George Mason University Korea
MATH 108 (Introduction to Calculus with Business Applications)
- Fall 2022 (In-Person)

Syllabus

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Office</th>
<th>Tel</th>
<th>e-mail</th>
<th>Common Office Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. C. Kim</td>
<td>Mason Bldg</td>
<td>ext 555</td>
<td><a href="mailto:ckim50@gmu.edu">ckim50@gmu.edu</a></td>
<td>4:00-4:50 on Monday, Wednesday</td>
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<td>Zoom ID: 954 6188 4697</td>
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<td></td>
<td>(On-Line and In-Person)</td>
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<td>4:30-5:20 on Thursday or by Appointment</td>
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<td>Zoom ID: 936 0196 0496</td>
</tr>
</tbody>
</table>

Course Objectives: (by the Catalog http://catalog.gmu.edu/course-search/?subject=MATH)

1. To develop a facility with the concepts and techniques of differential and integral calculus.
2. The material covered will be: various methods of integration, conic sections, parametric equations, infinite series, and power series.
3. To provide a strong foundation in calculus as preparation for subsequent courses in mathematics and many other disciplines.
4. To improve the student’s analytic thinking, quantitative reasoning and problem-solving ability.

Learning Objectives: At the end of this course, the successful student will be able to

1. Develop analytical and numerical expressions using real problems.
2. Students are able to interpret quantitative information and draw inferences from them.
3. Given a quantitative problem, students are able to formulate the problem quantitatively and use appropriate arithmetical, algebraic, and combinatorial methods to solve the problem.
4. Apply appropriate mathematics principles to evaluate expressions, and find and test potential solutions.
5. Students are able to evaluate logical arguments using various calculus computations.
6. Apply basic algebraic mathematics and computations to solve Quantitative problems.

Textbook:


Other Resources:

1. The Math Tutoring Centre is located 6th floor, GMU building. Help is available on a walk-in bases with an appointment.

Teaching Mode: 3 hours of Lectures per week (Classroom: G101)

Evaluation: (All of evaluations should be in-person.)

- 25% Test #1 (75 minutes) 17:00 - 18:15, Sep. 28th, 2022. (in-class test, new material only)
- 25% Test #2 (75 minutes) 17:00 - 18:15, Nov. 2nd, 2022. (in-class test, new materials only)
- 25% Test #3 (75 minutes) 16:00 - 17:15, Dec. 12th, 2022. (in-class test, new material only)
- 10% Participation during classes: M/C Pop Quizzes, T/F Questions, Participation during the classes via Zoom
- 15% Recitation with Tutor in Mathematic Tutoring Center or Instructor

1 ver. 2: Revised on August 15th, 2022.
2 There is a tentative schedule for tests below. You are responsible for keeping up with all information announced in the classroom and on Blackboard. There will be no makeup tests. You may replace your (officially approved) missed test grade with your final exam percentage.
3 There will be no lecture on the test dates.
Missed Tests

1. Students who are unable to be present for a midterm due to illness, must contact the instructor by email or in person prior to the time of the evaluation or within the time period stated in academic policy.

2. Students who miss a test will NOT be given the opportunity to write a make-up test. Failure to provide the appropriate documentation in time will lead to a grade of zero for the missed evaluation.

Honor Code

1. It is mandatory that each student's conduct is within the guidelines of the George Mason Honor Code.

2. Sharing information of any kind about tests, exams, quizzes will result at a minimum in a grade of zero for all parties involved.

3. Violations will also be reported to the university Honor committee where further consequences such as expulsion from the university may be incurred.


Evaluation Guideline

1. All of the tests will be closed-book and written without calculators or any other aids.

2. There will be no supplemental test.

3. Grades will be assigned as indicated in the George Mason Academic Calendar.

4. Any tests written in pencil or erasable pen are ineligible for remarking.

5. There is no intrinsic reason for giving a non-zero mark for an incorrect solution. Part marks (if any) are awarded entirely at the examiner’s discretion. If a test is submitted for re-marking, the whole test may be re-marked. The result may possibly be that the student receives a lower mark on any or all questions.

6. Students are responsible for completing all recommended homework in a timely fashion as the course progresses. Homework must be kept organized and legible as it may be recalled for marking as part of the student’s evaluation.

