| Discipline | Course Number | Title |
|---|---|---|
| Mathematics | 293 | MTH 293 08/08/2021-Calculus III |
| College | Division | Department |
| | Math, Science and Engineering Tech | Math & Engineering Studies |
| Faculty Preparer | | Yin Lu |
| Date of Last Filed Assessment Report | | 03/07/2018 |

**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

   The course was assessed in Spring-Summer 2017.

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

   Four major course outcomes were assessed. In general, students did better on the first part of course content; there were more struggles with the second part of the course.

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

   The suggestion for the course was to focus more effort in course preparation for the second part of course contents. A fifth course outcome was added for the next assessment to get more information about students' learning.

**II. Assessment Results per Student Learning Outcome**

Outcome 1: Perform basic operations of Vector Algebra.

- Assessment Plan

    o   Assessment Tool: End of semester exam

    o   Assessment Date: Winter 2020

    o   Course section(s)/other population: All course sections

- o Number students to be assessed: A random sample of 20% of students enrolled or a minimum of 30 students

- o How the assessment will be scored: Departmentally-developed rubric

- o Standard of success to be used for this assessment: 70% of students sampled will score an average of 70% or higher on each exam question that addresses Outcome 1

- o Who will score and analyze the data: Department

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 |
|---|---|
| 549 | 60 |

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 sample of 60 students was selected for assessment.

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.

I was only able to assess students in the face-to-face sections that I taught due to data availability.

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

Outcome-related test questions were identified. Each problem is assessed on a 10-point scale, 4 points for concept and formulas setup, 6 points for skills in getting the correct answer.

7 points or higher was considered as meeting the standard of success.

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 |
|---|
| Fifty of 60 students (83%) scored a 7 or higher, meeting the standard of success.  Ten students scored below 7. |

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

| Most of the students can perform the basic operations of vector algebra correctly. |
|---|

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 students had trouble distinguishing vector quantity (such as velocity) from scalar quantity (such as speed). Students need more explanation in lecture. |
|---|


Outcome 2: Differentiate functions of several variables.

- Assessment Plan

  - Assessment Tool: End of semester exam

  - Assessment Date: Winter 2020

  - Course section(s)/other population: All course sections

  - Number students to be assessed: A random sample of 20% of students enrolled or a minimum of 30 students

  - How the assessment will be scored: Departmentally-developed rubric

  - Standard of success to be used for this assessment: 70% of students sampled will score an average of 70% or higher on each exam question that addresses Outcome 2

  - Who will score and analyze the data: Department

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 |
|---|---|

| 549 | 60 |
|---|---|

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 sample of 60 students were selected for assessment

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.

I was only able to assess students in the face-to-face sections that I taught due to data availability.

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

Outcome-related test questions were identified. Each problem is assessed on a 10-point scale, 4 points for concept and formulas setup, 6 points for skills in getting the correct answer.

7 points or higher was considered as meeting the standard of success.

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

Fifty of 60 students (83%) scored a 7 or higher, meeting the standard of success. Ten students scored below 7.

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

Most students can perform partial derivatives correctly.

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.

We need to cover more applications in lecture.

Outcome 3: Integrate and find limits of functions of several variables.

- Assessment Plan

    - Assessment Tool: End of semester exam

    - Assessment Date: Winter 2020

    - Course section(s)/other population: All course sections

    - Number students to be assessed: A random sample of 20% of students enrolled or a minimum of 30 students

    - How the assessment will be scored: Departmentally-developed rubric

    - Standard of success to be used for this assessment: 70% of students sampled will score an average of 70% or higher on each exam question that addresses Outcome 3

    - Who will score and analyze the data: Department

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 |
|---|---|
| 549 | 60 |

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 sample of 60 students was selected for assessment.

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.

I was only able to assess students in the face-to-face sections that I taught due to data availability.

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

Outcome-related test questions were identified. Each problem is assessed on a 10-point scale, 4 points for concept and formulas setup, 6 points for skills in getting the correct answer.

7 points or higher was considered as meeting the standard of success.

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: No

Thirty-nine of 69 students (65%) scored a 7 or higher, while 21 students scored below a 7. Students did not meet the standard of success.

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

Most students could perform integration in rectangular coordinates.

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 need more practice with integration in cylindrical and spherical coordinates.


Outcome 4: Perform calculations in Vector Calculus.

- Assessment Plan

    o Assessment Tool: End of semester exams

    o Assessment Date: Winter 2020

    o Course section(s)/other population: All course sections

    o Number students to be assessed: A random sample of 20% of students enrolled or a minimum of 30 students

    o How the assessment will be scored: Departmentally-developed rubric

    o Standard of success to be used for this assessment: 70% of students sampled will score an average of 70% or higher on each exam question that addresses Outcome 4

    o Who will score and analyze the data: Department

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 |
|---|---|
| 549 | 60 |

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 sample of 60 students was selected for assessment.

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.

