MAT 131 – CALCULUS I – FALL 2021

Class webpage: https://www.math.stonybrook.edu/~jstarr/mat131.fall21/mat131.fall21.htm
Course Description: The description in the undergraduate bulletin: The differential calculus and integral calculus, emphasizing conceptual understanding, computations and applications, for students who have the necessary background from 12th-year high school mathematics. Differentiation of elementary algebraic, trigonometric, exponential, and logarithmic functions; graphing; modeling and maximization; the Riemann integral; and the fundamental theorem. May not be taken for credit in addition to MAT 125 or 141 or AMS 151.

Prerequisites: In order to take MAT 131, you must have either
• passed MAT 123 with a B or higher, or
• received a score of 5 or better on the mathematics placement examination.

Textbook: Calculus (an OpenStax resource), by Gilbert Strang, Edwin Herman, et al., freely available at the CNX website. We will also be using WebAssign for online homework assignments this semester. There a link to the free ebook from within WebAssign.

Lectures: Primary instruction will occur in lectures, with practice and reinforcement provided in a smaller classroom setting during recitations.

Lecture	Time	Room	Instructor
LEC 1	TuTh 9:45-11:05am	Frey Hall 102	Jason Starr
LEC 2	TuTh 6:30-7:50pm	Frey Hall 100	Radu Laza

Recitations: Please regularly attend recitation. Most of the one-on-one interaction so crucial in this course will happen in recitation.

Recitation	Time	Room	Instructor
R01	TuTh 1:15-2:10pm	Library N4000	Roberto Albesiano
R02	TuTh 8:00-8:55am	EarthSpaceSci 183	Roberto Albesiano
R03	MW 10:30-11:25am	EarthSpaceSci 069	Danfei Wang
R04	MW 4:25-5:20pm	Physics P130	Danfei Wang
R05	MF 1:00-1:55pm	Staller Ctr 3218	Luke Kiernan
R06	MW 9:15-10:10am	Frey Hall 328	Yunpeng Niu
R07	WF 11:45am-12:40pm	Chemistry 128	Jacob Laxer
R08	MF 10:30-11:25am	Physics P113	Luke Kiernan
R20	TuTh 1:15-2:10pm	LgtEngrLab 154	Myeongjae Lee
R21	TuTh 8:00-8:55am	EarthSpaceSci 181	Myeongjae Lee
R22	MF 10:30-11:25am	Physics P112	Yunpeng Niu
R23	MW 4:25-5:20pm	EarthSpaceSci 069	Shamuel Auyeung
R24	MF 1:00-1:55pm	Library N4072	Jiasheng Teh
R25	MW 9:15-10:10am	StallerCtr 3220	Shamuel Auyeung
R26	WF 11:45am-12:40pm	Chemistry 128	Jacob Laxer
R27	MF 10:30-11:25pm	Physics P113	Luke Kiernan

Grading System: The relative significance of exams and problem sets in determining final grades is as follows.

Date: Fall 2016.

Component	Percentage
Midterm I	20%
Midterm II	20%
Final Exam	45%
Recitation / Problem Sets	15%

Handbacks: Graded problem sets and exams will be handed back in recitation. If you cannot attend the recitation in which a problem set or exam is handed back, it is your responsibility to attend your recitation instructor's office hours and get your graded work.
FAILURE TO RETRIEVE GRADED WORK IS NOT GROUNDS FOR A MAKE-UP, A REGRADE, OR CHANGE OF A FAIL TO AN INCOMPLETE.
You are responsible for collecting any graded work by the end of the semester. After the end of the semester, the recitation instructor is no longer responsible for returning your graded work. If you have a question about the grade you received on a problem set or exam, you must contact the recitation instructor (not the grader or the lecturer).

Course Learning Objectives: The course learning objectives include the following. Each of these is an important learning objective for *all* mathematics courses. Each is amplified with specific examples.

• **Acclimate to New Mathematics.** Gain familiarity with a new mathematical idea (be it a definition, a result, an algorithm, etc.) through examples, through basic results that involve that idea, and through deeper results that reflect the significance of the idea. **Example.** The derivative is an example of a limit: the limit of the difference quotient.

• **Apply and Model.** Understand how an abstract notion or result can lead to an algorithm or computation arising in a context different from the original notion or result. Understand the necessary hypotheses and limitations of that model. **Example.** The result that a local max / min of a differentiable function on an open interval is a critical point leads to the algorithm for solving optimization problems.

