Bergen Community College

Assessment Report for 2008-2010

Department/Program: Mathematics / A.S. Degree

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Liaison: Dr. Randolph Forsstrom

Assessment Project Coordinator (if not the Department Leader): Dr. Ruth Feigenbaum

Date Submitted: March 4, 2010

Program(s), if applicable (AAS, Interdepartmental, etc.):

Associate in Science (A.S.) Degree in Mathematics

Mission/Goal statement of the department or program:

See Appendix II

SEMESTER 1: Create the Assessment Plan

Goal or learning objective being assessed:

Students completing MAT-280 Calculus I will be able to construct mathematical representations (models) of real-world applications (see Appendix I)

Relevant Core Competencies: (check as many as apply)

☐ Communication	☐ Quantitative Reasoning	☒ Critical Thinking
☐ Civic Responsibility	☐ Technological and Information Fluency	☐ Personal Skills
☐ Interpersonal Skills	☒ Creativity and Aesthetic Appreciation	☐ Applied Knowledge

Means of Assessment:

Students in selected sections of MAT-280 Calculus I will complete a (common) set of assignments that will require the students to construct mathematical representations (models) for various applications that involve calculus-based techniques.

The faculty involved with the assessment of MAT-280 Calculus I will develop a grading rubric for the assignments to ensure consistent evaluation of student performance across the various sections of the course.

SEMESTER 2: Develop an Assessment Strategy

Criterion for success:

The mean score for the students engaged in the construction of correct mathematical representations (models) for the real-world applications will be at least 75%.

Dean's Comments:

VP's Comments:

SEMESTER 3: Implement Assessment Plan & Strategy

Summary and analysis of data collected:

78 students from four different sections of MAT-280 Calculus I participated in the assessment study. Each student was required to complete six problems that required the construction of a mathematial model for a real-world application.

The following results were obtained:

Application - Model	Points	Mean Score	Percent Grade
Labeled Diagram	2	1.59	80%
Primary Equation	1	0.74	74%
Secondary Equation(s)	2	1.42	71%
Total points	5	3.75	75%

(The Summary should appear here. Use attachments only to provide information to support the summary.)

SEMESTER 4: Reporting and Revising

Use of results:

The application of calculus-based techniques to analyze and solve optimization problems is one of the core components of a calculus I course. In this assessment study, the faculty who participated in the study were able to segment the problem solution process so that it became possible for them to identify the degree to which students are able to master each of the various sub-tasks that are involved rather than to just obtain one overall measure of the process as a whole. As a result of this segmentation, the faculty were able to acquire much more insight as to the degree of difficulty that students experience with each individual sub-task of the solution process which in turn allowed them to identify where more time needs to be devoted to explaining and developing the particular sub-task.

In this first stage of the solution process the overall task is to create a mathematical model to represent a real-world application. With regard to the criterion for success, the overall mean grade of 75% indicated a success for the task as a whole and that the construction of secondary equaton(s) is clearly the most difficult subtask for the students. As a result of these findings, the faculty involved with teaching calculus I will now be able to focus more on this particular sub-task and to attempt to identify the factors that are contributing to student difficulty with it.

Dean's Comments:

VP's Comments:

Assessment: MAT-280 Calculus I

Optimization Problems – Grading Rubric

The following grading rubric should be used in order to ensure consistent grading for all students involved in the assessment study.

Optimization Problems: Application – model

Task	Points
labeled diagram (includes all variables and/or constants)	2
provides an accurate representation of the application	
primary equation (objective function)	1
expressed as a function of the variables and/or constants represented in the diagram.	
secondary equations (constraints)	2
each expressed in terms of the variables and/or constants represented in the diagram.	
Total:	5

Optimization Problems: Synthesis - formulate

Task	Points
primary equation as a function of one variable	3
proper use of the secondary equations to obtain a simplified expression for the primary equation (objective function) as a function of one variable.	
specified interval for the variable	2
proper identification of the endpoint(s) or the proper open interval for the variable in the primary equation.	
Total:	5

Optimization Problems: Analysis – analyze

Task	Points
identification of all critical values	2
proper use of the first derivative to identify all critical values and exclusion of any critical value(s) that are not contained in the defined interval for the variable in the primary equation.	
determination of the absolute maximum and minimum	3
proper use of the Extreme Value Theorem or the second derivative test to identify the absolute maximum and the absolute minimum on the defined interval and proper identification of all variables in the solution to the application.	
Total:	5

Appendix I

MAT-280 Calculus I

Name: ______________________________

Optimization Problems: **Application - model**

Directions:
Given the problem specification, construct a labeled diagram (identify all variables in the diagram), write the primary equation (the function to be maximized or minimized), and write all of the secondary equations that represent relations between variables in the problem. Do nothing else.

1. A company makes a block of cheese designed to have the height exactly five times the width. If they want a block of 1800 cubic mm, determine the dimensions which would minimize the surface area.

2. Determine the dimensions of a rectangle of maximum area if the perimeter is to be 1000 meters.

3. A farmer wants to fence off land along a river into five equal areas by using one section of fence parallel to the river and six sections perpendicular to it. If the outer fence cost $ 9 per meter and the inner fence cost $ 6 per meter, determine the dimensions to maximize the total area if $ 9,000 is available to purchase fence (assume that the river is straight and that no fence is required along the river).

4. A cardboard box manufacturer wants to make open top boxes from pieces of cardboard that are 12 square inches by cutting out equal size squares from the four corners and then turning up the sides. Determine the length of the side of the square to be cut out in order to obtain a box of maximum volume.

5. A circular cylindrical metal container, open at the top, is to have a capacity of 24 PI cubic inches. The cost of the material used for the bottom of the container is 15 cents per square inch, and that of the material used for the curved side part is 10 cents per square inch. If there is no waste of material, find the dimensions that will minimize the cost of the material.

6. A wire 60 inches long is to be cut into two pieces. One of the pieces will be bent into the shape of a circle and the other into the shape of an equilateral triangle. Where should the wire be cut so that the sum of the areas of the circle and triangle is minimized ?

MAT-280 Calculus I

Name: ______________________________

Optimization Problems: **Synthesis - formulate**

Directions:
Given the problem specification, the labeled diagram, the primary equation, and the secondary equations, write the primary equation (the function to be maximized or minimized) as a function of one variable and identify the interval that corresponds to that variable. Do nothing else.

1. A farmer wants to fence off land along a river into four equal areas by using one section of fence parallel to the river and five sections perpendicular to it. If the outer fence cost \$ 3 per meter and the inner fence cost \$ 2 per meter, determine the dimensions to maximize the total area if \$ 6000 is available to purchase fence (assume that the river is straight and that no fence is required along the river).

```
                 river
      ---------------------------------
  W   |       |       |       |       |
      |       |       |       |       |
      ---------------------------------
                   L
```

Primary equation: Total area $= A = L\,W$

Secondary equations:

Cost = \$ 3 (outer fence) + \$2 (inner fence)

$$
\begin{aligned}
\$\,6000 &= 3\,(2W + L) + 2\,(3W) \\
&= 6W + 3L + 6W \\
&= 12W + 3L
\end{aligned}
$$

reduce: $2000 = 4W + L$

2. A circular cylindrical metal container, open at the top, is to have a capacity of 24 PI cubic inches. The cost of the material used for the bottom of the container is 15 cents per square inch, and that of the material used for the curved side part is 10 cents per square inch. If there is no waste of material, find the dimensions that will minimize the cost of the material.

Primary equation: $C = 15 \quad r^2 + 10 (2 \quad r h)$

Secondary equation: $r^2 h = 24$

3. A rectangle is to be formed with a perimeter of 1000 meters. Determine the dimensions in order to maximize the total area.

```
                 L
          ---------------------
      W  |                     |
         |                     |
          ---------------------
```

Primary equation: total area = L W

Secondary equation: perimeter = 2 (L + W) = 1000

4. A company makes a block of cheese designed to have the height exactly five times the width. If they want a block of 1800 cubic mm, determine the dimensions which would minimize the surface area.

```
            _________
           /        /|
          /        / |
         /        /  /
        /_______ /  /
       |        |  /  L
   H   |        | /
       |        |/
        --------
          W
```

Primary equation: surface area = 2 (L W + L H + W H)

Secondary equations: volume = L W H = 1800

H = 5 W

5. A publisher wants to print the pages of a book with one inch margins at the top and bottom, and one-half inch margins on the sides. The publisher is willing to vary the page dimensions, subject to the condition that the area of the page is 50 square inches. Determine the dimensions that will maximize the printed area of the page.

```
                     W
         ---------------------------
        |          1''              |
        |     -----------------     |
    L   | ½''|                 | ½''|
        |     -----------------     |
        |          1''              |
         ---------------------------
```

Primary equation: printed area = $(W - 1)(L - 2)$

Secondary equation: page area = $L W = 50$

6. A wire 60 inches long is to be cut into two pieces. One of the pieces will be bent into the shape of a circle and the other into the shape of an equilateral triangle. Where should the wire be cut so that the sum of the areas of the circle and triangle is minimized ?

Primary equation: total area = $\pi r^2 + \frac{\sqrt{3}}{4} s^2$

Secondary equation: $2 \pi r + 3 s = 60$

MAT-280 Calculus I

Name: ______________________________

Optimization Problems: **Analysis – analyze**

Directions:
Given the mathematical problem, determine the solution(s) using calculus-based techniques.

1. Determine the absolute maximum value of:

$$A = f(w) = 2000\,w - 4\,w^{2} \qquad \text{on: } [\,0,\ 500\,]$$

2. Determine the absolute minimum value of:

$$C = f(x) = 5\,x^{2} + \frac{1250}{x} \qquad \text{on: } x > 0$$

3. Determine the absolute maximum value of:

$$V = f(x) = (16 - 2\,x)(24 - 2\,x)\,x \qquad \text{on: } [0,\ 8\,]$$

4. Determine the absolute maximum value of:

$$P = f(r) = \frac{1000\,r}{[\,200 + r\,]^{2}} \qquad \text{on: } r > 0$$

5. Determine the absolute minimum value of:

$$S = f(w) = 10\left[\,\frac{432}{w} + w\,\right] \qquad \text{on: } w > 0$$

6. Determine the absolute maximum of:

$$A = f(s) = \pi\left[\frac{60 - 3\,s}{2\,\pi}\right]^{2} + \frac{\sqrt{3}}{4}\,s^{2} \qquad \text{on: } [\,0,\ 20\,]$$