I was only able to assess students in the face-to-face sections that I taught due to data availability.

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

Outcome-related test questions were identified. Each problem is assessed on a 10-point scale, 4 points for concept and formulas setup, 6 points for skills in getting the correct answer.

7 points or higher was considered as meeting the standard of success.

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: No

Thirty-eight of 60 students (63%) scored a 7 or higher while 22 students scored below 7. This falls below the standard of success.

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

Most students can do basic vector operations such as divergence or curl of vector fields.

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.

Instructors need to place more emphasis on learning flux integrals.

Outcome 5: Find relative and absolute extrema of functions of several variables.

- Assessment Plan

    o Assessment Tool: End of semester exam

    o Assessment Date: Winter 2020

    o Course section(s)/other population: All course sections

    o Number students to be assessed: A random sample of 20% of students enrolled or a minimum of 30 students

    o How the assessment will be scored: Departmentally-developed rubric

    o Standard of success to be used for this assessment: 70% of students sampled will score an average of 70% or higher on each exam question that addresses Outcome 5

    o Who will score and analyze the data: Department

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 |
|---|---|
| 549 | 60 |

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 sample of 60 students was selected for assessment.

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.

> I was only able to assess students in the face-to-face sections that I taught due to data availability.

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

> Outcome-related test questions were identified. Each problem is assessed on a 10-point scale, 4 points for concept and formulas setup, 6 points for skills in getting the correct answer.
>
> 7 points or higher was considered as meeting the standard of success.

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
>
> Forty-two of 60 students (70%) scored 70% or higher. This meets the standard of success.

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

> Most students are more familiar with the 2nd order Partial Test.

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 need more instruction on LaGrange multipliers in lecture. Additional emphasis should be placed on this content.

## 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.

> Time is still a big issue, properly covering topics in Vector Calculus needs more time and effort.

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?

This course is crucial for students who are in engineering majors. Vector Calculus still remains one of the important subjects.  Calculus 3 is a prerequisite the next upper level courses.

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

As soon as possible.

4.
Intended Change(s)

| Intended Change | Description of the change | Rationale | Implementation Date |
|---|---|---|---|
| Assessment Tool | Expand the selection of students used in the assessment beyond face-to-face courses. | Work with part-time and other full-time instructors to randomly collect data for at least 10% of the students for a valid sample. | 2022 |
| Course Assignments | Provide additional sample problems for the integration in cylindrical and spherical coordinates. | This concept was more challenging to students. | 2022 |
| Course Assignments | Increase lecture time and sample problems on LaGrange multipliers. | Students had more difficulty with this concept. | 2022 |
| Course Assignments | Increase lecture time on learning flux integrals. | Students had more difficulty with this concept. | 2022 |
| Course Materials (e.g. textbooks, handouts, on-line ancillaries) | Increase lecture time on distinguishing between vector quantity and scalar quantity. | Students had more difficulty with this concept. | 2022 |

| Course Materials (e.g. textbooks, handouts, on-line ancillaries) | Provide additional information and study problems on partial derivatives. | Students had more difficulty with this concept. | 2022 |
|---|---|---|---|

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

> 6.

## III. Attached Files

Assessment Problems
Assessment Data

| | | |
|---|---|---|
| **Faculty/Preparer:** | Yin Lu | **Date:** 08/26/2021 |
| **Department Chair:** | Lawrence David | **Date:** 08/27/2021 |
| **Dean:** | Victor Vega | **Date:** 08/31/2021 |
| **Assessment Committee Chair:** | Shawn Deron | **Date:** 05/19/2022 |

| Discipline | Course Number | Title |
|---|---|---|
| Mathematics | 293 | MTH 293 08/17/2019-Calculus III |
| Division | Department | Faculty Preparer |
| Math, Science and Engineering Tech | Math & Engineering Studies | Yin Lu |
| Date of Last Filed Assessment Report | | |

**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
>
> The assessment report was filed Spring-Summer 2017.

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

> The learning outcomes were covered by 10 assessment problems, which were divided into four major groups. The success rates were:
>
> 57% for group 1 (basic operations of vectors and their applications)
> 67% for group 2 (vector and partial differentiation, and their applications)
> 53% for group 3 (multiple integration and their applications)
> 37% for group 4 (vector calculus and its applications)
>
> Generally, students did OK on basic concepts and skills, but were ***weak on application topics***, as can be seen in the assessment results of group 1, 2, 3.
>
> Group 4 was the weakest due to the fact there is more physics background involved in the topics, and ***insufficient class time*** is another major concern. Topics in group 4 carry more weight in applications for engineering major students.

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

> There were two suggestions made:
> [1] Split the course as two courses:  one for students who don't need Vector Calculus, one for students majoring in Math, Physics and Engineering.

[2] Increase class contact hours from 4 hours per week to 5 hours per week.

