MATH 165 - 4 Credits – Sections 9-14 & 19-24
Calculus I

Syllabus / Course Outline\(^1\) – Spring 2016

**Instructor:** Dr. Miriam Castillo-Gil – Carver 386 – Phone: 294-8184– miriamc@iastate.edu, 
website: http://orion.math.iastate.edu/miriamc/

**Office Hours:** M 1:10-2:00 pm, T 10:00-11:45 am, W 1:10-2:00 pm
In the event you absolutely can not make it to any of my office hours I am available by appointment. The purpose of the office hour is to go over problems you have trouble with, clarify concepts covered in class and discussing grades.

**Lectures:** For Sections 9-14 lecture will be on MWF @ 10:00-10:50 am in MacKay 0117. For sections 19-24 lecture will be on MWF @ 2:10-3:00 pm in Carver 101.

**Recitation Sections:** The following is a list of the recitation sections with corresponding TA information and office hours.

With Mr. Joshua Carlson:
- Section 9: meets Tuesday at 8:00-8:50 am in Carver 0274
- Section 11: meets Tuesday at 10:00 -10:50 am in Carver 0282
- Section 13: meets Tuesday at 12:10 -1:00 pm in Howe 1220

**Joshua’s Office Hours:** TBA
**Office:** Carver
**Joshua’s e-mail:** jmsdg7@iastate.edu

With Mr. Alex Schulte:
- Section 10: meets Tuesday at 9:00-9:50 am in Carver 0282
- Section 12: meets Tuesday at 10:00-10:50 am in Carver 0274
- Section 14: meets Tuesday at 12:10-1:00 pm in Black 1026

**Alex’s Office Hours:** TBA
**Office:** Carver
**Alex’s e-mail:** aschulte@iastate.edu

With Miss Beth Bjorkmann:
- Section 19: meets Thursdays at 11:00 - 11:50 am in Carver 0196
- Section 20: meets Thursdays at 12:10-1:00 pm in Carver 0196
- Section 21: meets Thursdays at 2:10-3:00 pm in Carver 0174

**Beth’s Office Hours:** TBA
**Office:** Carver
**Beth’s e-mail:** bjorkman@iastate.edu

\(^1\)This document is subject to adjustment by the instructors, with notice given to the students.
With Mr. Caleb Logemann:

- Section 22: meets Thursdays 2:10-3:00 pm in Carver 0184
- Section 23: meets Thursdays 3:10-4:00 pm in Carver 0132

Caleb’s Office Hours: TBA
Office: Carver
Caleb’s e-mail: logemann@iastate.edu

Course Webpage: All course information and materials will be posted in Blackboard Learn


Calculators and Other Electronic Devices: You may use any calculator that does not have wireless communication features. Calculators are permitted on most exams, the midterm consists of two parts, in one of which calculator is not allowed; however, the TA’s reserve the right to allow calculators during quizzes, depending on its true need during such. Also, whether calculator is allowed or not answers without procedure will result in considerable loss of points. Other electronic devices, such as laptops, iDevices, etc., may be used during lecture for educational purposes only.

Homework: Homework will be done online with MyMathLab in which you will automatically be enrolled (if everything is working properly!). Homework assignments will be due on Fridays before midnight beginning the second week, and including the last week of classes (Dead Week). The lowest six assignments will be dropped. Students should first attempt to complete the homework by themselves before seeking outside help, such as other students and the professor. There is, however, no penalty for students working together.

Exams: There will be a departmental midterm and a departmental final exam. The Midterm will take place on the evening of Wednesday February 24, 8:15-9:45 pm. Tentatively it will cover up to section 3.9 in the textbook. The time and place for the final exam will be as designated by the registrar (the info is available approximately at mid semester). Sample final and midterm exams are available online at http://orion.math.iastate.edu/dept/calculus/exams/exams.html or at the Departmental Syllabus page http://orion.math.iastate.edu/dept/CoursePages/165-6/

In addition 3 in-class exams will be given. The best 3 scores of the in-class exams and midterm will comprise the 50% of your grade, the final exam is comprehensive and will count 25% of your grade (The final exam can not be dropped!)