7. Talking to another student, glancing over another student’s paper or being caught with non-allowed materials during an evaluation may result in a zero mark for that evaluation and a record of academic misconduct lodged with the Registrar’s office.

8. During an evaluation sharing of pencils, pens or erasers is NOT PERMITTED and PDAs, phones and pagers must be turned off and out of reach.

9. During any evaluation, coats, jackets and bags must be placed out of reach.

Other Resources

The Math Tutoring Centre: The Academic Resource Center, GMUK is in the business of looking at your papers and problems to improve your academic achievement in the area of Writing, Mathematics, Accounting, Statistics, and Economics. You are invited to utilize the faculty and student tutor services at a variety of stages in your academic activities. They do help you become conscious of particular error patterns that emerge in your work. For more information, please contact Professor Eunmee Lee, director of Academic Resource Center (ellee45@gmu.edu, office #621).
Disability Services

Reasonable accommodations are available for students who have a documented disability. Please contact Disability Services if you require accommodations: Mason Korea Student Care at GMUK Office of Disability Services, Student Union Building I (SUB I), room 4205, Phone: 703-993-2474

Counseling & Psychological Service (CAPS)

1. (Fairfax Campus) Counseling and Psychological Services provides a wide range of free services to students. Individual and group therapy, workshops, online self-help, and community education programs are designed to enhance students’ personal experience and academic performance. (703) 993-2380; http://caps.gmu.edu

2. (Songdo Campus) Individual counseling is available. You may schedule an appointment here: Appointments. Group counseling is available. If you are interested in group counseling, please email wellness@gmu.edu or call +82-32-626-6142 to schedule a consultation. Please be aware that you may be asked to reschedule your appointment due to time constraints if you are more than 10 minutes late. To schedule an online appointment: https://appointmentwithjan.as.me

Regarding electronic devices

Please be respectful of your peers and your instructor and do not engage in activities with electronic devices such as laptops, tablets, cell phones, etc. that are unrelated to class. Such disruptions show a lack of professionalism and it will affect your participation grade. Cell phones shall be set to silent/vibrate and placed out of sight when not used for class activities, and especially during exams and quizzes.

Diversity

You are expected to behave in accordance with the GMU Diversity Statement: http://ctfe.gmu.edu/professional-development/mason-diversity-statatement/

Privacy

Students must use their masonlive email account to receive important University information, including messages related to this class. See http://masonlive.gmu.edu for more information.

Student Care

Mason Korea Student Care is committed to providing an empowering environment for all Mason students to seek support services and to explore healthy life choices. We offer educational programming, one-on-one consultations, and resources in the areas of disability services, sexual and interpersonal violence, financial well-being, substance use, and collegiate recovery. We also assist students in encountering barriers to personal success. Please email Mason Korea-related inquiries to spark214@gmu.edu.