Our course instructors were more favorable for suggestion [2]. ***There was no response from the Assessment Committee about these suggestions***. The recommendation was: instead of using a sample of 30 students, try use a larger sample for next assessment. The Spring-Summer 2019 course assessment was done by a sample of 60 students, with better students' success rates ***but not significantly better*** than what was found in 2017 Report.

## II. Assessment Results per Student Learning Outcome

Outcome 1: Perform basic operations of vectors in plane and space.

- Assessment Plan

    o   Assessment Tool: Mid semester and end of semester exams

    o   Assessment Date: Winter

    o   Course section(s)/other population: All course sections

    o   Number students to be assessed: Number of students to be assessed is approximately 50

    o   How the assessment will be scored:

    o   Standard of success to be used for this assessment:

    o   Who will score and analyze the data:

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) |
|---|---|---|
| 2018, 2017 | 2018, 2019 | 2018 |

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

| # of students enrolled | # of students assessed |
|---|---|
| 572 | 60 |

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.

Some course instructors did not turn in their students' final exams for assessment.

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.

> Out of the students' final exams collected, a sample of 60 students was selected from different sections for assessment.

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

> Two problems were used to assess students' learning of vector operations in plane and space. Each problem is graded on a 10-point scale: four points for concept / comprehension and six points for ability to work out the correct answers. Seven points or above is success; below seven points is failure. If the sum of both problems is 14 or higher, then it is a success.

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
>
> 42 students (70%) scored 14 or higher, while 18 students scored below 14. Overall, students' learning met the standard of success for this outcome.

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

> Most students can perform the basic operations of vectors.

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 students have difficulty understanding the nature of the quantities involved in the vector operations; for example, velocity is a vector quantity, speed is a scalar quantity (non-vector quantity) etc.


Outcome 2: Find domain, range, limits and partial derivatives of functions with more than one independent variable.

- Assessment Plan
  - Assessment Tool: Mid semester and end of semester exams

- o Assessment Date: Winter

- o Course section(s)/other population: All course sections

- o Number students to be assessed: Number of students to be assessed is approximately 50

- o How the assessment will be scored:

- o Standard of success to be used for this assessment:

- o Who will score and analyze the data:

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) |
|---|---|---|
| 2018 | 2019, 2018 | 2018 |

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

| # of students enrolled | # of students assessed |
|---|---|
| 453 | 60 |

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.

Some instructors did not turn in their students' final exams for course assessment.

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 sample of 60 students' final exams was selected from different sections for assessment.

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

Two problems were used to assess students' learning of vector operations in plane and space. Each problem is graded on a 10-point scale: four points for concept / comprehension and six points for ability to work out the correct answers. Seven points or above is success; below seven points is failure. If the sum of both problems is 14 or higher, then it is a success.

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>No</u> |
|---|
| 42/60 students (70%) could not correctly evaluate the limit of functions with two variables. Overall, the standard of success was not met for this outcome. |

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

| Most students could perform partial differentiations correctly using product rule or chain rule. |
|---|

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.

| Quite a number of students did not know how to find limits of functions with more than one variable. Limits of functions with multi-variables are more complicated than the limits of functions with one variable. Instructors need to show more examples to illustrate their differences and explain to students the proper way of finding limits of functions with multi-variables. |
|---|

Outcome 3: Graph functions of several variables.

- Assessment Plan
    - o  Assessment Tool: Mid semester and end of semester exams
    - o  Assessment Date: Winter
    - o  Course section(s)/other population: All course sections
    - o  Number students to be assessed: Number of students to be assessed is approximately 50
    - o  How the assessment will be scored:
    - o  Standard of success to be used for this assessment:
    - o  Who will score and analyze the data:

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) |
|---|---|---|
| 2018 | 2019, 2018 | 2018 |

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

| # of students enrolled | # of students assessed |
|---|---|
| 453 | 60 |

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.

Some instructors did not turn in their students' final exams for course assessment.

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.

60 students' final exams were selected for course assessment.

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

Problems [7] and [8] were used to assess students' learning of this outcome. Each problem is scored on a 10-point scale: Four points for coordinate system setup and six points for ability of completing all graph details correctly. If the sum of both problems is 14 or more, it is a success.

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: No

Some instructors modified problems [7] and [8] on their final exams, causing difficulty in assessing students' learning of this outcome. Roughly one third of students failed to meet this learning outcome.

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

Most students are used to graphing functions using a rectangular coordinate system.

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 need more work in graphing functions using cylindrical or spherical coordinate systems.

Outcome 4: Solve multiple integrals using an appropriate coordinate systems (rectangular, cylindrical, spherical).

- Assessment Plan

    o   Assessment Tool: Mid semester and end of semester exams

    o   Assessment Date: Winter

    o   Course section(s)/other population: All course sections

    o   Number students to be assessed: Number of students to be assessed is approximately 50

    o   How the assessment will be scored:

    o   Standard of success to be used for this assessment:

    o   Who will score and analyze the data:

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) |
|---|---|---|
| 2018 | 2019, 2018 | 2018 |

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

| # of students enrolled | # of students assessed |
|---|---|
| 453 | 60 |

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.