The exams are closed books and closed notes. Exams must be taken during the scheduled times, see make up policies below. The dates of the in-class exams are as follows: Exam 1, on Friday February 5th, Exam 3, on Monday March 28, and Exam 4 on Friday April 22.

Quizzes: There will be 14 Quizzes, taken during recitation sessions on Tuesdays or Thursdays (depending on your section), including Tuesday or Thursday of the last week of classes, corresponding to Dead Week, and the top 10 scores will be considered for a 15% of your grade.

Grading Policy: Your grade will be computed as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online Homework</td>
<td>10%</td>
</tr>
<tr>
<td>Quizzes (best 10 out of 14)</td>
<td>15%</td>
</tr>
<tr>
<td>Exams (Best 3 out of a total of 4 including Midterm)</td>
<td>50%</td>
</tr>
<tr>
<td>Final Exam (Cumulative)</td>
<td>25%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
</tbody>
</table>
An overall score of 90% or better guarantees at least an A-; 80% or better guarantees at least a B-; 70% or better guarantees at least a C-. These thresholds might be adjusted down at the end of the semester.

Any issues about grading for the exams and quizzes must be addressed within two weeks of the test date. After that time no score changes will be allowed.

**Blackboard:** Grades, ClassNotes and other class materials will be posted in Blackboard. In fact the class notes can be found in the course calendar, for which you will find a link in Blacboard.

**SI:** Supplemental Instruction (SI) will be available for this course. This is one option to develop learning and is not meant to replace attending class, reading the book, or other course assignments. More information will be available online: [http://www.asc.dso.iastate.edu/supplemental/](http://www.asc.dso.iastate.edu/supplemental/)

**Accommodations:** Please address any special needs or special accommodations with Dr. Castillo-Gil at the beginning of the semester or as soon as you become aware of your needs. Those seeking accommodations based on disabilities should obtain a Student Academic Accommodation Request (SAAR) form from the Disability Resources (DR) office (515-294-6624). DR is located on the main floor of the Student Services Building, Room 1076. *No retroactive accommodations will be provided in this class.*

**Conduct and Academic Dishonesty:** We expect all students to behave in a respectful manner during lecture, and you will be asked to leave the lecture if you are being inappropriate and/or disruptive. For more information, including [make up policies](#), see the *Class Policies* provided by the Department of Mathematics.

**Make up Policies:** The first quiz missed for any reason will count as a drop, as we have 4 drops. Subsequent missed quizzes for excusable reason can be made up, please contact your TA directly to make up the quizzes. As for exams, there will be opportunity to make them up, given that the reason to miss the exam is due to a legitimate excuse as sated by university policies, and is well documented. A request must be made in advance to make up the exam to be missed, unless of course, the reason is a last minute emergency (such as an illness, dead in the family, accident, etc.) If any of the exams is missed for a reason other than the listed as legitimate excuses (as per university policies) there will be no make up allowed, such as personal trips, job interviews, sleeping-in, etc. The midterm exam, as it is departmental, can be made up only within departmental guidelines, that is, there will only be one opportunity to retake it, and again documentation shall be presented to be entitled to the make up, if the reason to miss it is not an emergency previous arrangements shall be made, with at least a 10-day notice.

**Extra Credit:** Occasionally there might be a possibility to earn extra credit on the exams and/or quizzes. Extra credit will not be assigned on an individual basis; and most importantly, no extra credit assignments will be available upon request at the end of the semester to improve grades. Students will **NOT** be given the opportunity to complete old assignments at the end of the semester to improve their grades.

**Course Objectives :** The specific Learning objectives of the course is listed below. In particular, the departmental midterm and final exams will test on some subset of these objectives.