• **Specialize.** Pass from general theorems, definitions, and methods to specific examples. Be able to compute with those examples. **Example.** The general formula for the Riemann integral as a limit of Riemann sums specializes to computable limits for the Riemann integral of a polynomial function.

• **Generalize.** Understand examples of ideas, constructions and arguments originally developed in one context yet that extend to another context. **Example.** The formula for the derivative of a general inverse function, which extends the power law to fractional exponents, also allows us to compute derivatives of logarithm functions and inverse trigonometric functions.

• **Prove.** For a conjectured result, often expected from examples, heuristics and other indirect evidence, rigorously prove the result using techniques such as proof by induction, proof by contradiction, proof by cases, and more advanced proof techniques. **Example.** The power law tells us a quick formula for the derivative of a polynomial function, but the complete proof of the power law using the limit of a difference quotient requires the Binomial Theorem.

Course Outcomes / Key Skills: The course outcomes / key skills include the following.

• Definition, basic properties and graphs of elementary functions: powers, exponentials, logarithms, and trigonometric.

• The definition, basic properties and graphs of even and odd functions.

• The definition and meaning of increasing and decreasing for functions and graphs.

• Reflection, translation and scaling of graphs and the corresponding transformation of the functions.

• Definition, basic properties, and graphs of inverse functions. Computation of an inverse function.

• Definition, basic laws, and techniques for computing limits, one-sided limits, limits using the squeeze theorem, limits equal to infinity, and limits at infinity.

• Identifying all discontinuity points (both the location and type), the domain of a function, and all vertical and horizontal asymptotes. Application of these notions to curve-sketching.

• The statement of the Intermediate Value Theorem and its use in finding zeroes of functions.

• The definition of the derivative as the limit of a difference quotient, and methods for computing derivatives directly from the definition.

• Using the derivative to compute the equations of tangent lines.

• Using the rules of differentiation: the sum rule, the product rule, the power rule and the derivatives of exponentials.

• Given the values of the limits of sin(x)/x and of 1-cos(x) as x tends to zero, find the formulas for the derivatives of the functions sin(x) and cos(x) from the definition as a limit of a difference quotient.

• Finding derivatives of other trigonometric functions such as tan(x), cot(x), sec(x) and csc(x) using the derivatives for sin(x) and cos(x) and the rules for differentiation.

• Finding derivatives using the chain rule.

• Finding the tangent slope to a parametric curve at a specified point.

• Finding derivatives using implicit differentiation, including derivatives of inverse functions.

• Finding derivatives using logarithmic differentiation.

• Finding the linear approximation to the value of a function, using a known nearby value and derivative or using differentials.

• Understanding differential notation and the geometric interpretation of differentials. Using differentials to approximate values of functions.

• Solving related rates problems.

• Absolute maxima and minima; local maxima and minima; inflection points. Know how to find the absolute maximum and absolute minimum value of a differentiable function on a closed, bounded interval. Know how to find local maxima and minima and inflection points of functions, and use this to help graph the function.

• L'Hôpital's rule. Recognize indeterminate forms. Simplify limits leading to indeterminate forms using l'Hôpital's rule. Know how to transform other indeterminate forms into one of these two types.

• Optimization problems. Given a word problem attempting to maximize or minimize some quantity given a collection of constraints, turn this into a calculus problem for finding an absolute maximum or absolute minimum. Solve this calculus problem.

• Know how to set up a Riemann sum associated to a given integrand and a given interval. Be able to evaluate the limit of Riemann sums to compute the Riemann integral in the case of some simple integrands.

• Antiderivatives. Recognize the most common antiderivatives: those arising as the derivatives of polynomial functions, trigonometric functions, exponential functions, logarithmic functions and inverse trigonometric functions.

• Know the statement of the Fundamental Theorem of Calculus. Understand how to use this to evaluate definite integrals when you can find a simple form for the antiderivative. Understand how the fundamental theorem always gives an antiderivative of a continuous function, where the antiderivative is defined in terms of the Riemann integral/definite integral.

• Given a limit of sums, recognize when this is a limit of Riemann sums. Be able to use the fundamental theorem of calculus to evaluate this limit of Riemann sums.

• Simplify antiderivatives using direct substitution.

• Evaluate definite integrals using substitution and the Fundamental Theorem of Calculus.

Academic Resources: There are a number of organizations on campus offering tutoring and other academic resources in various locations. The mathematics department offers drop-in tutoring in the Math Learning Center. You are strongly encouraged to talk to a tutor in the MLC if you have an issue and are unable to attend your lecturer's or recitation instructor's office hours (or if you have previously arranged to meet them in the MLC).