> Some instructors did not turn in their students' final exams for assessment.

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.

> 60 students were selected from different course sections for assessment.

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

Two problems (problems [7] and [8]) were used to assess students' learning on this outcome. Each problem was graded on a 10-point scale: four points for concept / comprehension and six points for ability to work out the correct answers. Seven points or above is success; below seven points is failure. If the sum of both problems is 14 or higher, then it is a success.

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: No

There were 40 students who scored 14 or higher and 20 students who scored below 14. Only 66% of students met the standard of success. Overall, students' performance was okay, but not as expected.

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

Most students are capable of evaluating multiple integrals in a rectangular coordinate system.

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 students have a difficult time selecting an easier coordinate systems to evaluate multiple integrals. Instructors need to show students how to use graphs to select the proper coordinate system for evaluating the multiple integrals.

Outcome 5: Solve selected applications problems, including using second partial derivatives test and the method of LaGrange Multiplers to find extrema of functions of more than one variable, finding surface area or volume using multiple integrals.

- Assessment Plan
    - Assessment Tool: Mid semesster and end of semester exams
    - Assessment Date: Winter
    - Course section(s)/other population: All course sections
    - Number students to be assessed: Number of students to be assessed is approximately 50
    - How the assessment will be scored:

o   Standard of success to be used for this assessment:

o   Who will score and analyze the data:

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) |
|---|---|---|
| 2018, 2017 | 2019, 2018 | 2018 |

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

| # of students enrolled | # of students assessed |
|---|---|
| 572 | 60 |

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.

Some instructors did not turn in their students' final exams for course assessment.

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.

60 students' final exams were selected from different course sections for assessment.

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

Four problems were used to assess students' learning for this outcome. These problems are divided into two groups. Group 3 includes problems [5] and [6] for applications of differentiation to find extrema of functions with multi-variables, such as 2nd Partial Test and Lagrange Multipliers Method. Group 5 consists of problems [9] and [10], for applications of integration in Vector Calculus, such as Divergence THM, Stoke's THM. Each problem is graded on 10-point scale: 7 points or above is success; below 7 points is failure. For each group, if the sum of both problems is 14 or more, then it is counted as success.

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: No

Students did much better in Group 3 than in Group 5. Learning outcomes in Group 3 met the standard of success, with 70% (42 of 60) of students scoring 14 or higher, while the learning outcomes in Group 5 did not meet the standard of success, as only 28% (17 of 60) scored 14 or higher.

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

Most students understand how to use differentiation to find maximum or minimum of functions with more than one variable.

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.

More efforts are needed to address applications in Vector Calculus, such as Green's Theorem, Divergence Theorem, Stoke's Theorem. Please see attached file "History and Issues in MTH 293" for more details and suggestions.

## 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.

Efforts have been made to improve students' learning of vector operations and derivatives of functions with more than one variable.

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?

Vector Calculus remains a critical part of our efforts for improvement.

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

As soon as possible.

4.
Intended Change(s)

| Intended Change | Description of the change | Rationale | Implementation Date |
|---|---|---|---|
| Other: increase course contact hours | Increase course contact hours from | Due to the amount of materials required to be | 2020 |

| | 4 hours per week to 5 hours per week. | covered, more time is needed to improve students' learning of Vector Calculus topics. Please see attached file "History and Issues about MTH 293" for details and explanation. | |
|---|---|---|---|

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

> 6.

## III. Attached Files

Assessment Summary
Issues about MTH 293
Assesment Problems

| | | | |
|---|---|---|---|
| **Faculty/Preparer:** | Yin Lu | **Date:** 08/17/2019 |
| **Department Chair:** | Lisa Manoukian | **Date:** 09/19/2019 |
| **Dean:** | Victor Vega | **Date:** 09/27/2019 |
| **Assessment Committee Chair:** | Shawn Deron | **Date:** 12/24/2020 |

| Discipline | Course Number | Title |
|---|---|---|
| Mathematics | 293 | MTH 293 07/17/2017-Calculus III |
| Division | Department | Faculty Preparer |
| Math, Science and Engineering Tech | Mathematics | Yin Lu |
| Date of Last Filed Assessment Report | | |

**I. Assessment Results per Student Learning Outcome**

Outcome 1: Perform basic operations of Vector Algebra.

- Assessment Plan

    o Assessment Tool: End of semester exam

    o Assessment Date: Winter 2017

    o Course section(s)/other population: All course sections

    o Number students to be assessed: A random sample of 20% of students enrolled or a minimum of 30 students

    o How the assessment will be scored: Departmentally-developed rubric

    o Standard of success to be used for this assessment: 70% of students sampled will score an average of 70% or higher on each exam question that addresses Outcome 1.

    o Who will score and analyze the data: Department

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 | 2017 | |

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

| # of students enrolled | # of students assessed |
|---|---|
| 180 | 30 |

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.