**Chapter 2 — Limits**

**Section 2.1: Average Rate of Change.**

- State the definition of average rate of change
- Describe what the rate of change does and does not tell us in a given context
- Interpret and work with analytic, graphical, and numerical information
- Work successfully and efficiently with function notation, substitution in functions \((x \rightarrow a + h)\), how a graph represents a function
• Describe the relationship between the secant line and the average rate of change and apply the relationship in a given context.

• Describe the relationship between the tangent line and the instantaneous rate of change and apply the relationship in a given context.

Section 2.2: Working with limits, and Section 2.4

• State and work with the definition of limit as described on page 66

• Demonstrate, describe, and recognize ways in which limits do not exist

• Evaluate limits given analytic, graphical, numerical function information

• Explain and give examples illustrating the indeterminate nature of $0/0$ forms

• Describe in simple language the statements of limit laws and use these laws to evaluate limits.

• Evaluate one sided limits and describe relationship between limits and one-sided limits.

• Justify (graphically, numerically) the approximation $\sin x \approx x$ for small $x$ and demonstrate that the approximation may not be good for large $x$.

• Work with limit statements to obtain other approximations in a manner similar to the $\sin x \approx x$ derivation.

Section 2.5: Continuity.

• State the definition of continuity and use the definition to ascertain the continuity or non continuity of a function at a point

• Explain and illustrate ways in which function can be discontinuous.

• Recognize graphs of continuous functions and recognize graphs of discontinuous functions

• Generate functions and graphs of functions demonstrating the different types of discontinuities

• Make a continuous extension of a function.

Section 2.6: Infinite limits and limits at Infinity

• Work with $1/0$ forms in the context of one-sided limits to determine existence and location of vertical asymptotes

• Use limits to determine existence and location of horizontal asymptotes

• State the definitions of vertical and horizontal asymptotes (pgs. 105, 111) and work with these definitions to create graphs of functions.

• Evaluate and work with limits $x \to \pm\infty$ by working with dominant terms.

• Explain the difference between $x \to \infty$ and $x = \infty$. 
Chapter 3 — Differentiation

Section 3.1: Tangents and the Derivative at a Point.

- State the limit definition of derivative of a function $f(x)$ at a point $(x, f(x))$ and use the limit definition to calculate a derivative or identify where the derivative fails to exist at a point.

- Interpret the limit definition of the derivative of a function $f(x)$ at a point $x = a$ as
  - the slope of the graph of a function $f(x)$ at a point $x = a$,
  - the slope of the tangent to the curve at a point $x = a$, and
  - the rate of change of a function $f(x)$ with respect to $x$ at $x = a$.

- Recognize and be flexible in the use of different representations of the definition of derivative, including
  $$ f'(a) = \lim_{b \to a} \frac{f(b) - f(a)}{b - a} = \lim_{h \to 0} \frac{f(a + h) - f(a)}{h} $$

- Interpret and be able to represent the definition of derivative analytically, graphically, and numerically.

- Given a context, apply units to the derivative.

- Given the derivative of a function at a point, sketch a graph of the “elements” (i.e., local linearity).

Section 3.2: The Derivative as a Function

- Interpret the derivative of a function and state the domain for the derivative, namely, identifying the points of a function $f$ for which the derivative does not exist.

- Analytically determine the derivative of a function with respect to $x$ at a generic $x$-value.

- Interpret and use (apply?) different notation representing the derivative of a function including
  $$ f'(x) = y' = \frac{dy}{dx} = \frac{df}{dx} = \frac{d}{dx}f(x) = D_x f(x) $$

- Estimate the derivative of a function $f$ with respect to $x$ at a point $(a, f(a))$ using the graph of the function and the tangent line to the function at $x = a$. Similarly, graph the function and the tangent line to the function for $x = a$ when given $f'(a)$.

- Give examples of functions where the derivative at a point does not exist and why.

- Give examples of continuous functions which are not differentiable.

Section 3.3: Differentiation Rules.