Please be aware that tutors in the MLC deal with students on a first-come, first-served basis. Thus it may be preferrable to speak with your lecturer or instructor in their office hours. (Even if you find them in the MLC, they may be obliged to speak to other students before speaking with you.)

Late / Missed Problem Set Policy: Under no circumstances will late homework be accepted.

When there is a valid excuse, a homework may be waived, and then the homework total will be computed using the remaining homeworks (each weighted a bit more).

Problem Sets: There will be eleven WebAssign problem sets, with the lowest score dropped when computing final grades. There will be eleven paper homeworks, with the lowest score dropped when computing final grades.

Policy on Problem Set Cooperation: For all problem sets, students are allowed to work together. However, the final answer you turn in must be based on your own understanding and must be in your words. Per university policy, all instances of suspected academic dishonesty will be referred to the academic judiciary.

WebAssign: A portion of each weekly problem set will be completed via a web interface. You can access the web interface from any computer with Internet access and a recent web browser (the computers in the SINC sites, for instance).

After they are assigned, the online problems may be completed anytime before the assigned deadline. You can look at problems online, print them out, work on them as long as you like, and then answer them in a later Internet session (before the deadline). The online problems are automatically graded with instant feedback.

The online problems are of different types; some are short answer and some are multiple choice. There are different problems and different variants of the same problem. Different students will be assigned different problems. So do not try to compare your answers to another student's answers. As always, you are encouraged to work with other students to understand the course material. However all answers you submit for credit must be based on your own understanding and must be written in your own words.

Accessing WebAssign: Each registered student will have an account on the WebAssign web site. Registered students do not need to do anything special to set up the account (students who add late to the course should contact the instructor to make sure they have an account). Your account username is your Stony Brook NetID your Blackboard username. And your password should be the same as your NetID password. (If you change your NetID password, the account password will automatically change.)

To access your account, make sure you go to http://www.webassign.net/sunysb/login.html. Do not log in through www.webassign.net. If you get to a page that asks for the institution code, you are in the wrong place.

If you have any issues accessing your WebAssign account, please contact Jason Starr. Include the number of your recitation and your full name.

When you first access the WebAssign account, please go to the My Options page (in the upper right of the screen) and put in your email address.

Doing the Assignment: WebAssign has a variety of different question types, ranging from multiple choice to fill-in-the-blank to symbolic questions. Here are some things to keep in mind as you work through your assignments:

- Some questions require entering symbolic notation. Answer symbolic questions by using calculator notation. You must use the exact variables specified in the questions. The order is not important as long as it is mathematically correct. Clicking on the eye button previews the expression you enter in proper mathematical notation. Clicking on the symbolic formatting help button provides tips for using the correct keystrokes.

- When you click on some WebAssign math questions an input palette will open. This palette, called mathPad, will help you enter your answer in proper notation.

• You can save your work without grading by selecting the Save Work button at the end of the question. After you save your work, it will be available to you the next time you click the assignment.

• Please note that WebAssign will not automatically submit your answers for scoring if you only Save your work. Please be sure to Submit prior to the due date and time.

• You can submit answers by question part or for the entire assignment. To submit an individual question answer for grading, click the "Submit New Answers to Question" button at the bottom of each question. To submit the entire assignment for grading, click the "Submit All New Answers" button at the end of the assignment.

• Some WebAssign questions check the number of significant figures in your answer. If you enter the correct value with the wrong number of significant figures, you will not receive credit, but you will receive a hint that your number does not have the correct number of significant figures.

• While different students may get slightly different versions of the assignment, your questions will be the same every time you return. This means you can print out the assignment, work the problems, and then come back later and put in your answers. Since you get multiple attempts to get the question correct, be sure to leave yourself enough time to rework the problems that you did wrong.

• Each question is (typically) worth one point. If a question has multiple answers, each of those are worth a fraction of a point.

• If you put in a wrong answer for a question and ask to have it graded, you will be told it is wrong and be ably to try again. However, if you put in the correct answer on the second try, you get half credit. On the third try, you get 1/3 credit, and so on.

• If you have issues with the assignment, you can use the "Ask your Teacher" button to send a message to your TA and/or lecturer. You should make it clear which problem you are talking about, and what, specifically, your issue is. Using "Ask your teacher" is prefered to sending an email because your question gets saved with your assignment.

Paper Homework: There will also be weekly *paper homework* assigned the week prior to the homework deadline and collected in recitation (usually the last recitation of each week). Graded paper homeworks will be returned in recitation.

Under no circumstances will late homework be accepted.