> There were some withdrawals. Some sections' final exams were not turned in. The actual number of final exams collected for the assessment is 130.

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.

> 20% of 130 is 26. Based on the assessment sample description given in the Course Master Syllabus above, a random sample of 30 final exams were selected for assessment.

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

> Problems 1, 2, and 3 of the departmental final exam were used for the assessment of this learning outcome. Each problem was scored on a 10-point basis, 5 points for concept and formula setup and 5 points for work and answers. A total score of 21 and above was considered a success, a score below 21 was considered a failure.

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: No
>
> There were 17 successes and 13 failures. The success rate was 57% (17/30).

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

> Most students are capable of performing basic vector operations such as addition, scalar multiplication, dot product and cross-product.

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.

> Need more effort in the following topics: finding orthogonal projection of vector u onto vector v, finding a vector orthogonal to 2 given vectors. finding volume of a parallelepiped, perform differentiation using chain rule.

> Suggestion for improvement: helping students develop skills in solving more application problems, such as finding area, volume, gaining better insight and intuition into vector formulas such as orthogonal projection and cross-product.

Outcome 2: Differentiate functions of several variables.

- Assessment Plan

    o Assessment Tool: End of semester exam

    o Assessment Date: Winter 2017

    o Course section(s)/other population: All course sections

    o Number students to be assessed: A random sample of 20% of students enrolled or a minimum of 30 students

    o How the assessment will be scored: Departmentally-developed rubric

    o Standard of success to be used for this assessment: 70% of students sampled will score an average of 70% or higher on each exam question that addresses Outcome 2.

    o Who will score and analyze the data: Department

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 | 2017 | |

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

| # of students enrolled | # of students assessed |
|---|---|
| 180 | 30 |

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.

> There were some withdrawals. Some sections' final exams were not turned in. The actual number of final exams collected for the assessment is 130.

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.

20% of 130 is 26. Based on the assessment sample description given in the Course Master Syllabus above, a random sample of 30 final exams were selected for assessment.

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

Problems 4, 5, and 6 on the departmental final exam were selected for the assessment of this outcome. Each problem is assessed on a 10-point basis; 5 points for formula setup and 5 points for work and answers. Total score is 30 points; 21 points and above (70% of 30 points) was considered a success and below 21 points was considered a failure.

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: No

There were 20 successes and 10 failures; the success rate was 20/30 which is 67%.

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

Most students are capable of taking partial derivatives of basic functions with multiple variables. Most students are capable of understanding the concept of 2nd partial derivative test.

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.

Need more practice in chain rule and using the method of Lagrange Multipliers to find maximum and minimum with constraints. Some students did have trouble understanding the Lagrange Multipliers method. Suggestion: using more graphics to help students visualize the geometric concepts involved in Lagrange Multipliers method.

Outcome 3: Integrate functions of several variables.

- Assessment Plan
  - Assessment Tool: End of semester exam
  - Assessment Date: Winter 2017

- o Course section(s)/other population: All course sections
- o Number students to be assessed: A random sample of 20% of students enrolled or a minimum of 30 students
- o How the assessment will be scored: Departmentally-developed rubric
- o Standard of success to be used for this assessment: 70% of students sampled will score an average of 70% or higher on each exam question that addresses Outcome 3.
- o Who will score and analyze the data: Department

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 | 2017 | |

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

| # of students enrolled | # of students assessed |
|---|---|
| 180 | 30 |

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.

There were some withdrawals and some sections' final exams were not turned in. Only 130 departmental final exams were collected.

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.

Out of 130 final exams, based on the Course Master Syllabus description, a minimum of 30 exams are selected for the assessment of the learning outcome.

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

Problems 7 and 8 of the departmental final exams are used for the assessment of this learning outcome. Each problem is scored on a 10-point basis (5 points for concept and formula setup, 5 points for work and answers). The total score is 20 points; a score of 14 and above is considered a success, and a score of below 14 is considered a failure.

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>No</u>

There were 11 successes and 19 failures, and the success rate was 37% (11/30).

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

Most students are capable of performing basic integration skills such as substitution method and integration by parts.

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.

Having some difficulty with [1] setting up iterated integrals in specific order of integration, [2] evaluate triple integrals with an appropriate coordinate system (rectangular, cylindrical or spherical).

Suggestion: helping students develop graphic skills to understand the geometry properties of the integration region, which helps to gain better understanding in evaluating the integrals.


Outcome 4: Perform calculations in Vector Calculus.

- Assessment Plan

    o Assessment Tool: End of semester exams

    o Assessment Date: Winter 2017

    o Course section(s)/other population: All course sections

    o Number students to be assessed: A random sample of 20% of students enrolled or a minimum of 30 students

    o How the assessment will be scored: Departmentally-developed rubric

    o Standard of success to be used for this assessment: 70% of students sampled will score an average of 70% or higher on each exam question that addresses Outcome 4

    o Who will score and analyze the data: Department

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 | 2017 | |

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

| # of students enrolled | # of students assessed |
|---|---|
| 180 | 30 |

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.