- Calculate derivatives of functions (without the use of technology) by applying differentiation rules, including the derivative of:
  - a constant function, a constant multiple of a function, the power of $x$, a sum of functions, a product of functions, a quotient of functions, and exponential functions.

- Verify analytically (i.e., using the limit definition of derivative) the derivative rules for a constant function, a constant multiple of a function, the power of $x$ (where $n$ is an integer or $n = \pm 1/2$, a sum of functions, and exponential functions (which explains why we use $e$).
• Interpret and make use of notation for second- and higher-order derivatives as well as be able to calculate higher-order derivatives.

Section 3.4: The Derivative as a Rate of Change

• Interpret the difference quotient as an average rate of change over a specified interval. Interpret the instantaneous rate of change as the rate at which the function is changing at a point. Attach units to the difference quotient and the instantaneous rate of change based on the context.

• Given a position function, solve for the (instantaneous) velocity of the object using the definition of derivative of the object’s position with respect to time. Solve for the speed of an object or graph the speed as a function of time when speed = |v’(t)| = |ds/dt|

• Relate the acceleration of an object to the object’s position and object’s velocity, (i.e., Acceleration = d²s/dt² = s''(t) = ds/dt = v’(t)). Assign units to acceleration based on the context.

• Apply knowledge of the position, velocity, and acceleration functions to solve problems related to motion.

Section 3.5: Derivatives of Trigonometric Functions

• Use the limit definition to express the derivatives of the trigonometric functions.

• Graphically demonstrate why d/dx(sin(x)) = cos(x) and why d/dx(cos(x)) = −sin(x).

• Use the derivative rules to establish the derivative rules for tan(x), sec(x), cot(x), and csc(x).

• Use the derivative rules to evaluate the derivatives of functions which contain the trigonometric functions.

Section 3.6: The Chain Rule

• Apply the Chain Rule to find the derivative of a composition of functions. Identify the order at which functions are embedded in another, particularly when the chain rule needs to be repeated to find the derivative of a function.

Section 3.7: Implicit Differentiation

• Apply the chain rule to differentiate implicitly defined functions

• Find higher-order derivatives using implicit differentiation

Section 3.8: Derivatives of Inverse Functions and Logarithms

• State the definition one-to-one function (Section 1.6). State why only a one-to-one function can have an inverse.

• Produce a formula for the inverse of a one-to-one function given a formula for the function and perform the algebra (function composition) to demonstrate that you have the correct inverse.

• Given the graph of a one-to-one function, draw the graph of the inverse function.

• Interpreting the derivative of a function as the slope of a tangent line, draw a picture illustrating that d(f⁻¹)/dx∣ₓ=b = 1/f'(f⁻¹(b)).
State the definition of the logarithm (Section 1.6). Demonstrate the ability to manipulate logarithms (and exponentials)

State and work with the derivative of the natural logarithm function.

Derive the definition of the logarithm by differentiating the expression $e^{\ln x} = x$.

Explain the reasoning leading to $\frac{d}{dx} \ln |x| = \frac{1}{x}$.

**Section 3.9: Inverse Trigonometric Functions**

- Define the inverse sine and cosine functions, including the domain, and range of these functions and their relation to the sine and cosine function. Draw the graphs of the inverse sine and cosine functions, and describe the relation to the graphs of the sine and cosine functions.

- Define the inverse tangent function, including the domain, and range of the function and its relation to the tangent function. Draw the graphs of the inverse tangent function, and describe the relation to the graph of the tangent functions.

- Explain the $\sin^{-1}$ notation and how it differs from $(\sin x)^{-1}$.

- Be able to write down the derivatives of the inverse sine, cosine, and tangent functions. Be able to apply these derivatives as needed in the contest of the project, quotient, and chain rules.

- Be able to derive the derivative of $\tan^{-1} x$ and $\sin^{-1} x$ by applying the chain rule to the equations $\tan(\tan^{-1} x) = x$ and $\sin(\sin^{-1} x)$.

**Section 3.10: Related Rates**

- Set up and solve related rates problems, clearly documenting work as elucidated in the box on Page 194.

- At the conclusion of a related rates problem write a sentence declaring exactly what was found and what it means.

**Section 3.11: Linearization and Differentials**

- Given a function that is differentiable at a point $(c, f(c))$ be able do describe what you will see if you zoom in on the graph at this point.

- Be able to define and work with the linearization of a function at a point, and describe the relationship between the linearization and the tangent line.

- Use the linearization to calculate an approximation to a function near a “nice point.”

- Be able to define and work with the differential. Explain the relationship between the quantities $\Delta f$ and $df$ and be able to draw and clearly label an picture to illustrate these quantities.

- Calculate a differential and use it to estimate the change in a function over a small interval.
Chapter 4 — Applications of Derivatives

Section 4.1: Extreme Values of Functions.

- Write and explain the definition of absolute maximum and absolute minimum of a function.
- Write the Extreme Value Theorem. Give examples of (i) function(s) that are continuous on an interval \((a, b)\) but do not have an absolute maximum or an absolute minimum; (ii) function(s) that are not continuous on an interval \([a, b]\) and do not have an absolute maximum or absolute minimum.
- Explain the difference between an absolute extreme point and a relative extreme point.
- Given a function \(f\) continuous on a closed interval \([a, b]\), find the values at which \(f\) takes on its absolute maximum and minimum values and find the values of extreme values.
- Write the definition of critical points and explain their importance in finding relative and absolute extreme points.
- Identify both the candidates for extreme values of a function and the extreme values of the functions, if relevant.

Section 4.3: Monotonic Functions and the First Derivative Test

- Explain what it means for a function to be increasing (decreasing) on an interval. Give graphical and symbolic interpretations.
- Given a function \(f\), use the first derivative to identify the intervals on which \(f\) is increasing, decreasing.
- Use the first derivative test to determine the nature (relative maximum, relative minimum, neither) of a critical point.
- Justify the First Derivative Test as stated on Page 240. Use graphs and knowledge about monotonicity in your justification.

Section 4.4: Concavity and Curve Sketching

- State the definitions of concave up and concave down.
- Use slopes of tangents to a graph to relate the concavity of a function to the increasing/decreasing nature of the first derivative.
- Explain what it means for a point to be an inflection point and use analysis of the second derivative to identify inflection points.
- Use the second derivative test to classify critical points.
- Give examples to show that the second derivative test yields no information for a critical point \(c\) if \(f''(c) = 0\).
- Use the tools of calculus and algebra to sketch, by hand, good graphs of functions, including labels of the intercepts, critical points, inflection points, asymptotes, intervals of monotonicity, and documentation of concavity.
- Given graphical and textual information about a function \(f\) (e.g. intercepts, where \(f'\) is \(\pm\) or a graph of \(f'\), etc.) draw a graph of \(y = f(x)\).
- Given a graph of a function \(f\), sketch a graph of \(f'\). Given a graph of \(f'\), sketch a graph of \(f\).
Section 4.5: Indeterminant Forms and L’Hôpital’s Rule

- Explain why $0^0$ and $\frac{\infty}{\infty}$ are indeterminant forms. Explain what is meant by indeterminant form.
- Use L’Hôpital’s rule to evaluate limits involving indeterminant forms.
- Use logarithms and L’Hôpital’s rule to evaluate limits of indeterminant forms such as $0^0$, $\infty^0$, $1^\infty$.

Section 4.6: Applied Optimization

- Use the tools of calculus to solve applied optimization problems. Write complete solutions including illustrations, identification of variables, verification that the solution produced is the extreme sought.

Section 4.7: Newton’s Method

- Use Newton’s method to find approximate solutions to equations such as $f(x) = 0$ or $g(x) = h(x)$.
- Justify and derive the Newton’s method recursion as on Page 275.

Section 4.8: Antiderivatives.

- Evaluate antiderivatives of elementary functions.
- Explain the significance of the $+C$ for antiderivatives.
- Find the value of the constant $+C$ in the context of initial value problems.

Chapter 5—Integration

Section 5.1: Area and Estimating with Finite Sums.

- Describe upper and lower sums and what they tell you about area.
- Given a partition and set $\{t_1, \ldots, t_n\}$ of points, with a single $t_i$ in each subinterval, draw the rectangles and calculate the associated Riemann Sum.
- Use Riemann sums to approximate distance and net distance traveled, given a velocity function. During this process keep track of units and know which units go with each quantity.
- Approximate the average of a function and explain why this approximation is also a Riemann sum.

Section 5.2: Sigma Notation and Limits of Finite Sums

- Given a sum written in sigma notation, write out the expanded form of the sum, and evaluate the sum.
- Given a sum displayed expanded form write the sum using sigma notation.
- Be able to manipulate sums using the algebra rules on page 308 of the text book.
- Provide all details in using an equal interval, $n + 1$ point partition, with right or left endpoints to obtain a Riemann sum. Given the formulas on Page 309, evaluate the limit of the result as $n \to \infty$ and interpret the result.
- Explain the contributions given by positive and negative terms of a Riemann sum and give a geometric interpretation.
Section 5.3: The Definite Integral.

- Write the limit definition of definite integral (Page 315), including the relationship to a partition of an interval and explanations of all notation.
- Use the rules in Table 5.4, Page 317, to evaluate and manipulate definite integrals.
- Explain and describe the relationship of the definite integral to area under the graph of a non-negative function.
- Find the average value of a continuous function over an interval and explain how the average value formula arises from the definition of the definite integral.

Section 5.4: The Fundamental Theorem of Calculus.

- Write the statement of the Fundamental Theorem of Calculus (Part 1) and explain what the theorem says about definite integrals.
- Provide an outline of the proof of the FTC with diagrams. See Page 326.
- Write the statement of the Fundamental Theorem of Calculus (Part 2) and explain what the theorem says about definite integrals.
- Use the FTC (Parts 1 and 2) to evaluate derivatives of functions defined by integrals and to evaluate definite integrals. (say something about the use of the chain rule?)
- If $f(t)$ is a rate function, use Riemann sums to explain the meaning of $\int_a^b f(t) \, dt$ as a net change.

Section 5.5: Definite Integration and the Substitution Method.

- Evaluate indefinite integrals using the substitution method (when needed) showing complete work with differentials.
- Given an integral, identify and implement the appropriate substitution.
- Find the antiderivatives of $\sin^2 \theta$ and $\cos^2 \theta$.

Section 5.6: Substitution and Area Between Curves

- Explain, in terms of area, the difference between $\int_a^b f(x) \, dx$ and $\int_a^b |f(x)| \, dx$, with reasons. Evaluate each of these integrals for a given function $f$.
- Given a velocity function $v(t)$, explain the difference between $\int_a^b v(t) \, dt$ and $\int_a^b |v(t)| \, dt$, with reasons.
- Evaluate definite integrals and use substitution when needed. Make the appropriate changes in the limits of integration when performing such an integration. * I changed the wording.
- Given two functions $y = f(x)$ and $y = g(x)$, be able to set up and evaluate the integral(s) to calculate the area between the graphs of the two curves over a given interval. * I changed the wording.
Chapter 7 — Integrals and Transcendental Functions

Section 7.2: Exponential Change and Separable Differential Equations.

- Solve simple separable equations (with and without initial conditions.)
- After solving a differential equation, be able to answer further questions about the situation being modeled.
- State the definitions of half-life and doubling-time and work with these ideas.
- Given a written description of a change phenomenon, write a separable differential equation to model the phenomenon.
- Given a separable differential equation and a context, write a short paragraph describing what the equation is modeling.
- Give examples of phenomena for which the rate of change of a quantity is proportional to the value of the quantity and show that the quantity is modeled by an exponential function.