Exams: Here are some notes on exams.

• The common exams are online exams and follow the Stony Brook University policies for online exams. In particular, the exams are closed notes, closed books, and students are not allowed to use computers or other electronic devices to help them with test problems (since the exam is online, students will use computers to read questions and input answers).

• If you have a university-approved reason for taking an exam at a time different than the scheduled exam (because of a religious observance, a student-athlete event, etc.), please contact your instructor and Jason Starr as soon as possible.

Identification during Exams: For all exams, you must bring your Stony Brook ID, to be checked against picture sheets.

Midterm 1: Midterm 1 will be on Thursday, September 30. There will be two parts, both of which are mandatory. The first part is an in-lecture exam during the regular Thursday lecture. The second part is an online exam held from 8:15-9:35pm.

Midterm 2: Midterm 2 will be on Thursday, November 4. There will be two parts, both of which are mandatory. The first part is an in-lecture exam during the regular Thursday lecture. The second part is an online exam held from 8:15-9:35pm.

Final Exam: The final exam is Wednesday, December 8 from 2:15-5pm.

Schedule of Topics and Assignments: Please do the assigned reading from the syllabus before lecture.

The schedule for topics covered in lecture is as follows.

• Week 1, August 23 August 27 Section 1.1 Review of Functions, p. 8 Section 1.2 Basic Classes of Functions, p. 36 Section 1.3 Trigonometric functions, p. 62 Appendix C Review of Pre-Calculus, p. 2017

• Week 1 Topics. Students should be able to: Understand the concept of function, and be familiar with all the elementary functions and their graphs. Work with piecewise functions and functions defined by tables or graphs. Understand how functions (and their graphs) change under composition with an affine function (i.e., translations). Work with functions, and solve algebraic equations. Use basic modeling ideas to solve word problems. Write and use equations of lines given two points, point and slope, etc.

• Week 2, August 30 September 3
Section 1.4 Inverse Functions, p. 78
Section 1.5 Exponential and Logarithmic Functions, p. 96
Section 2.1 A Preview of Calculus, p. 126
Paper Homework 1 due in recitation.

• Week 2 Topics. Students should be able to:
Understand the meaning of an inverse function.
Understand the horizontal line test.
Understand how the graph of an inverse function is related to the graph of the original function.
Understand the exponential and logarithmic functions, including the exponential rules and logarithm rules.
Calculate averate rates of change for functions defined by graphs or tables.
Be able to sketch secant lines to a graph, and to use the slopes of secant lines to estimate the slope of the tangent line at a point.

• Week 3, September 6 September 10
Section 2.2 The Limit of a Function, p. 137
Section 2.3 The Limit Laws, p. 162
Section 2.4 Continuity, p. 181
Paper Homework 2 due in recitation.
No class on Septebmer 6.

• Week 3 Topics. Students should be able to:
Understand the concept of the limit of a function for values of the input near a specified value (but not necessarily equal to that specified value).
Understand one-sided limits.
Be able to estimate such limits by inspection of the graph.
Use the "algebra of limits" to calculate limits of functions (in the case where the limit is finite only).
Understand what it means for a limit not to exist.
Calculate limits using algebra (factoring, evaluation).
Understand the statement of the squeeze theorem, and its use.
Understand the relationship between an unboundedly increasing or decreasing limit and the vertical asymptotes of the graph.
Understand the relationship between the value of a limit as the input "increases to infinity" or "decreases to negative infinity" and horizontal asymptotes of the graph.
State and understand the definition of continuity at a point and ways that a function can fail to be continuous at a point.
Define continuity on an interval. Understand the "algebra of continuous functions".

• Week 4, September 13 September 17
Section 2.5 The Precise Definition of a Limit, p. 196
Section 3.1 Defining the Derivative, p. 216
Paper Homework 3 due in recitation.

• Week 4 Topics. Students should be able to:
Understand the precise definition of the limit of a function.
Understand the Intermediate Value Theorem, and use it to find roots of continuous functions via repeated approximation.
Understand the meaning of the tangent to a curve at a point.

Calculate the slope of a tangent as the limit of a difference quotient.
Calculate the derivative of a given function at a point.
Estimate a derivative from a table of values of the function.
Understand velocity as a rate of change, and the difference between average and instantaneous velocity.

• Week 5, September 20 September 24
Section 3.2 The Derivative as a Function, p. 234
Section 3.3 Differentiation Rules, p. 249
Section 3.4 Derivatives as Rates of Change, p. 268
Paper Homework 4 due in recitation.