For emergencies after the normal business hour (Mon-Fri 9 AM to 5 PM), you can contact 032-626-5119. NOTE: If you are reporting a situation involving an imminent threat of harm to self or others, please the Police at 119 first.
# Course Contents & Schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Dates</th>
<th>Topics</th>
<th>Text Book</th>
<th>Recommended Problems</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td></td>
<td></td>
<td></td>
<td><strong>Section 1.1</strong>: # 36, 52, 74, 80, 88.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Section 1.2</strong>: # 26, 28, 38, 46, 54, 70.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Section 1.3</strong>: # 18, 22, 24, 32, 40, 46, 54, 70, 72, 84.</td>
</tr>
<tr>
<td>01</td>
<td>0822</td>
<td>Functions</td>
<td>1.1-3</td>
<td><strong>Section 1.4</strong>: # 9, 17, 27, 39, 45, 60.</td>
</tr>
<tr>
<td></td>
<td>0824</td>
<td>Various</td>
<td>1.1-3</td>
<td><strong>Section 1.5</strong>: # 17, 19 D), 25, 31, 33, 39, 53, 60.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Function</td>
<td>1.4</td>
<td><strong>Section 1.6</strong>: # 9, 15, 21, 27, 33, 49, 53, 77.</td>
</tr>
<tr>
<td>02</td>
<td>0829</td>
<td>Exp. Ft</td>
<td>1.5-6</td>
<td><strong>Section 1.7</strong>: # 16, 22, 33, 45, 54.</td>
</tr>
<tr>
<td></td>
<td>0831</td>
<td>Log Ft</td>
<td>1.5-6</td>
<td><strong>Section 1.8</strong>: # 8, 15, 23, 46.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Section 1.3</strong>: # 18, 22, 24, 32, 40, 46, 54, 70, 72, 84.</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td><strong>Section 1.4</strong>: # 9, 17, 27, 39, 45, 60.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Section 1.5</strong>: # 17, 19 D), 25, 31, 33, 39, 53, 60.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Section 1.6</strong>: # 9, 15, 21, 27, 33, 49, 53, 77.</td>
</tr>
<tr>
<td>03</td>
<td>0905</td>
<td>Trig. Ft</td>
<td>1.7-8</td>
<td><strong>Section 1.7</strong>: # 16, 22, 33, 45, 54.</td>
</tr>
<tr>
<td></td>
<td>0914</td>
<td></td>
<td></td>
<td><strong>Section 1.8</strong>: # 8, 15, 23, 46.</td>
</tr>
<tr>
<td>04</td>
<td>0919</td>
<td>Limit</td>
<td>2.1-2</td>
<td><strong>Section 2.1</strong>: # 27, 45, 53, 63, 77, 83.</td>
</tr>
<tr>
<td>05</td>
<td>0926</td>
<td>Derivative</td>
<td>2.4-5</td>
<td><strong>Section 2.2</strong>: # 9, 11, 13, 15, 23, 35(C), 39(C), 47, 59, 63.</td>
</tr>
<tr>
<td></td>
<td>0928</td>
<td></td>
<td></td>
<td><strong>Section 2.3</strong>: # 27, 39, 53, 61, 63, 75, 95.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Section 2.4</strong>: # 9, 13, 31, 33, 37, 41, 57, 71, 73, 75, 81, 87.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Section 2.5</strong>: # 47, 55, 59, 81, 91.</td>
</tr>
<tr>
<td>06</td>
<td>1004</td>
<td>Differential</td>
<td>2.6</td>
<td><strong>Section 2.6</strong>: # 27, 29, 31, 37, 39, 47.</td>
</tr>
<tr>
<td>07</td>
<td>1010</td>
<td>No Class</td>
<td>3.2-3</td>
<td><strong>Section 2.7</strong>: # 21, 23, 25, 33, 37, 45.</td>
</tr>
<tr>