There were withdrawals and some sections' final exams were not turned in. 130 final exams were actually collected for the assessment.

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.

Based on the Course Master Syllabus, a sample of 30 students were selected for the assessment of this learning outcome.

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

Problems 9 and 10 of the departmental final exam are used for the assessment of this learning outcome. Each problem is scored on a 10-point basis; 5 points for concept and formula setup and 5 points for work and answers. A score of 14 and above is considered a success and below 14 is considered a failure.

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: No

There were 11 successes and 19 failures. The success rate was 37% (11/30).

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

This is an important chapter for the engineering major students, about 37% of students sampled are capable of applying Divergence Theorem (to find outward flux) and Stoke's Theorem (to find circulation flux).

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.

Having quite some difficulty with setting up flux integrals to find circulation flux (using Stoke's Theorem) and outward flux (using Divergence Theorem).

Suggestion for improvement: more discussion and homework practices.

## 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 is required by most engineering majors; students enrolled in this course would benefit from this course in their future study.

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

Any time after the report is completed.

3.
Intended Change(s)

| Intended Change | Description of the change | Rationale | Implementation Date |
|---|---|---|---|
| Other: class contact hours | Suggestion [1]: Increase the class contact hours from 4 hours per week to five hours per week. This would allow 10 to 14 extra contact hours per semester, which is very crucial for our students to better comprehend the contents of this course, especially for the last chapter "vector | Students need more time to comprehend the course materials. | 2018 |

| | calculus". As a transferable course, the last chapter "vector calculus" is required by most engineering, math and physics major students. Most of our instructors teaching MTH 293 support this idea.<br><br>Suggestion [2]: Offer a simpler version of Calculus 3 (with 4 contact hours per week) for non-engineering majors, who don't need vector calculus. This would help improve students learning success rate. | | |
|---|---|---|---|

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

## III. Attached Files

Assessment data file
MTH 293 Dept Final
MTH 293 F17 report note

**Faculty/Preparer:**       Yin Lu      **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:** 03/06/2018

| Discipline | Course Number | Title |
|---|---|---|
| Mathematics | 293 | MTH 293 05/14/2013-Calculus III |
| Division | Department | Faculty Preparer |
| Math, Science and Health | Mathematics | Yin Lu |
| Date of Last Filed Assessment Report | | |

**I. Assessment Results per Student Learning Outcome**

Outcome 1: Perform basic operations of Vector Algebra.

- Assessment Plan

    o Assessment Tool: End of semester exam

    o Assessment Date: Fall 2011

    o Course section(s)/other population: All course sections

    o Number students to be assessed: Twenty percent of students enrolled - approximately 20

    o How the assessment will be scored: Departmentally-developed rubric

    o Standard of success to be used for this assessment: 70% of students sampled will score an average of 70% or better on exam items that address Outcome 1.

    o Who will score and analyze the data: Department

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) |
|---|---|---|
| | | 2012 |

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

| # of students enrolled | # of students assessed |
|---|---|
| 93 | 20 |

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.

Based on the assessment plan, 20% of the students enrolled in the course would be assessed, out of 93 students enrolled, this amounts to about 20 of 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.

Spring-Summer 2012 MTH 293 was only offered in face-to-face lecture format, at the main campus. 10 students were selected from N1 section, 10 students were selected from N2 section.

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

Students were asked to find the volume of a parallelepided using three given vectors with a common vertex. Students need to know how to apply the dot product and cross product of vectors to work out the answer. Work must be shown on [1] how to setup a correct formulas for the volume of parallelepiped, and [2] how to work out the correct answer with or without using a TI-83+/84+ calculator. Grading scale: 1 thru 10, with 7 as standard of success.

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

Out of 20 students assessed, 17 scored over 7, 3 scored below 7. Success rate: 85%. The standard of success on this outcome was met (as proposed on the course master syllabus).

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

Most students were capable of performing the basic operations of Vector Algebra, either by long-hand calculation or with the aid of a TI-84+ 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.

More continuing emphasis should be put on the applications of vector algebra, these are very useful skills for engineering majors. Suggested plan: add more homework and quizzes on these topics, such as finding the area of triangles, area of parallelograms, volume of parallelopiped, distance from a point to a plane, etc.

Outcome 2: Differentiate functions of several variables.

- Assessment Plan

    o Assessment Tool: End of semester exam

    o Assessment Date: Fall 2011

    o Course section(s)/other population: All course sections

    o Number students to be assessed: Twenty percent of students enrolled -
      approximately 20

    o How the assessment will be scored: Departmentally-developed rubric

    o Standard of success to be used for this assessment: 70% of students sampled
      will score an average of 70% or better on exam items that address Outcome
      2.

    o Who will score and analyze the data: Department

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) |
|---|---|---|
| 2011 | | |

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

| # of students enrolled | # of students assessed |
|---|---|
| 66 | 20 |

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.