• Week 5 Topics. Students should be able to:
Define the derivative function of a specified function.
Given the graph of a function, sketch the graph of the derivative function.
Recognize points of non-differentiability from the graph of the original function.
Calculate the second derivative function as an iterated derivative function of a specified function.
Calculate the derivatives of polynomials, sums and products, and quotients.

• Week 6, September 27 October 1
Section 3.5 Derivatives of Trigonometric Functions, p. 280
MIDTERM 1 on Thursday, September 30. Part I in-lecture paper exam. Part II online exam beginning at 8:15pm.
No WebAssign homework due this week. No paper homework due this week.

• Week 6 Topics. Students should be able to:
Apply the mathematical notion of derivative to calculate the instantaneous rate of change of various quantities: displacement, velocity, population, revenue, etc.
Understand via a geometric argument the proof that sin(x)/x limits to 1 as x approaches 0.
Know the derivatives of the standard trigonometric functions.

• Week 7, October 4 October 8
Section 3.6 The Chain Rule, p. 290
Section 3.7 Derivatives of Inverse Functions, p. 302
Paper Homework 5 due in recitation.
Drop-down deadline: October 8.

• Week 7 Topics. Students should be able to:
Understand the chain rule, and apply it in many situations.
Know the derivatives of the standard inverse trigonometric functions.
Know the derivatives of radical functions.

• Week 8, October 11 October 15
Section 3.8 Implicit Differentiation, p. 312
Section 3.9 Derivatives of Exponential and Logarithmic Functions, p. 322
Paper Homework 6 due in recitation.
No class on October 11-12.

• Week 8 Topics. Students should be able to:
Calculate derivatives implicitly.
Use implicit differentiation to calculate slopes of implicitly defined curves and find tangent lines.
Know the derivatives of exponential and logarithmic functions.
Use the technique of logarithmic differentiation to find derivatives of large products, quotients, exponentials, etc.

• Week 9, October 18 October 22
Section 4.1 Related Rates, p. 346
Section 4.2 Linear Approximations and Differentials, p. 359
Section 4.3 Maxima and Minima, p. 371
Paper Homework 7 due in recitation.

• Week 9 Topics. Students should be able to:
Solve related-rates problems as an application of the chain rule and implicit differentiation.
Apply linear approximations in calculations (e.g., to approximate the cube root of 9).
Estimate how errors in measurement propagate in calculations.
Locate critical points of a function; classify as to local maximum or minimum or neither.
Determine the maximum value of a function on a closed interval.

• Week 10, October 25 October 29
Section 4.4 The Mean Value Theorem, p. 384
Section 4.5 Derivatives and the Shape of a Graph, p. 395
Section 4.6 Limits at Infinity and Asymptotes, p. 412
Paper Homework 8 due in recitation.

• Week 10 Topics. Students should be able to:
Know the statement of the Mean Value Theorem and its consequences.
Understand the relation between the second derivative and concavity of a graph.
Make accurate sketches of graphs of functions, including critical points, concavity, and inflection points.
Be able to sketch the graph of a function given the graph of the derivative function (and one point on the graph).
Use relative maxima and minima and limit information to understand functions and sketch their graphs.

• Week 11, November 1 November 5
Section 4.7 Applied Optimization Problems, p. 444
MIDTERM 2 on Thursday, Nov 4th. Part I in-lecture paper exam. Part II online exam beginning at 8:15pm.
No WebAssign homework due this week. No paper homework due this week.

• Week 11 Topics. Students should be able to:
Translate an optimization problem into a search for the maxima/minima of a function on an interval, and translate the solution back to the original problem.

• Week 12, November 8 November 12
Section 4.8 L'Hôpital's Rule, p. 459
Section 5.1 Approximating Areas, p. 512
Section 5.2 The Definite Integral, p. 533
Paper Homework 9 due in recitation.

• Week 12 Topics. Students should be able to:
Understand when l'Hôpital's rule can be used and how to use it (iterating if necessary).
Estimate the area under the graph of piecewise-linear function.
Estimate areas of more general (positive) functions using (finite) right-hand and left-hand sums.
Use Sigma notation for sums.
Understand the general definition of a (finite) Riemann sum.
Represent a definite integral as a limit a Riemann sum.
Extend the notion of area to "signed area" so as to include functions with negative values.

• Week 13, November 15 November 19
Section 4.10 Antiderivatives, p. 490
Section 5.3 The Fundamental Theorem of Calculus, p. 553
Section 5.4 The Net Change Theorem, p. 570
Paper Homework 10 due in recitation.

• