prerequisite, and revise the SLOs once again.

II. Assessment Results per Student Learning Outcome

Outcome 1: Solve systems of linear equations and interpret those solutions in applications.

- Assessment Plan
  - Assessment Tool: Outcome-related common departmental final exam questions
  - Assessment Date: Spring/Summer 2023
  - Course section(s)/other population: All sections

- Number students to be assessed: All students in each section, or a stratified sample of at least 100
- How the assessment will be scored: Departmentally-developed rubric
- Standard of success to be used for this assessment: 75% of students will score 75% or higher on average on questions for each outcome
- Who will score and analyze the data: Department faculty

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
2022	2023, 2022	2023, 2022

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
826	157

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

A representative sample was chosen from the available data.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

A systematic sample (every third student) was taken from every section for which data was available. A systematic sample in this case is effectively random since there is no correlation between the first letter of student's last name and student scores (every third student was chosen from an alphabetical list). This course had face-to-face day and evening, DL, and virtual modes, but no MM. By coincidence of which instructors turned in data, most sections assessed were DL.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

Common departmental final exams are used in the math department for assessment. Exams were scored using a 5-point rubric. Common finals consist of a set of required questions, mapped to each SLO. The average score on all questions for each SLO are used to determine the success or failure for each student for each SLO. The total successes for all students in the sample are used to determine whether the standard of success was met for each SLO overall. The standard of success was 75% of students will score 75% or higher on each SLO.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: Yes
The standard of success was 75% of students will score 75% or higher on the final exam questions covering this SLO. For this sample, 97% of students (152/157) scored 75% or higher on these questions.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

This is a relatively easy task, especially compared to the more abstract SLOs. Students learn this skill early in the course, and use it throughout, which reinforces mastery.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

Since most students master the outcome, we may want to make it more challenging, and include more interpretation and application questions.

Outcome 2: Perform standard computations including determinants, matrix inverses, eigenvalues and eigenvectors, and Gram-Schmidt orthogonalization.

- Assessment Plan
    - Assessment Tool: Outcome-related common departmental final exam questions
    - Assessment Date: Spring/Summer 2023
    - Course section(s)/other population: All sections
    - Number students to be assessed: All students in each section, or a stratified sample of at least 100
    - How the assessment will be scored: Departmentally-developed rubric
    - Standard of success to be used for this assessment: 75% of students will score 75% or higher on average, on questions for each outcome
    - Who will score and analyze the data: Department faculty

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
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2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
826	157

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

A representative sample was chosen from the available data.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

A systematic sample (every third student) was taken from every section for which data was available. A systematic sample in this case is effectively random since there is no correlation between the first letter of student's last name and student scores (every third student was chosen from an alphabetical list). This course had face-to-face day and evening, DL, and virtual modes, but no MM. By coincidence of which instructors turned in data, most sections assessed were DL.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

Common departmental final exams are used in the math department for assessment. Exams were scored using a 5-point rubric. Common finals consist of a set of required questions, mapped to each SLO. The average score on all questions for each SLO are used to determine the success or failure for each student for each SLO. The total successes for all students in the sample are used to determine whether the standard of success was met for each SLO overall. The standard of success was 75% of students will score 75% or higher on each SLO.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: Yes
The standard of success was 75% of students will score 75% or higher on the final exam questions covering this SLO. For this sample, 99% of students (155/157) scored 75% or higher on these questions.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

This SLO was revised to include more course objectives, with the expectation that the success rate might decrease since the added objectives were more difficult. In fact, the success rate went up. This is a computational outcome, which is done on a computer. It may be that students at this level (well into the STEM-only math track - or just weirdos who take math for fun) have almost universally mastered using calculators/computers to do calculations, so errors are rare.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

As with the first SLO, we may want to shift the emphasis from computation to application and interpretation.

Outcome 3: Apply the fundamental theorems of linear transformations on vector spaces.

- Assessment Plan
  - Assessment Tool: Outcome-related common departmental final exam questions
  - Assessment Date: Spring/Summer 2023
  - Course section(s)/other population: All sections
  - Number students to be assessed: All students in each section, or a stratified sample of at least 100
  - How the assessment will be scored: Departmentally-developed rubric
  - Standard of success to be used for this assessment: 75% of students will score 75% or higher on average, on questions for each outcome
  - Who will score and analyze the data: Department faculty

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
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2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
826	157

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

A representative sample was chosen from the available data.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

A systematic sample (every third student) was taken from every section for which data was available. A systematic sample in this case is effectively random since there is no correlation between the first letter of student's last name and student scores (every third student was chosen from an alphabetical list). This course had face-to-face day and evening, DL, and virtual modes, but no MM. By coincidence of which instructors turned in data, most sections assessed were DL.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

Common departmental final exams are used in the math department for assessment. Exams were scored using a 5-point rubric. Common finals consist of a set of required questions, mapped to each SLO. The average score on all questions for each SLO are used to determine the success or failure for each student for each SLO. The total successes for all students in the sample are used to determine whether the standard of success was met for each SLO overall. The standard of success was 75% of students will score 75% or higher on each SLO.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: Yes
The standard of success was 75% of students will score 75% or higher on the final exam questions covering this SLO. For this sample, 96% of students (151/157) scored 75% or higher on these questions.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

Students must develop an awareness of abstraction (i.e. what it even is; since it's mostly new in this course), and then master many abstract theorems and how to use them. As a result of past assessments, much emphasis has been put on this SLO, and various strategies used to teach it. Students are doing much better at shifting from a computational to an abstract paradigm in math.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

Abstraction is the main activity of mathematics and this course is most students' first exposure to it. This SLO could be expanded and/or divided even further in order to increase depth of focus (it was divided into two for this reason at the last syllabus review; obviously that can't continue indefinitely).

Outcome 4: Apply the basic theorems of inner product spaces.

- Assessment Plan
  - Assessment Tool: Outcome-related common departmental final exam questions
  - Assessment Date: Spring/Summer 2023
  - Course section(s)/other population: All sections
  - Number students to be assessed: All students in each section, or a stratified sample of at least 100
  - How the assessment will be scored: Departmentally-developed rubric
  - Standard of success to be used for this assessment: 75% of students will score 75% or higher on average, on questions for each outcome
  - Who will score and analyze the data: Department faculty

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
2022	2023, 2022	2023, 2022

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
826	157

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

A representative sample was chosen from the available data.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

A systematic sample (every third student) was taken from every section for which data was available. A systematic sample in this case is effectively random since there is no correlation between the first letter of student's last name and student scores (every third student was chosen from an alphabetical list). This course had face-to-face day and evening, DL, and virtual modes, but no MM. By coincidence of which instructors turned in data, most sections assessed were DL.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

Common departmental final exams are used in the math department for assessment. Exams were scored using a 5-point rubric. Common finals consist of a set of required questions, mapped to each SLO. The average score on all questions for each SLO are used to determine the success or failure for each student for each SLO. The total successes for all students in the sample are used to determine whether the standard of success was met for each SLO overall. The standard of success was 75% of students will score 75% or higher on each SLO.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: Yes
The standard of success was 75% of students will score 75% or higher on the final exam questions covering this SLO. For this sample, 96% of students (150/157) scored 75% or higher on these questions.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

Students seem to grasp the main ideas of these theorems, based on their applications in solving computational problems.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

Some theorems are harder than others. Even though the overall success rate was very high, there is still room for improvement on a more detailed level with these most difficult theorems.