<td></td>
<td>1012</td>
<td>Derivatives</td>
<td></td>
<td><strong>Section 2.8</strong>: # 21, 23, 25, 33, 37, 45.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Section 3.2</strong>: # 19, 21, 33, 37, 51, 53, 69, 71.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Section 3.3</strong>: # 23, 25, 31, 33, 39, 41, 47 A-D.</td>
</tr>
<tr>
<td>08</td>
<td>1017</td>
<td>Rules</td>
<td>3.4</td>
<td><strong>Section 3.4</strong>: # 19, 31, 37, 43, 47, 51, 53, 57, 63, 65, 69, 71, 83, 85, 93 A.C.</td>
</tr>
<tr>
<td></td>
<td>1019</td>
<td>Chain Rule</td>
<td>3.5</td>
<td><strong>Section 3.5</strong>: # 23, 27, 31, 37, 39, 45, 47, 55, 61, 62, 77, 87, 89, 93 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Section 3.6</strong>: # 27, 29, 34, 35, 49, 51, 55, 57.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Section 3.7</strong>: # 11, 17, 23, 25, 33, 35, 41.</td>
</tr>
<tr>
<td>09</td>
<td>1024</td>
<td>Implicit</td>
<td>3.6</td>
<td><strong>Section 3.8</strong>: # 11, 13, 23, 31, 43, 61, 77, 85, 87.</td>
</tr>
<tr>
<td>10</td>
<td>1031</td>
<td>EOD</td>
<td>3.8</td>
<td><strong>Section 3.9</strong>: # 11, 13, 23, 31, 43, 61, 77, 85, 87.</td>
</tr>
<tr>
<td></td>
<td>1102</td>
<td>Test #2</td>
<td></td>
<td><strong>Section 3.10</strong>: # 11, 13, 23, 31, 43, 61, 77, 85, 87.</td>
</tr>
<tr>
<td>11</td>
<td>1107</td>
<td>Graphing</td>
<td>4.1-2</td>
<td><strong>Section 4.1</strong>: # 41, 45, 55, 69-74, 89.</td>
</tr>
<tr>
<td></td>
<td>1109</td>
<td>l'Hopital's</td>
<td>4.3</td>
<td><strong>Section 4.2</strong>: # 13-16, 21, 35, 39, 63, 71, 87, 91.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Section 4.3</strong>: # 15, 23, 29, 37, 51, 55, 65.</td>
</tr>
<tr>
<td>12</td>
<td>1114</td>
<td>Sketching</td>
<td>4.4</td>
<td><strong>Section 4.4</strong>: # 9, 21, 33, 45, 51, 55, 79, 85.</td>
</tr>
<tr>
<td></td>
<td>1116</td>
<td>Optimization</td>
<td>4.5-6</td>
<td><strong>Section 4.5</strong>: # 33, 41, 49, 55, 61, 65, 71, 76, 79.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Section 4.6</strong>: # 21, 25, 27, 33, 39, 45.</td>
</tr>
<tr>
<td>13</td>
<td>1121</td>
<td>Antiderivative</td>
<td>5.2</td>
<td><strong>Section 5.1</strong>: # 23, 51, 57, 69, 71, 83.</td>
</tr>
<tr>
<td></td>
<td>1123</td>
<td>Substitution</td>
<td>5.4-5</td>
<td><strong>Section 5.2</strong>: # 23, 33, 35, 41, 61, 65, 79, 82.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Definite I</td>
<td></td>
<td><strong>Section 5.4</strong>: # 15, 17, 21, 30, 37, 47.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Section 5.5</strong>: # 21, 29, 37, 48 76, 79, 71.</td>
</tr>
<tr>
<td>14</td>
<td>1128</td>
<td>Theorem</td>
<td>5.5</td>
<td><strong>Section 5.6</strong>: # 21, 29, 37, 43 57, 61, 71.</td>
</tr>
<tr>
<td>15</td>
<td>1205</td>
<td>Application</td>
<td>6.3</td>
<td><strong>Section 6.3</strong>: # 69, 73, 77, 78.</td>
</tr>
<tr>
<td></td>
<td>1212</td>
<td>Test #2</td>
<td></td>
<td><strong>Section 6.4</strong>: # 69, 73, 77, 78.</td>
</tr>
</tbody>
</table>