   Based on the assessment plan from MTH 293 Master Syllabus, 20 students in this
   course would be assessed.

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.

   Fall 2011 semester MTH 293 was only offered in face-to-face lecture format. All
   students assessed were selected from lecture classes.

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

   In order to find the limit of a function of more than one independent variable,

students must show only one of the following: [1] if a limit exists, all paths converging to the limit point must lead to a same limit answer, or [2] if a limit does not exist, at least two paths must be found where limit answers are not equal.

The grading scale is 1 thru 10. 5 points for concepts, 5 points for calculation and support work. 7 points and above is success, below 7 is failure.

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

14 out of 20 students assessed had shown enough understanding of the learning objectives, the success rate of the outcomes was 70%. The standard of success was met for this outcome and tool.

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

Most students did okay on computation.

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.

Conceptual comprehension seemed weaker than computation. Need more emphasis on concept discussion. Suggested plan: require students to justify their answers/conclusions whenever possible.

Outcome 3: Integrate functions of several variables.

- Assessment Plan

    o Assessment Tool: End of semester exam

    o Assessment Date: Fall 2011

    o Course section(s)/other population: All course sections

    o Number students to be assessed: Twenty percent of students enrolled - approximately 20

    o How the assessment will be scored: Departmental rubric

    o Standard of success to be used for this assessment: 70% of students sampled will score an average of 70% or better on exam items that address Outcome 3.

- o   Who will score and analyze the data: Department

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) |
|---|---|---|
| 2012 | | |

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

| # of students enrolled | # of students assessed |
|---|---|
| 66 | 20 |

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.

Based on the assessment plan, we assessed 20 students, out of the total 66 students enrolled in this course.

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.

Only lecture sessions were offered in Fall 2012 semester, all students assessed were selected from the lecture (face-to-face) sections.

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

Assessment Tool: Require students, using an appropriate technique, to integrate a function of more than one variable. Students need to perform a change of order of integration so the integral can be solved. Grading scale: 1 thru 10, 4 points for correctly switching the order of integration, 6 points for the support work of the integration process. Scores 7 -- 10 are considered successes, scores below 7 are considered as failures.

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

There were 17 successes, 3 failures. With a success rate of 85%, most students assessed did show good understanding of the course objectives related to this learning outcome.

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

Most students understood interchanging the order of integration would be useful for solving the multiple integrals.

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.

Need  more emphasis on making sketches as an important part of the solving process. Most students who failed did not know how to make a proper sketch to help solve the problem.

Outcome 4: Perform calculations in Vector Calculus.

- Assessment Plan

    o   Assessment Tool: End of semester exams

    o   Assessment Date: Fall 2011

    o   Course section(s)/other population: All course sections

    o   Number students to be assessed: Twenty percent of students enrolled - approximately 20

    o   How the assessment will be scored: Departmental rubric

    o   Standard of success to be used for this assessment: 70% of students sampled will score an average of 70% or better on exam items that address Outcome 4.

    o   Who will score and analyze the data: Department

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) |
|---|---|---|
|  | 2012 |  |

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

| # of students enrolled | # of students assessed |
|---|---|
| 65 | 20 |

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.

> Only lecture format sections were offered on main campus; all students assessed were selected from lecture sections.

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.

> Based on the assessment plan, 20 of a total of 65 students enrolled were assessed.

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

> Tool: Require students to solve a system of differential equations in vector form. In order to successfully work out the correct answers, students need to be able to perform the basic operations of vector calculus correctly. Grading scale: 1 thru 10, of the major steps in the work, each weighed 5 points, scores 7 and above are considered as successes, scores below 7 are considered as failures.

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>No</u>
>
> There were 12 successes, 8 failures, success rate: 60%, standard of success was not met. As most of the failures were scored about 1 to 2 points below the passing standard, it shows that we need more effort to achieve an improvement in this learning objective, and this can be done.

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

> There were two parts in this work process, the 2nd part is based on the correct results of the first part. Those who succeeded have good understanding of this connection.

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.

> Need more discussion and HW practices. Most of the failures are caused by lack of practices.

**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?

   > The course is required by most engineering majors, students enrolled in this course would benefit from their learning in this course. The assessment results support this conclusion.

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

   > Any time after the report is done.

3. 
   Intended Change(s)

   | Intended Change | Description of the change | Rationale | Implementation Date |
   |---|---|---|---|
   | No changes intended. | | | |

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

## III. Attached Files

[Assessment Results](Assessment Results)

**Faculty/Preparer:** Yin Lu      **Date:** 5/21/13
**Department Chair:** Kristen Good      **Date:** 5/22/13
**Dean:** Martha Showalter      **Date:** 6/13/13
**Assessment Committee Chair:** Michelle Garey      **Date:** 7/16/13

**COURSE ASSESSMENT REPORT**

## I. Background Information

1. Course assessed:
   Course Discipline Code and Number: MTH 293
   Course Title: Calculus 3
   Division/Department Codes: MNB / MTHD

2. Semester assessment was conducted (check one):
   ☒ Fall 2006
   ☒ Winter 2007
   ☐ 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):
   ☒ Other (specify): quizzes, exams.

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

   If yes, have the tools been altered since its last administration? If so, briefly describe changes made.
   The idea remained much the same, but a new set of assessment problems were selected to assess the course objectives as stated on the updated course master syllabus (see notes about the selection of each assessment problem), the problems were handed to each section instructor, who administered the problems to the students though course exams and quizzes. Answers and work from the students were collected and graded by the instructor, then submitted to the course mentor for further analysis.

5. Indicate the number of students assessed/total number of students enrolled in the course.
   Fall 2006 semester: 35 students, Winter 2007 semester: 25 students.

6. Describe how students were selected for the assessment.
   Since this is a general course assessment, all students taking the course would be assessed. However, an individual course section instructor could do follow up assessment if they would like to do it.

## II. Results

1. Briefly describe the changes that were implemented in the course as a result of the previous assessment.
   The last assessment was done about five years ago; this assessment was done after the update of the course master syllabus. As consequences, this assessment responded more to the changes and course objectives listed on the new course master syllabus (please see the attached copy of the updated course master syllabus).

2. State each outcome (verbatim) from the master syllabus for the course that was assessed.
   Please refer to the attached page of Fall 2006 Assessment Problems.
   Problem [1] assessed Master Course Syllabus course outcome [3]: graph functions of several variables.
   Problem [2] assessed course outcome [2] of the Course Master syllabus: find partial derivatives of functions with more than one independent variable.
   Problem [3] responds to course outcome [5] of the Course Master syllabus: find extrema of functions of more than one variable.
   Problem [4] responds to course outcome [4] of the Course Master syllabus: solve multiple integrals using an appropriate coordinate system.
   Problem [5] responds to course instructional objective [9]: perform basic operation and selected applications of vector calculus.

**COURSE ASSESSMENT REPORT**

*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.*

Problems [1] [2] [3] [4] were given in quizzes and exams, problem [5] was also given but no results nor artifacts were collected. Most students did OK on problems [1] [3] [4], but did not do well on problem [2]. These problems were chosen to assess the students' learning at different stages of the course, a goal in this assessment is to find out how the results from this assessment could be used to improve future teaching of this course.

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.*

For each problem or outcome assessed, students must score at least 17.5 points (which is 70% of the full credit 25 points) to be judged successful. Please see the attached pages of assessment scores summary.
Prob [1], student success rate:  44 out of 60, which is an equivalent of 73%.
Prob [2], student success rate:  8 out of 60, which is an equivalent of 13%.
Prob [3], student success rate:  33 out of 60, which is an equivalent of 55%.
Prob [4], student success rate: 37 out of 60, which is an equivalent of 62%.
Prob [5], not enough data collected to support a reasonable conclusion.

5. Describe the areas of strength and weakness in students' achievement of the learning outcomes shown in assessment results.

Strengths: Capable of doing basic graphs, performing calculation work (as shown by the results of problems [1] [3] [4]).

Weaknesses: Less capable of doing symbolic work or solving critical thinking type problems, such as deriving a formula, proving / disproving a mathematical statement, etc (as shown by the results of problem [2]).

## 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.

Need to emphasize more on doing critical thinking type assignments or activities.

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:  More reasoning type assignments, besides direct calculation type assignments.

　　f. ☐ Course materials (check all that apply)
　　　　☐ Textbook
　　　　☐ Handouts
　　　　☐ Other:

    g. ☒ Instructional methods
       Change/rationale: More emphasis on teaching students to organize thoughts and present their solution work. I think this is a good way to help students improve their ability of critical thinking.

    h. ☐ Individual lessons & activities
       Change/rationale:

3.   What is the timeline for implementing these actions?
      Beginning from the Winter 2009 semester.

**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.
      Due to other factors, such as student's absences during the assessment, the data collected may not effectively reflect the student achievement of learning outcomes for this course (please see remarks on the attached pages of assessment scores).

2.   If the assessment tools were not effective, describe the changes that will be made for future assessments.
      The assessment methods must be changed and the assessment problems made part of the course exams, rather than have the students do them as bonus problems, take-home homework or quizzes. This would force students to be serious about the assessment and eliminate the uncertainty factors such as absences, lack of motivation, etc, making the assessment results more complete and accountable.

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

      If "Selected", provide the report date for remaining outcomes:  Winter 2009 Semester.

**Submitted by:**

Name: _____Yin Lu_____ _____Yin Lu_____ Date: __9-2-2008__
      Print/Signature

Department Chair: __Kristin Chatas__ __Kristy Chat__ Date: __9-22-2008__
      Print/Signature

Dean: __M. Shouals__ Date: __SEP 2 2 2008__
      Print/Signature