Outcome 5: Apply and interpret the theorems and applications of eigenvalues and eigenspaces, as well as their relationships to linear transformations.

- Assessment Plan
  - Assessment Tool: Outcome-related common departmental final exam questions
  - Assessment Date: Spring/Summer 2023
  - Course section(s)/other population: All sections
  - Number students to be assessed: All students in each section, or a stratified sample of at least 100
  - How the assessment will be scored: Departmentally-developed rubric
  - Standard of success to be used for this assessment: 75% of students will score 75% or higher on average, on questions for each outcome
  - Who will score and analyze the data: Department faculty

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
2022	2023, 2022	2023, 2022

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
826	157

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

A representative sample was chosen from the available data.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

A systematic sample (every third student) was taken from every section for which data was available. A systematic sample in this case is effectively random since there is no correlation between the first letter of student's last name and student scores (every third student was chosen from an alphabetical list). This course had

face-to-face day and evening, DL, and virtual modes, but no MM. By coincidence of which instructors turned in data, most sections assessed were DL.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

Common departmental final exams are used in the math department for assessment. Exams were scored using a 5-point rubric. Common finals consist of a set of required questions, mapped to each SLO. The average score on all questions for each SLO are used to determine the success or failure for each student for each SLO. The total successes for all students in the sample are used to determine whether the standard of success was met for each SLO overall. The standard of success was 75% of students will score 75% or higher on each SLO.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: Yes
The standard of success was 75% of students will score 75% or higher on the final exam questions covering this SLO. For this sample, 83% of students (131/157) scored 75% or higher on these questions.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

Students did well with the computational application of these theorems, which are the capstone of the course.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

The success rate was 83%, which is well above the 75%, but well below the high 90's of the previous SLOs. This is probably the hardest SLO in the course, and builds on most of the previous course objectives. The SLO itself seems to be about the right "size" in terms of content and importance. We can improve student achievement by focusing more on this outcome, now that the previous two (which got more focus after past assessments) have improved significantly.

Outcome 6: Solve common application problems like least squares approximation, Markov Chains, QR factorization, and others.

- Assessment Plan

- Assessment Tool: Outcome-related common departmental final exam questions
- Assessment Date: Spring/Summer 2023
- Course section(s)/other population: All sections for which data are available
- Number students to be assessed: All students in each section, or a stratified sample of at least 100
- How the assessment will be scored: Departmentally developed rubric.
- Standard of success to be used for this assessment: 75% of students will score 75% or higher on average, on questions for each outcome
- Who will score and analyze the data: Department faculty

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
2022	2022, 2023	2023, 2022

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
826	157

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

A representative sample was chosen from the available data.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

A systematic sample (every third student) was taken from every section for which data was available. A systematic sample in this case is effectively random since there is no correlation between the first letter of student's last name and student scores (every third student was chosen from an alphabetical list). This course had face-to-face day and evening, DL, and virtual modes, but no MM. By coincidence of which instructors turned in data, most sections assessed were DL.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

Common departmental final exams are used in the math department for assessment. Exams were scored using a 5-point rubric. Common finals consist of a set of required questions, mapped to each SLO. The average score on all questions for each SLO are used to determine the success or failure for each student for each SLO. The total successes for all students in the sample are used to determine whether the standard of success was met for each SLO overall. The standard of success was 75% of students will score 75% or higher on each SLO.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: Yes
The standard of success was 75% of students will score 75% or higher on the final exam questions covering this SLO. For this sample, 80% of students (126/157) scored 75% or higher on these questions.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

Students did well with the computational aspects of this outcome.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

The success rate for this outcome was 80%. Though well above the standard of success, there is room for improvement. Ironically, because it is a computational outcome, at the end of a long, challenging course focused on abstract (as opposed to computational) math, it may be that students don't give it enough attention. We can improve by stressing its importance and possibly assigning more homework problems on it, as well as quiz questions.

III. Course Summary and Intended Changes Based on Assessment Results

1. Based on the previous report's Intended Change(s) identified in Section I above, please discuss how effective the changes were in improving student learning.

The prerequisite change was for mathematical maturity, which is difficult to measure, and therefore to assess. It is reasonable to assume that it would be reflected in an overall increase in student success, which was in fact observed.

2. Describe your overall impression of how this course is meeting the needs of students. Did the assessment process bring to light anything about student achievement of learning outcomes that surprised you?

The course continues to meet the specific needs of learning introductory linear algebra, as well as an introduction to abstract maths (proofs in particular). I was surprised that some success rates were so high. Many faculty are concerned about an increase in cheating since the pandemic as more courses are taught online or virtually and assessments are often not proctored. That could be an effect here, though online computer algebra systems (like wolframalpha.com) have been available for years, and students have been able to cheat online just as easily. Also, if students were cheating en masse, one would expect all SLO success rates to be consistently inflated, and they are not.

3. Describe when and how this information, including the action plan, was or will be shared with Departmental Faculty.

Via email to the department, as well as sharing during a department meeting.

4.

Intended Change(s)

Intended Change	Description of the change	Rationale	Implementation Date
Outcome Language	SLO 1 will be updated to include the related, but more difficult topic of Lease Squares Solutions, which is now part of SLO 6.	SLO 1 is solving systems of linear equations. When the solution set is empty, an approximate solution can be calculated using the Least Squares (LS) technique. Solving systems is one of the first objectives students see early in the course. The LS technique requires more advanced content students don't know until much later in the course, so these objectives have	2024

		been treated separately, in different SLOs. They are naturally related though, and in practice one will often solve a system (SLO 1) and then do the LS process (in SLO 6) immediately after if the solution set is empty. Students do very well on solving systems, which is "too easy" to be an SLO on its own. They struggle more with LS solutions, so it makes sense to combine the two both as naturally related objectives, as well as to balance out the difficulty and content of SLO 1.	

5. Is there anything that you would like to mention that was not already captured?

It is math department policy that all instructors of a course submit their graded final exams to the course mentor at the end of the semester to be used for assessment. Some instructors do, and some don't. The sample in this assessment is almost all DL sections, which is due in part to the rapid growth in enrollment/demand for that modality (76% of the population is DL) for this course, as well as the coincidence of which instructors did and didn't turn in their finals. I don't think this sample is representative of the population, in particular the face-to-face and virtual modalities, though it is representative of the sections for which data were available. (Every section for which data were available was sampled, and the one F2F section was included in its entirety - though there were only 8 students in it.) This is an area for improvement, though faculty are not in a position to implement such an improvement inasmuch as they cannot compel colleagues to follow departmental policy. (The one exception being part-timers,

whom the DC can compel as a condition of continued teaching; though in practice that may be difficult when staffing is an ongoing challenge.)

III. Attached Files

Rubric
Data

Faculty/Preparer:	Lawrence David	**Date:** 08/24/2023
Department Chair:	Nichole Klemmer	**Date:** 09/14/2023
Dean:	Tracy Schwab	**Date:** 09/15/2023
Assessment Committee Chair:	Jessica Hale	**Date:** 02/26/2024

Course Assessment Report
Washtenaw Community College

Discipline	Course Number	Title
Mathematics	197	MTH 197 08/23/2021- Linear Algebra
College	Division	Department
	Math, Science and Engineering Tech	Math & Engineering Studies
Faculty Preparer		Lawrence David
Date of Last Filed Assessment Report		11/01/2017

I. Review previous assessment reports submitted for this course and provide the following information.

1. Was this course previously assessed and if so, when?

Yes August 2017.

2. Briefly describe the results of previous assessment report(s).

There are two major types of outcomes in this course, computational and abstract. Students did much better on the computational outcomes than the abstract one, as was expected. There were 6 SLOs, 5 of which were computational, with 1 abstract outcome. What was not expected was the size of the discrepancy. 49% of students scored 75% or higher on the abstract outcome, while some of the computational outcomes had success rates in the 90s, with one at 98%.

3. Briefly describe the Action Plan/Intended Changes from the previous report(s), when and how changes were implemented.

The master syllabus was revised, and the single abstract SLO was split into 2, while one of the computational outcomes was eliminated (though the content was still included in the course objectives). In addition, more focus was given to teaching the abstract content of the course, not just in the specific SLOs, but as a paradigm for understanding and doing mathematics.

II. Assessment Results per Student Learning Outcome

Outcome 1: Solve systems of linear equations.

- Assessment Plan

- Assessment Tool: Common departmental exam questions
- Assessment Date: Spring/Summer 2019
- Course section(s)/other population: All sections
- Number students to be assessed: All students
- How the assessment will be scored: Department rubric
- Standard of success to be used for this assessment: 75% of students will score 75% or better
- Who will score and analyze the data: Departmental faculty

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
2020	2021	2020

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
326	193

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

All students in all sections for which data were available were included in the sample. Some instructors did not turn in data (final exams), and some students didn't take the final exam (did not complete the course though they remained enrolled).

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

There were 11 sections total; 8 face-to-face (F2F) and 3 distance learning (DL). There is no mixed mode (MM) modality for this course. The DL course was developed in Summer 2020, piloted with 1 section Fall 2020, and had 3 DL sections in Winter 2021. The F2F sections were almost all daytime, as a coincidence of which instructors turned in data and the fact that the majority of sections offered are daytime.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

The final exams were all on Bb, scored automatically using a rubric for each question. Most questions were either 5 or 10 points, with fractions of a point possible. Further, most questions had multiple parts (like "choose all correct answers" with up to a dozen or more choices), and in some cases negative points were possible for incorrect answers (to prevent students from just choosing every answer). This makes for a complicated rubric, but it was done in an effort to achieve integrity of the assessment (make it hard to cheat). As such, strictly speaking each question had a custom rubric (available to students on Bb) based on the number of points possible and answer choices for that question.

Currently there are two (2) forms of the final exam, a paper version and a digital version on Bb. They cover the same material and the same SLOs, but they are quite different in format. As it turns out, none of the instructors who give the paper final (one or two) turned in the exams for assessment scoring, so this assessment was only done with the Bb finals.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: <u>Yes</u>
96% of students (185/193) scored 75% or higher on this outcome. This is the most basic outcome in the course, taught the first week and used over and over again throughout the semester. Students who can't do this one by the end of the course will be unable to do much else. Still, it is really high; more on this in the Course Summary section.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

This is a computational outcome whose major component is done on a computer. There is some interpretation and set up required depending on the context or specific application, and then the computational tasks are automated by the computer. Students seem to have a good grasp of both of these things. This is the first major thing students learn in the course, and they do it almost every day in class so by the end of the course they pretty much have it down.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

One area of improvement could be in the interpretation of the results and the differences in the various types of results possible. For example if the solution set has infinitely many vectors in it, what does that say about the system?

Outcome 2: Compute determinants and inverses of matrices.

- Assessment Plan
    - Assessment Tool: Common departmental exam questions
    - Assessment Date: Spring/Summer 2019
    - Course section(s)/other population: All sections
    - Number students to be assessed: All students
    - How the assessment will be scored: Department rubric
    - Standard of success to be used for this assessment: 75% of students will score 75% or better
    - Who will score and analyze the data: Departmental faculty

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
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2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
326	193

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

All students in all sections for which data were available were included in the sample. Some instructors did not turn in data (final exams), and some students didn't take the final exam (did not complete the course though they remained enrolled).

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

There were 11 sections total; 8 F2F and 3 DL. There is no MM modality for this course. The DL course was developed in Summer 2020, piloted with 1 section Fall 2020, and had 3 DL sections in Winter 2021. The F2F sections were almost all daytime, as a coincidence of which instructors turned in data and the fact that the majority of sections offered are daytime.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

The final exams were all on Bb, scored automatically using a rubric for each question. Most questions were either 5 or 10 points, with fractions of a point possible. Further, most questions had multiple parts (like "choose all correct answers" with up to a dozen or more choices), and in some cases negative points were possible for incorrect answers (to prevent students from just choosing every answer). This makes for a complicated rubric, but it was done in an effort to achieve integrity of the assessment (make it hard to cheat). As such, strictly speaking each question had a custom rubric (available to students on Bb) based on the number of points possible and answer choices for that question. Currently there are two forms of the final exam, a paper version and a digital version on Bb. They cover the same material and the same SLOs, but they are quite different in format. As it turns out, none of the instructors who give the paper final (one or two) turned in the exams for assessment scoring, so this assessment was only done with the Bb finals.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: <u>Yes</u>
98% of students (189/193) scored 75% or higher on this outcome. This is another relatively easy, computational outcome. Students are taught to do this on a computer, so though it still requires enough understanding to use the computer correctly (a Computer Algebra System like wolframalpha.com for example) they pretty much don't make arithmetic mistakes (which some would scandalously call "math" mistakes - as if math is just computation!). Further comments in the Course Summary section.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

This is another computational SLO done mostly (but not always) on a computer. Students are really good at using technology to do this task.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

There is room for improvement in the hand calculation of this outcome (computing determinants by hand in particular). There are a bunch of theorems

about determinants that make computing them by hand even faster than on a computer. In some cases they can be done by observation. Students may tend to rely on the computer as a crutch to not have to learn the theorems (though it's hard to draw that conclusion from this data; that's just conjecture).

Outcome 3: Apply the fundamental theorems of linear transformations on vector spaces.

- Assessment Plan
  - Assessment Tool: Common departmental exam questions
  - Assessment Date: Spring/Summer 2019
  - Course section(s)/other population: All sections
  - Number students to be assessed: All students
  - How the assessment will be scored: Department rubric
  - Standard of success to be used for this assessment: 75% of students will score 75% or better
  - Who will score and analyze the data: Departmental faculty

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
2020	2021	2020

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
326	193

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

All students in all sections for which data were available were included in the sample. Some instructors did not turn in data (final exams), and some students didn't take the final exam (did not complete the course though they remained enrolled).