- Dates: Four numbers mean months and days. The first two are months and the next two are days.
- There will be Monday’s lecture on Oct. 4th (Tuesday).
- There will be no class on 1010 (Oct. 10th) because of nationwide holidays.

All chapter, section and page references pertain to Calculus for Business, Economics, Life Sciences, and Social Sciences.
Weekly Assignment

Weekly Assignment #01

1. Sketch $x = 2$ on line, plane and space respectively.

2. Evaluate $|-2021|, |113|, |x|, |x + 3|$ respectively.

3. Sketch the graph of $y = -|x - 2|.$

4. Factor completely each polynomial:
   (a) $1 - 8x^2 - 9x^4$
   (b) $(x - 5)^2 - 5(x - 5)^3$
   (c) $(2x + 1)^{-3} - 3(2x + 1)^{-2}$
   (d) $x^3 - 3x^2 - x + 3$
   (e) $\frac{1}{2}(x^2 + 4)^{\frac{3}{2}} + x \cdot \frac{1}{6}(x^2 + 4)^{\frac{1}{2}}$.

5. Use synthetic division and long division to find the quotient and remainder when $-4x^3 + 2x^2 - x + 1$ is divided by $x + 2$.

6. Perform the indicated operations and simplify the result:
   \[
   \frac{\frac{2x+5}{x}}{\frac{x^2}{x-3}} - \frac{\frac{x}{x-3}}{\frac{(x+1)^2}{x+3}}.
   \]

7. Simplify each expression: $\frac{(4x^{-1}y^{\frac{3}{2}})^{\frac{3}{2}}}{(xy)^{\frac{3}{2}}}$.

8. Find the distance and the midpoint between two points: $(3, -2), (-5, 2)$

9. Find and simplify $\frac{f(x + h) - f(x)}{h}, h \neq 0$, for each function:
   $f(x) = x^2 - 3x + 2, \quad f(x) = \sqrt{x + 2}, \quad f(x) = \frac{1}{x - 3}$.

Weekly Assignment #02

1. Find the domain of each function.
   (a) $g(x) = \frac{3}{2x - 1}$.
   (b) $f(x) = \frac{|x - 2|}{x - 2}$.

2. Sketch the graph of $h(x) = |x + 2| - 3$ by using the transformation methods. Find the range of the function.

3. Evaluate the given function for $f(x) = x^2 - x$ and $g(x) = x^3 - 1$.
   (a) $\frac{f(2 + h) - f(2)}{h}$.
   (b) $\frac{g(1 + h) - g(2)}{h}$.

4. Sketch the graph of $f(x) = |2x + 1| - |x - 3|$. Find the range of the function, and $x-$, $y-$ intercepts.

5. Solve the inequality $|2x + 1| - |x - 3| \leq 1$ by using the graph of $f(x) = |2x + 1| - |x - 3|$. 

Weekly Assignment #03

1. Write an equation of the line with the indicated slope and intercept.
   (a) Slope : $-\frac{1}{2}$ and $y$-intercept : 3.
   (b) Slope : $-\frac{1}{2}$ and $x$-intercept : 3.

2. At a price of $9.00 per box of oranges, the supply is 320,000 boxes and the demand is 200,000 boxes.
   At price of $8.00 per box, the supply is 220,000 boxed and the demand is 400,000 boxes.
   (a) Find a price-supply equation of the form $p = mx + b$, where $p$ is the price in dollars and $x$ is the corresponding supply in thousands of boxes.
   (b) Find a price-demand equation of the form $p = mx + b$, where $p$ is the price in dollars and $x$ is the corresponding demand in thousands of boxes.
   (c) Graph the price-supply and price-demand equations in the same coordinate system and find their point of intersection, which is called the equilibrium point.

3. Graph the function $f(x) = 3x^2 + 12x + 5$ by starting with the graph of $y = x^2$ and using transformations (shifting, compressing, stretching, and/or reflection).
   **Hint:** Write the function in the form of $f(x) = a(x - h)^2 + k$.

4. Suppose that the manufacturer of a gas clothes dryer has found that, when the unit price is $p$ dollars, the revenue $R$ (in dollars) is $R(p) = -4p^2 + 4000p$.
   (a) What unit price should be established for the dryer to maximize revenue?
   (b) What is the maximum revenue?

5. Sketch the graph of the function $f(x) = 1 - 2^x + 3$ by starting with the graph of $y = 2^x$ and using transformations (shifting, compressing, stretching, and/or reflection). And find its domain, range, x-intercept(s), y-intercept(s) and any asymptote(s).

Weekly Assignment #04

1. Sketch the graph of the function $f(x) = 1 - 2^{x+3}$ by starting with the graph of $y = 2^x$ and using transformations (shifting, compressing, stretching, and/or reflection). And find its domain, range, x-intercept(s), y-intercept(s) and any asymptote(s).

2. Solve for $x : \log_{10} x + \log_{10}(x + 1) = \log_{10} 6$.

Weekly Assignment #05

1. If $\cos A = -\frac{3}{5}$, $\pi < A < \frac{3\pi}{2}$, find $\sin A$, and $\tan A$.

2. Sketch the graph of $y = \cos x + \sin x$ on $[0, \pi]$.

3. Prove the identity $\frac{\sin 3x}{\sin x \cos x} = 4 \cos x - \sec x$.

4. Given $\cos A = \frac{2}{3}$, $\frac{3\pi}{2} < A < 2\pi$, find $\sin 2A, \sin \frac{A}{2}$.

5. If $\cos A = -\frac{3}{5}$, $\pi < A < \frac{3\pi}{2}$, find $\sin \left(\frac{A}{2}\right)$.
**Weekly Assignment #06**

1. \[ \lim_{x \to -2} \frac{(x+3)|x+2|}{x+2} \]

2. \[ \lim_{x \to -2} \frac{|(x+3)(x+2)|}{x+2} \]

3. \[ \lim_{x \to 1} \frac{x-1}{1-\sqrt{x}} \]

4. \[ \lim_{x \to 8} \frac{x-8}{\sqrt{2x} - 4} \]

5. \[ \lim_{x \to 1} \frac{\sqrt{x} + 8 - \sqrt{9}}{x-1} \]

6. \[ \lim_{x \to 1} \frac{x^2 - 3x + 2}{x-1} \]

7. \[ \lim_{x \to 1} \frac{x^2 + 3x + 2}{x-1} \]

**Weekly Assignment #07**

1. A graph of \( f(x) \) is shown below. There are six **special points** \( \{C_1 \ldots C_6\} \) at which \( f \) **fails to be smooth**. Answer part (a) . . . (e), placing the correct answers in the boxes provided.
In the following list all special points at which:

(a) $f$ is not continuous. \{ \}
(b) $f$ is continuous from the right. \{ \}
(c) $f$ is continuous from the left. \{ \}
(d) $f$ has vertical asymptotes. \{ \}
(e) $f$ has removable discontinuities. \{ \}

2. Determine the values of $p$ and $q$ such that the function is continuous on the entire real line.

\[
f(x) = \begin{cases} 
  x^2 + px + q & \text{if } 1 < x < 3 \\
  x + 1 & \text{if } |x - 2| \geq 1 
\end{cases}
\]

3. Find the equation of the tangent line to the graph of $f(x) = x^2 - 2x$ at $(2,0)$ by the definition.

Weekly Assignment #08

1. Find the equation of the tangent line to the graph of $f(x) = x^2 - 2x$ at $(-1,1)$ by the rules.

2. The following limits represent $f'(a)$ for some function $f$ and some real number $a$.

   - Find a possible function $f$ and number $a$.
   - Evaluate the limit by computing $f'(a)$.

   (a) \[ \lim_{x \to 1} \frac{x^{100} - 1}{x - 1} \]

3. Find the derivative of the given function $f$.

   (a) $f(t) = \frac{xt - 4}{t^2 - x}$, \( t : \text{constant} \)

   (b) $f(x) = \frac{xt - 4}{t^2 - x}$, \( t : \text{constant} \)

4. Approximate $\sqrt{15.8}$.

5. Sketch the graph of $f(x) = \frac{e^x}{2} + \frac{e^{-x}}{2}$.

Weekly Assignment #09

1. A computer manufacturer determines that the demand function for their computers is $p = \frac{1000}{\sqrt{x}}$, where $x$ is the demand for computers at a given price, $p$. The cost of producing $x$ computers is given by the following cost function: $C(x) = 10,000 + 100\sqrt{x} + 10x$. Determine the marginal cost, marginal revenue, and marginal profit at $x = 100$ computers.

2. Find $f'(x)$ for $f(x) = \frac{3e^x}{e^x + 1}$.

3. Find $f'(x)$ for $f(x) = 3e^x \cdot e^{x+1}$.
Weekly Assignment #10

1. Find the following antiderivative using the indicated substitution.
\[ \int \sin^3 \theta \, d\theta, \quad u = \cos \theta \text{ (Hint: } \sin^2 \theta = 1 - \cos^2 \theta) \]

2. Use a suitable change of variables to determine the following indefinite integral.
\[ \int (\cos \theta - 1) (\cos^2 \theta - 2 \cos \theta)^3 \sin \theta \, d\theta \]

3. Use a change of variables to evaluate the following definite integral.
\[ \int_0^2 \frac{t}{\sqrt{5 + t^2}} \, dt \]

4. Compute the following indefinite integral.
\[ \int 2^x \, dx \]

Weekly Assignment #11

1. Find \( f'(x) \) for
   (a) \( f(x) = \frac{\ln(x + 2 + x + 1)}{x^4} \)
   (b) \( f(x) = \frac{1}{e^x} \)
   (c) \( f(x) = \sqrt{1 + \sqrt{1 + \sqrt{x}}} \)
   (d) \( f(x) = \sqrt{1 + \sqrt{x}} \)
   (e) \( f(x) = \sqrt{1 + \sqrt{x}} \)
   (f) \( f(x) = 5^{x^3 + 2x} \)
   (g) \( f(x) = \log_3(10x^3 - 100x - 1000) \)

2. Find \( f'(x) \) and find the equation of the tangent line to the graph of \( f \) at the indicated value of \( x \).
   (a) \( f(x) = \frac{x^4}{(3x - 8)^2}, x = 4 \)
   (b) \( f(x) = \ln \sqrt{x}, x = e^2 \)

3. Find \( f'(x) \) and find the equation of the tangent line to the graph of \( f \) at the indicated value of \( x \).
   (a) Use implicit differentiation to find \( \frac{dy}{dx} \).
   \[ (xy)^2 + 3x = y^2 \]
   (b) Find the equation of the tangent line to the graph of the following equation at the indicated point.
   \[ \tan(xy) = y, \quad \left( \frac{\pi}{4}, 1 \right) \]

Weekly Assignment #12

1. At a sand and gravel plant, sand is falling off a conveyor and onto a conical pile at a rate of 10 cubic feet per minute. The diameter of the base of the cone is approximately three times the altitude. At what rate is the height of the pile changing when the pile is 15 feet high?

2. Find an equation of the tangent line to the graph of \( xy + x^2y^2 = 6 \) at the point \((2, 1)\).

3. Find the derivative of \( y = xe^x \).
4. The radius of a circular oil slick expands at a rate of 2 m/min. How fast is the area of the oil slick increasing when the radius is 25 m?

5. A manufacturer of sunglasses currently sells one type for $15 a pair. The price $p$ and the demand $x$ for these glasses are related by $x = f(p) = 9,500 - 250p$. If the current price is increased, will revenue increase or decrease?

**Weekly Assignment #13**

1. For the given function $y = 1 + \frac{x^2}{x^2 + 1}$,
   
   (a) Find local max / min.
   (b) Find absolute max / min.
   (c) Find the intervals where the function is increasing or decreasing.
   (d) Find the intervals where the function is concave upward or downward.
   (e) Sketch the graph of $f(x)$.

2. Evaluate the following limit with either L'Hôpital’s rule or previous learned methods.

$$\lim_{x \to 0} \frac{\sqrt{1 + x} - \sqrt{1 - x}}{x}$$

**Weekly Assignment #14**

1. A hobby store has 30 feet of fencing to fence off a rectangular area along one wall of one display room. What dimensions of the rectangular will maximize the area?

2. A rectangular box(with no top) is to contain 2250 cm$^3$. Find the dimension to minimize the area of material used to construct the box if the length of the base is three times the width.

3. All units in a 30-unit apartment building are rented out when the monthly rent is set at $r = $1,000 per month. A survey reveals that for each $40 increase in rent, one additional apartment becomes vacant. Suppose that each occupied unit costs $120 per month in maintenance. Which rent $r$ maximizes monthly profit?

4. A closed cylindrical can is to hold 1000 cm$^3$ of liquid. How should we choose the heights and radius to minimize the cost of material needed to produce the can?

5. A straight section of railroad track crosses two highways 400 m and 600 m from an intersection. Find the dimensions of the largest rectangular lot that can be laid out in the triangle formed by the railroad and highways.

**Weekly Assignment #15**

You can run at a speed of 6 mph and swim at a speed of 3 mph and are located on the shore, 4 miles East of an island that is 1 mile North of the shoreline. How far should you run West to minimize the time needed to reach the island?

Set up, but do not evaluate, the following optimization problem.
You are building five identical pens adjacent to each other with a total area of 1000 m$^2$, as shown in the following figure. What dimensions should you use to minimize the amount of fencing?
3. Find $\int_{\frac{1}{2}}^{1} \frac{1}{x^2} f\left(\frac{1}{x}\right) \, dx$ if $\int_{1}^{2} f(x) \, dx = 3$.

4. Compute $F'(x)$.
   
   (a) $\int_{0}^{1} (x^2 + x + 2) \, dx$.

   (b) $\int_{-2}^{1} (2 - x - x^2) \, dx$.

   (c) $\int_{-2}^{2} (1 - |x - 1|) \, dx$. 