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

There were 11 sections total; 8 F2F and 3 DL. There is no MM modality for this course. The DL course was developed in Summer 2020, piloted with 1 section Fall 2020, and had 3 DL sections in Winter 2021. The F2F sections were almost all daytime, as a coincidence of which instructors turned in data and the fact that the majority of sections offered are daytime.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

The final exams were all on Bb, scored automatically using a rubric for each question. Most questions were either 5 or 10 points, with fractions of a point possible. Further, most questions had multiple parts (like "choose all correct answers" with up to a dozen or more choices), and in some cases negative points were possible for incorrect answers (to prevent students from just choosing every answer). This makes for a complicated rubric, but it was done in an effort to achieve integrity of the assessment (make it hard to cheat). As such, strictly speaking each question had a custom rubric (available to students on Bb) based on the number of points possible and answer choices for that question.

Currently there are two forms of the final exam, a paper version and a digital version on Bb. They cover the same material and the same SLOs, but they are quite different in format. As it turns out, none of the instructors who give the paper final (one or two) turned in the exams for assessment scoring, so this assessment was only done with the Bb finals.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: <u>Yes</u>
95% of students (183/193) scored 75% or higher on this outcome. These results are very surprising. This SLO is one of the abstract ones that was added in the 2017 syllabus update as a result of the previous assessment. The previous abstract outcome had a success rate of 49% in the previous assessment. We made significant changes in the syllabus and especially in the teaching of the course to address this, and these data suggest the changes were effective. Maybe not as effective as they seem (see comments in the Course Summary section), but these results are very encouraging.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

Students seem to have grasped the major concepts of this outcome much better than anticipated. Either that or the extraordinary measures taken during the

pandemic were extraordinarily helpful to students and inflated their scores. My guess is it's a combination of both.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

This is still a difficult outcome for students and continued emphasis is appropriate. In particular I'd like to continue to develop ways to teach it that facilitate student mastery. We added an optional OER textbook that treats the abstract outcomes (SLOs 3 and 4) differently, and probably with more emphasis than the traditional text we've been using for years. As it turns out, all sections in this assessment used the OER instead of the traditional text, which may explain part of the surprisingly high performance on the abstract outcome.

Outcome 4: Apply the basic theorems of inner product spaces.

- Assessment Plan
  - Assessment Tool: Common departmental exam questions
  - Assessment Date: Spring/Summer 2019
  - Course section(s)/other population: All sections
  - Number students to be assessed: All students
  - How the assessment will be scored: Department rubric
  - Standard of success to be used for this assessment: 75% of students will score 75% or better
  - Who will score and analyze the data: Departmental faculty

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
2020	2021	2020

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
326	193

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

All students in all sections for which data were available were included in the sample. Some instructors did not turn in data (final exams), and some students didn't take the final exam (did not complete the course though they remained enrolled).

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

There were 11 sections total; 8 F2F and 3 DL. There is no MM modality for this course. The DL course was developed in Summer 2020, piloted with 1 section Fall 2020, and had 3 DL sections in Winter 2021. The F2F sections were almost all daytime, as a coincidence of which instructors turned in data and the fact that the majority of sections offered are daytime.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

The final exams were all on Bb, scored automatically using a rubric for each question. Most questions were either 5 or 10 points, with fractions of a point possible. Further, most questions had multiple parts (like "choose all correct answers" with up to a dozen or more choices), and in some cases negative points were possible for incorrect answers (to prevent students from just choosing every answer). This makes for a complicated rubric, but it was done in an effort to achieve integrity of the assessment (make it hard to cheat). As such, strictly speaking each question had a custom rubric (available to students on Bb) based on the number of points possible and answer choices for that question. Currently there are two forms of the final exam, a paper version and a digital version on Bb. They cover the same material and the same SLOs, but they are quite different in format. As it turns out, none of the instructors who give the paper final (one or two) turned in the exams for assessment scoring, so this assessment was only done with the Bb finals.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: <u>Yes</u>
93% of students (180/193) scored 75% or higher on this outcome. These results are also surprising, for the same reasons as the previous SLO. This is the second abstract SLO that was created out of the previous single abstract SLO (the old one was deleted and replaced with 2 new ones). Again, see further comments in the Course Summary section.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

The comments for this SLO are essentially the same as for SLO 3. Students did better than expected, which is great.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

See comments for SLO 3.

Outcome 5: Compute eigenvalues and eigenvectors and use them in applications.

- Assessment Plan
  - Assessment Tool: Common departmental exam questions
  - Assessment Date: Spring/Summer 2019
  - Course section(s)/other population: All sections
  - Number students to be assessed: All students
  - How the assessment will be scored: Department rubric
  - Standard of success to be used for this assessment: 75% of students will score 75% or better
  - Who will score and analyze the data: Departmental faculty

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
2020	2021	2020

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
326	193

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

All students in all sections for which data were available were included in the sample. Some instructors did not turn in data (final exams), and some students

didn't take the final exam (did not complete the course though they remained enrolled).

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

There were 11 sections total; 8 F2F and 3 DL. There is no MM modality for this course. The DL course was developed in Summer 2020, piloted with 1 section Fall 2020, and had 3 DL sections in Winter 2021. The F2F sections were almost all daytime, as a coincidence of which instructors turned in data and the fact that the majority of sections offered are daytime.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

The final exams were all on Bb, scored automatically using a rubric for each question. Most questions were either 5 or 10 points, with fractions of a point possible. Further, most questions had multiple parts (like "choose all correct answers" with up to a dozen or more choices), and in some cases negative points were possible for incorrect answers (to prevent students from just choosing every answer). This makes for a complicated rubric, but it was done in an effort to achieve integrity of the assessment (make it hard to cheat). As such, strictly speaking each question had a custom rubric (available to students on Bb) based on the number of points possible and answer choices for that question. Currently there are two forms of the final exam, a paper version and a digital version on Bb. They cover the same material and the same SLOs, but they are quite different in format. As it turns out, none of the instructors who give the paper final (one or two) turned in the exams for assessment scoring, so this assessment was only done with the Bb finals.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: Yes
99% of students (192/193) scored 75% or higher on this outcome. This is a computational task that is done both by hand and on a computer in this class. First students learn to do it by hand, then on a computer, and afterwards do it whichever way is most convenient in the context (yes sometimes doing it by hand is easier/quicker). Students almost never make a mistake doing it on a computer, and the final exam questions for this SLO were designed to be done on a computer. Hand calculation problems were not given because the exam was on Bb and completed remotely (unproctored), so there was no way to know if students

actually did it by hand. That probably explains why the success rate is so high. See further comments in the Course Summary section.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

This is a computational outcome done mostly on a computer, and by the end of the course (i.e. on the final exam used for this assessment) only done by hand if it's quicker than a computer. Students are good at using technology to do this.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

As with the other computational outcomes, an area to improve is the interpretation of the results. There are interpretation questions for this outcome, and if a student made a mistake on this outcome, it was usually in an interpretation question.

Outcome 6: Calculate the least-squares solution to a system of linear equations.

- Assessment Plan
  - Assessment Tool: Common departmental exam questions
  - Assessment Date: Spring/Summer 2019
  - Course section(s)/other population: All sections
  - Number students to be assessed: All students
  - How the assessment will be scored: Department rubric
  - Standard of success to be used for this assessment: 75% of students will score 75% or better
  - Who will score and analyze the data: Departmental faculty

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
2020	2021	2020

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
326	193

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

    All students in all sections for which data were available were included in the sample. Some instructors did not turn in data (final exams), and some students didn't take the final exam (did not complete the course though they remained enrolled).

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

    There were 11 sections total; 8 F2F and 3 DL. There is no MM modality for this course. The DL course was developed in Summer 2020, piloted with 1 section Fall 2020, and had 3 DL sections in Winter 2021. The F2F sections were almost all daytime, as a coincidence of which instructors turned in data and the fact that the majority of sections offered are daytime.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

    The final exams were all on Bb, scored automatically using a rubric for each question. Most questions were worth either 5 or 10 points, with fractions of a point possible. Further, most questions had multiple parts (like "choose all correct answers" with up to a dozen or more choices), and in some cases negative points were possible for incorrect answers (to prevent students from just choosing every answer). This makes for a complicated rubric, but it was done in an effort to achieve integrity of the assessment (make it hard to cheat). As such, strictly speaking each question had a custom rubric (available to students on Bb) based on the number of points possible and answer choices for that question.

    Currently there are two forms of the final exam, a paper version and a digital version on Bb. They cover the same material and the same SLOs, but they are quite different in format. As it turns out, none of the instructors who give the paper final (one or two) turned in the exams for assessment scoring, so this assessment was only done with the Bb finals.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

    Met Standard of Success: Yes

78% of students (151/193) scored 75% or higher on this outcome. This is another computational outcome. In the previous assessment the success rate was 87%, so this is quite a drop. It may be due to the fact that a heavy emphasis was put on the abstract SLOs, and the abstract nature of the course in general, and less time and attention was given to the "easy" computational outcomes. We probably didn't give this outcome enough time; the pendulum may have swung a bit too far in the other direction.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

Students are good at using a computer to do the computational parts of this outcome.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

This outcome requires more than just computation. There is significant interpretation and setup that must be done first, and this is where improvement can be made.

III. Course Summary and Intended Changes Based on Assessment Results

1. Based on the previous report's Intended Change(s) identified in Section I above, please discuss how effective the changes were in improving student learning.

The changes were very effective. We replaced one abstract outcome with 2 more specific abstract outcomes (essentially split it in two). We then made some major changes in how we teach the course. It's not just the outcomes, it's a whole paradigm. Math is about abstraction and generalization, but students usually don't start to learn that until the second year of college math, and traditionally it's in this class, Linear Algebra. So we made a concerted effort to stress the abstract nature of the course content, and of math in general. For example we would sometimes explain the abstract nature of things students learned in previous courses to help them understand how computational methods arise out of abstract axioms and theorems.

2. Describe your overall impression of how this course is meeting the needs of students. Did the assessment process bring to light anything about student achievement of learning outcomes that surprised you?

I think the course is meeting the needs of students well. We can always make it better. I want to continue to develop rigorous and accurate assessments to better understand how and what students are learning, and at what levels. As mentioned in previous sections of this report, the high success rates of SLOs 1-5 were surprising. As much as we'd like to give all the credit to instructors' hard work at improving the course, I suspect part of the high success rates are due to the Covid pandemic and the delivery and assessment changes that were made in response to it. Every section in the sample for this assessment was either a virtual or online class. There were no in-person, face-to-face sections of the course offered over the past 3 semesters. In particular, the final exams were all unproctored, given on Blackboard. There was a time limit, and the questions were carefully and intentionally written to make cheating difficult, and guessing futile. However the incidence of cheating - especially collaborating with other students - may have been higher than in F2F sections or DL sections with exams proctored in a testing center.

3. Describe when and how this information, including the action plan, was or will be shared with Departmental Faculty.

At a department meeting and via email to department faculty.

4.

Intended Change(s)

Intended Change	Description of the change	Rationale	Implementation Date
Outcome Language	We deleted one of the computational SLOs in the last syllabus review, and then split the abstract SLO into 2 new ones. In the next syllabus review I'd like to add the old computational one back (we've still taught it) and combine it with another computational SLO, making the wording more general, and including the	This will better represent the course as we envision and actually teach it. It should also make future assessments more accurate and meaningful since there will be more types of questions that can be used to assess this outcome.	2021

	specifics in the course objectives.		
Pre-requisite	Pending department/dean approval, increase the prerequisite from Calc I to Calc II.	The intended sequence of courses for students is Calc I, Calc II, Linear Algebra, Calc III, Differential Equations. Technically students don't need to know much Calculus to learn Linear Algebra; the prerequisite is a mathematical maturity requirement. Linear Algebra is a big step up from computational to abstract math. Many students find it to be the most difficult math class at the college for that reason. Interestingly, the prerequisite for the equivalent course at the University of Michigan (Math 214) is Calc II, presumably for the same math maturity reason.	2022

5. Is there anything that you would like to mention that was not already captured?

6.

III. Attached Files

MTH 197 data

Faculty/Preparer:	Lawrence David	**Date:**	08/23/2021
Department Chair:	Lawrence David	**Date:**	08/24/2021
Dean:	Victor Vega	**Date:**	08/26/2021
Assessment Committee Chair:	Shawn Deron	**Date:**	10/30/2021

Course Assessment Report
Washtenaw Community College

Discipline	Course Number	Title
Mathematics	197	MTH 197 08/03/2017-Linear Algebra
Division	Department	Faculty Preparer
Math, Science and Engineering Tech	Mathematics	Lawrence David
Date of Last Filed Assessment Report		

I. Assessment Results per Student Learning Outcome

Outcome 1: Solve systems of linear equations with a parametric solution.

- Assessment Plan
    - Assessment Tool: Common departmental exam questions
    - Assessment Date: Fall 2012
    - Course section(s)/other population: all
    - Number students to be assessed: all students
    - How the assessment will be scored: rubric
    - Standard of success to be used for this assessment: 75% of students will score 75% or better
    - Who will score and analyze the data: departmental faculty

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
2016, 2016, 2015	2016, 2017, 2015	2016, 2015

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
387	246

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

Data was unavailable for some sections because some part-time instructors did not submit the data (final exams) for analysis. Also, some students did not complete the activity (final exam) so no data was collected from them.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

All students from every section were included, except as described above.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

Two common final exam questions were used to assess the outcome. In each question, students were given a system of linear equations and asked to find the solution to the system and write it in parametric form.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: Yes
92% of students across all sections analyzed scored 75% or better on these questions. This result far exceeds the goal of 75% considered a success according to the syllabus. The outcomes for this class vary greatly in difficulty for students, and this outcome has relatively low difficulty. This probably explains in part why most students achieved this outcome.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

Students did very well on this outcome. The standard of success was 75% of students succeeding, and in this outcome had a 92% success rate. A calculator is used to do the tedious calculations with a built-in matrix algebra function ("RREF" on the TI-84, which row reduces a matrix to reduced echelon form). Almost all students are able to learn how to row reduce a matrix using the calculator, which is the main computational task for this outcome. Students tend to be strong in computational tasks, especially those that are algorithmic and aided by a calculator.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

The main room for improvement is interpreting the solution to a system, especially geometrically. However interpretation isn't currently part of the outcome, so we may want to consider adding an interpretation component to the outcome to make it more challenging and comprehensive. Based on the data, we are doing well in getting students to be able to succeed with the outcome as it is.

Outcome 2: Compute determinants and inverses of matrices.

- Assessment Plan
    - Assessment Tool: Common departmental exam questions
    - Assessment Date: Fall 2012
    - Course section(s)/other population: all
    - Number students to be assessed: all students
    - How the assessment will be scored: rubric
    - Standard of success to be used for this assessment: 75% of students will score 75% or better
    - Who will score and analyze the data: departmental faculty

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
2016, 2016, 2015	2017, 2016, 2015	2016, 2015

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
387	246

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

Data was unavailable for some sections because some part-time instructors did not submit the data (final exams) for analysis. Also, some students did not complete the activity (final exam) so no data was collected from them.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

All students from every section were included, except as described above.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

Three common final exam questions were used to assess the outcome. Students were asked (1) to calculate the determinant of a matrix by hand, (2) to find the inverse of the matrix, and (3) a qualitative question about the relationship between the value of the determinant and the invertibility of the matrix.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: Yes
98% of students across all sections analyzed scored 75% or better on these questions. This result far exceeds the goal of 75% considered a success according to the syllabus. The outcomes for this class vary greatly in difficulty for students, and this outcome has relatively low difficulty. This probably explains in part why most students achieved the outcome.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

Students did really well at this computational outcome. The standard of success was a 75% success rate, and they achieved a 98% success rate. Students were allowed to use a calculator to calculate the inverse, though they were required to calculate the determinant by hand. Usually they use a calculator to calculate determinants, but they still need to know how to do it by hand when necessary. So though they had to show the work to calculate the determinant by hand, they were able to use a calculator to check the final result. As with SLO 1, students tend to do well with computational tasks that are aided by a calculator.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

At 98% success there isn't much room for improvement for the outcome as written. We could consider rewriting it to make it more difficult and comprehensive, for example to include an interpretation component, in addition to the computation.

Outcome 3: Use the Gram-Schmidt algorithm to orthonormalize a set of vectors.

- Assessment Plan
  - Assessment Tool: Common departmental exam questions
  - Assessment Date: Fall 2012
  - Course section(s)/other population: all
  - Number students to be assessed: all students
  - How the assessment will be scored: rubric
  - Standard of success to be used for this assessment: 75% of students will score 75% or better
  - Who will score and analyze the data: departmental faculty

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
2016, 2016, 2015	2017, 2016, 2015	2016, 2015

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
387	246

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

Data was unavailable for some sections because some part-time instructors did not submit the data (final exams) for analysis. Also, some students did not complete the activity (final exam) so no data was collected from them.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

All students from every section were included, except as described above.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

A common final exam question was used to assess the outcome. Students were given a matrix and asked to find an orthonormal basis for the column space of the matrix. The main task required to do this is orthogonalizing the set of column vectors using the Gram-Schmidt algorithm.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: Yes
78% of students across all sections analyzed scored 75% or better on these questions. This result exceeds the goal of 75% considered a success according to the syllabus. This is probably the second most difficult outcome for most students, because it is difficult computationally, and also requires students to understand the abstract concept of an orthogonal set of vectors.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

At 78%, students just exceeded the standard of 75%. Students were good at using the algorithm, and following the formula.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

Students were not as good at consistency and detail. They were able to follow the algorithm and use the formula, but there are many steps in the algorithm, and opportunities to make mistakes. It also requires an understanding of the abstract context in order to see the big picture and know if the final answer makes sense. The main area of improvement is to better understand the abstract context of the algorithm. For example, what does "orthogonal" mean in reference to a set of vectors? How can you tell if a set is orthogonal or not? Why does the algorithm

produce an orthogonal set and how is the definition of an orthogonal set used to derive the algorithm? Understanding these abstract concepts should improve student success in the computational outcome.

Outcome 4: Apply the basic theory of subspaces and linear transformations.

- Assessment Plan
  - Assessment Tool: Common departmental exam questions
  - Assessment Date: Fall 2012
  - Course section(s)/other population: all
  - Number students to be assessed: all students
  - How the assessment will be scored: rubric
  - Standard of success to be used for this assessment: 75% of students will score 75% or better
  - Who will score and analyze the data: departmental faculty

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
2016, 2016, 2015	2017, 2016, 2015	2016, 2015

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
387	246

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

Data was unavailable for some sections because some part-time instructors did not submit the data (final exams) for analysis. Also, some students did not complete the activity (final exam) so no data was collected from them.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

All students from every section were included, except as described above.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

Two common final exam questions were used to assess the outcome. The first question asked if the set of all third degree polynomials of a certain form is a subspace of P4, and for an explanation of why or why not. The second question described a mapping from P2 to P2 and asked students to find the matrix for the transformation relative to the standard basis for P2.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: Yes
49% of students across all sections analyzed scored 75% or better on these questions. This result does not meet the goal of 75% considered a success according to the syllabus. The outcomes for this class vary greatly in difficulty for students, and this outcome is by far the most difficult for almost all students. The main reason is probably because this outcome requires a solid understanding of several abstract concepts, and the types of questions that can be asked about these concepts often seem arbitrary and unrelated to a student who doesn't understand those underlying concepts. So while students will have seen at least a dozen different questions on homework and exams that are based on these concepts, they may not recognize them as related, and in particular may have the experience that these final exam questions are new, or "things we didn't learn in class".

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

Most students demonstrated a basic understanding of at least some of the methods we use to determine if a subset is a subspace. For example, one method is to determine if the zero vector is in the subset. If it is not, then the subset is not a subspace. Most students demonstrated an understanding of this method, even if they weren't able to determine what the zero vector was in the given subset. Likewise, many students were able to reproduce the formula for the matrix of a transformation relative to a basis, though they were often unable to apply the formula in the given context.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

> This is the most difficult, most abstract outcome; and it is the most difficult probably because it is the most abstract. This course is usually students' first experience with abstract mathematics, which is a quantum step up in difficulty from computational math like calculus.
>
> Understanding the nature of abstract math in general, and the specific abstract concepts of this outcome, are the main areas of improvement. It's a paradigm shift where the answer to a question can be a paragraph or two of English, rather than a number. It's the difference between answering "why is this subset a subspace?" versus "what is the volume of this shape?"
>
> Realistically, the standard of 75% success may be high for this outcome in particular. As an instructor, if I get over 50% of my class to succeed with this outcome, I am thrilled. A student can master about half of this particular outcome and still get an A in the course, and be well prepared for the math courses that follow, where they will build upon and strengthen their understanding of abstract math.
>
> This is not to say that I think we should be satisfied with the 49% success rate from the current data. I think we should focus on this outcome in particular, and abstract math in general as we teach the course going forward.

Outcome 5: Compute eigenvalues and associated eigenvectors of linear transformations and use them to diagonalize matrices.

- Assessment Plan
  - Assessment Tool: Common departmental exam questions
  - Assessment Date: Fall 2012
  - Course section(s)/other population: all
  - Number students to be assessed: all students
  - How the assessment will be scored: rubric
  - Standard of success to be used for this assessment: 75% of students will score 75% or better
  - Who will score and analyze the data: departmental faculty

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
2016, 2016, 2015	2017, 2016, 2015	2016, 2015

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
387	246

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

Data was unavailable for some sections because some part-time instructors did not submit the data (final exams) for analysis. Also, some students did not complete the activity (final exam) so no data was collected from them.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

All students from every section were included, except as described above.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

Two common final exam questions were used to assess the outcome. The first question had three parts. Students were given a square matrix and asked: (a) Find the eigenvalues of the matrix, (b) Find the eigenspace corresponding to each eigenvalue, and (c) diagonalize the matrix. The second question asked students to orthogonally diagonalize a symmetric matrix.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: Yes
89% of students across all sections analyzed scored 75% or better on these questions. This result exceeds the goal of 75% considered a success according to the syllabus.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

Students did well with the algorithm to find the eigenvalues and associated eigenvectors of a matrix. Many students demonstrated an understanding of the concepts of eigenvalues and eigenvectors.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

Students didn't do as well with finding orthogonally diagonalizing a symmetric matrix. This task requires not only finding eigenvalues and eigenvectors, but normalizing a set of vectors as well as constructing a matrix factorization that satisfies certain conditions. This is both computationally and conceptually more difficult than simply finding eigenvalues and associated eigenvectors. Since the outcome as written only covers this simpler task, students are actually performing better than the reported success rate would suggest, since the second problem included these more difficult tasks that are not part of the outcome. As with the other successful outcomes, continuous improvement could include expanding the outcomes to include applications of eigenvalues and eigenvectors, like diagonalizing a matrix. We are effectively measuring such an expanded outcome already.

Outcome 6: Find a least square solutions to inconsistent systems of linear equations.

- Assessment Plan
    - Assessment Tool: Common departmental exam questions
    - Assessment Date: Fall 2012
    - Course section(s)/other population: all
    - Number students to be assessed: all students
    - How the assessment will be scored: rubric
    - Standard of success to be used for this assessment: 75% of students will score 75% or better
    - Who will score and analyze the data: departmental faculty

1. Indicate the Semester(s) and year(s) assessment data were collected for this report.

Fall (indicate years below)	Winter (indicate years below)	SP/SU (indicate years below)
2016, 2016, 2015	2016, 2015, 2017	2016, 2015

2. Provide assessment sample size data in the table below.

# of students enrolled	# of students assessed
387	246

3. If the number of students assessed differs from the number of students enrolled, please explain why all enrolled students were not assessed, e.g. absence, withdrawal, or did not complete activity.

Data was unavailable for some sections because some part-time instructors did not submit the data (final exams) for analysis. Also, some students did not complete the activity (final exam) so no data was collected from them.

4. Describe how students from all populations (day students on campus, DL, MM, evening, extension center sites, etc.) were included in the assessment based on your selection criteria.

All students from every section were included, except as described above.

5. Describe the process used to assess this outcome. Include a brief description of this tool and how it was scored.

A common final exam question was used to assess the outcome. The question presented students with an inconsistent system of equations and asked them to find the least squares solution. In this case, the solution set was infinite so the problem was more difficult than if there had been a unique solution.

6. Briefly describe assessment results based on data collected for this outcome and tool during the course assessment. Discuss the extent to which students achieved this learning outcome and indicate whether the standard of success was met for this outcome and tool.

Met Standard of Success: Yes
87% of students across all sections analyzed scored 75% or better on these questions. This result exceeds the goal of 75% considered a success according to the syllabus. This is another difficult, but strictly speaking computational outcome.

7. Based on your interpretation of the assessment results, describe the areas of strength in student achievement of this learning outcome.

Students did well with the formula for finding the least squares solution to an inconsistent system. It requires multiple steps to implement, and some students made minor computational mistakes, but overall demonstrated competency in using the formula.

8. Based on your analysis of student performance, discuss the areas in which student achievement of this learning outcome could be improved. If student met standard of success, you may wish to identify your plans for continuous improvement.

As with the other outcomes, the biggest area of improvement is in understanding and applying the abstract concepts upon which the formula is based. The problem on the exam was one of the "harder ones" from the homework, so a lack of understanding of the concepts was revealed more than it would likely have been on an easier problem.

II. Course Summary and Action Plans Based on Assessment Results

1. Describe your overall impression of how this course is meeting the needs of students. Did the assessment process bring to light anything about student achievement of learning outcomes that surprised you?

This course primarily serves STEM students who want to transfer to a 4-year institution or are already enrolled at one and have chosen to take the course at WCC. That group is further broken down into math majors and non-math majors, particularly engineering and science majors. The course transfers to 4-year institutions as an introductory linear algebra course, also known as a computationally-based linear algebra course. Such courses are generally taken by non-math majors, though some math programs also require such a course. In that context, this course meets the needs of the target audience well. In fact, it goes above and beyond what is required of many introductory courses at 4-year schools. The syllabus is based directly on an equivalent course at the University of Michigan, in order to meet their requirements for the course to transfer. This is because the majority of our transfer students come from, or hope to transfer to, the U of M. Because the course is essentially the same as what is taught at U of M, a student who does well in our linear algebra course will be very well prepared compared to students who succeed at similar courses anywhere in the country. The one big surprise was the large difference in success levels between the more abstract outcomes and the more computational ones. I knew anecdotally that students did better on computational problems than abstract ones, but the data shows a very clear and wide gap in success rates.

2. Describe when and how this information, including the action plan, was or will be shared with Departmental Faculty.

This information, including the action plan, will be shared at a math department meeting once the report is complete.

3. Intended Change(s)

Intended Change	Description of the change	Rationale	Implementation Date
Outcome Language	Some of the outcome language needs minor tweaks to be more accurate. Some outcomes will be expanded to include interpretation components and/or application components, pending department approval of those changes to the master syllabus.	The minor language tweaks will make the outcomes more specific and accurate. The additional components would be a part of continuous improvement, essentially raising the bar because we are greatly exceeding it with some of the outcomes as they are written.	2017

4. Is there anything that you would like to mention that was not already captured?

Context and Major Conclusions:

This course is unique in the math curriculum at WCC in that it includes a significant amount of abstract math. Traditionally, the first linear algebra course serves double duty as an introduction to the abstract math of upper level undergraduate courses, as well as teaching the content of the subject itself. This is usually a challenge for students, and they sometimes report feeling like the course is unnecessarily difficult since the computational parts of the course are "clouded" in abstract concepts. In later math courses, they discover that abstract concepts are the foundation of mathematics, and that the computational algorithms we derive from the concepts only exist because of them. The real power of math is in abstraction and generalization, which is why it is the universal language of science and engineering, and why so much math is required in those programs.

Instructors of this course therefore face a unique challenge in helping students with the paradigm shift from computational to abstract mathematics. Students often take on an identity of being "good at math" or "not good at math", and in K-12 and early college, "good at math" means being good at computational math. Abstract math is much more difficult, and students who struggle with it often get frustrated with the instructor or the course or both, since they "know" they're good at math so if they're not succeeding in this one course, it must be the course and not them.

Personally I love this challenge, and the satisfaction of helping a student understand the nature of abstract math and succeed at doing it is incredibly rewarding. However, the relevant point is that the unique nature of this course is the context in which to interpret the assessment data.

The main conclusion I draw from the data is that student success follows very closely the computational and abstract natures of the outcomes. Students did much better on outcomes that were entirely computational, and not as well on outcomes that were very abstract.

It's appropriate for the outcomes to be what they are because they reflect the content of the subject matter of the syllabus, and that syllabus is fairly universal across undergraduate curricula nationwide. As such, the data is clear that the abstract parts of the course are where we can improve the most, and where we should focus our instructional efforts.

III. Attached Files

Data
Rubric

Faculty/Preparer:	Lawrence David	**Date:** 08/21/2017
Department Chair:	Lisa Rombes	**Date:** 08/21/2017
Dean:	Kristin Good	**Date:** 08/24/2017
Assessment Committee Chair:	Michelle Garey	**Date:** 10/30/2017

COURSE ASSESSMENT REPORT

I. Background Information

1. Course assessed:
   Course Discipline Code and Number: MTH 197
   Course Title: Linear Algebra
   Division/Department Codes: MNB / MTH

2. Semester assessment was conducted (check one):
   ☐ Fall 20__
   X Winter 2009
   ☐ Spring/Summer 20__

3. Assessment tool(s) used: check all that apply.
   ☐ Portfolio
   ☐ Standardized test
   ☐ Other external certification/licensure exam (specify):
   ☐ Survey
   ☐ Prompt
   ☐ Departmental exam
   ☐ Capstone experience (specify):
   X Other (specify): common exam questions.

4. Have these tools been used before?
   X Yes
   ☐ No

   If yes, have the tools been altered since its last administration? If so, briefly describe changes made.
   The course master syllabus was revised and updated in Fall 2008, some course contents and course objectives were changed to match what are covered in the current textbook.

5. Indicate the number of students assessed/total number of students enrolled in the course.
   42 students from both sections in Winter 2009 Semester participated in the assessment.

6. Describe how students were selected for the assessment.
   All students enrolled in both sections of Winter 2009 Semester.

II. Results

1. Briefly describe the changes that were implemented in the course as a result of the previous assessment.
   With the use of TI-calculators in teaching course subjects, we are able to put more time into the discussion of conceptual topics, helping students do more critical thinking. The calculator is useful in verifying conjecture and providing clues to help students understand more abstract topics of the course subjects, such as finding Null Space and Column Space of linear transformations, which eventually lead to the Rank Theorem.

2. List each outcome that was assessed for this report exactly as it is stated on the course master syllabus.
   [1] Outcome 1: Solve systems of linear equations. [2] Outcome 2: Compute determinants. [3] Outcome 4: Apply the basic theory of subspaces and linear transformations. [4] Outcome 6: Compute the eigenvalues and associated eigenvectors of linear transformations. [5] Outcome 7: Finding least square solutions to inconsistent systems of linear equations. ***Please see the attached copy of assessment problems and remarks about how & why these problems were selected.***

3. Briefly describe assessment results based on data collected during the course assessment, demonstrating the extent to which students are achieving each of the learning outcomes listed above. ***Please attach a summary of the data collected.***
   The assessment problems were carefully selected to reflect the different aspects of the course subjects, some problems checked the algebra skills (such as problems [1](a), [3], [4]), some problems checked the ability of performing critical thinking, using some basic concepts discussed in the related topics (such as problems [1](b) and [2]). Each problem was graded on a 20-point basis, with the total of 5 problems equal to 100 points. For each student, scores of each problem was listed, we would look at each student's total score (to understand their

average performance) and also compare the scores of each problem separately, to find out the strengths and weaknesses of the students' learning. ***Please see the attached summary of assessment scores collected.***

4. For each outcome assessed, indicate the standard of success used, and the percentage of students who achieved that level of success. ***Please attach the rubric/scoring guide used for the assessment.***
   We would analyze the scores of all students who received a grade of C or better. For each problem, a score of 14 or above is considered successful (this is the equivalent of 70 points on a 100-point basis). Below we listed the percentage of students (with a grade of C or better) who are successful for each problem.
   - For problem [1], 28 out of 32, or 87.5%
   - For problem [2], 30 out of 32, or 93.75%
   - For problem [3], 31 out of 32, or 96.88%
   - For problem [4], 21 out of 32, or 65.63%
   - For problem [5], 28 out of 32, or 87.5%

   Overall, 29 out of 32 students who got a C or better passed the assessment with 70% or higher.

5. Describe the areas of strength and weakness in students' achievement of the learning outcomes shown in assessment results.
   Strengths: Able to use a calculator to find the solutions of basic types questions, such as using the method of row reduction to solve a system of linear equations, evaluate determinant, etc.

   Weaknesses: May have trouble solving problems where the answers can not be completely determined with a calculator, and where some algebra skills & concepts may be needed. This is shown by the results of problem [4].

III. Changes influenced by assessment results

1. If weaknesses were found (see above) or students did not meet expectations, describe the action that will be taken to address these weaknesses.

   Put more emphasis on the discussion of critical thinking topics, showing students how to resolve problems where a combination of algebra skills and calculator would be required. Students need to understand that calculator is a good tool, but it can not think, they need to learn how to think or reason to resolve problems.

2. Identify intended changes that will be instituted based on results of this assessment activity (check all that apply). Please describe changes and give rationale for change.
   a. ☐ Outcomes/Assessments on the Master Syllabus
   Change/rationale:

   b. ☐ Objectives/Evaluation on the Master Syllabus
   Change/rationale:

   c. ☐ Course pre-requisites on the Master Syllabus
   Change/rationale:

   d. ☐ 1st Day Handouts
   Change/rationale:

   e. ☒ Course assignments
   Change/rationale:Emphasize more on assignments requiring critical thinking. Students need to understand that ***calculator is a good tool, but it cannot resolve all the problems.*** They need to figure out the best way to resolve the problems

f. ☐ Course materials (check all that apply)
- ☐ Textbook
- ☐ Handouts
- ☒ Other: Upgrade the model of calculators. The current calculator model (TI-83+) required for the course has limited capability on performing vector operations, such as finding eigenvalues and eigenvectors. Some students really have problems with learning these concepts & topics, as is shown by the results of problem [4]. A better ***equipped*** calculator would smooth out this learning process.

g. ☐ Instructional methods
Change/rationale:

h. ☐ Individual lessons & activities
Change/rationale:

3. What is the timeline for implementing these actions? Over the next several semesters, beginning Fall 2009.

IV. Future plans

1. Describe the extent to which the assessment tools used were effective in measuring student achievement of learning outcomes for this course.

   Given the fact that, out of the 32 students who successfully completed the course, 29 of them passed the assessment, we can conclude that the assessment tools used so far are effective for this course.

2. If the assessment tools were not effective, describe the changes that will be made for future assessments.

3. Which outcomes from the master syllabus have been addressed in this report?
   All _____ Selected √
   If "All", provide the report date for the next full review: ________________.
   If "Selected", provide the report date for remaining outcomes: Fall 2011.

Submitted by:

Print: Yin Lu (Faculty/Preparer)	**Signature** Yin Lu	**Date:** 8-13-2009
Print: Kristin Chatas (Department Chair)	**Signature** [signature]	**Date:** 8-18-2009
Print: Martha A. Showalter (Dean/Administrator)	**Signature** M Showalter	**Date:** AUG 20 2009

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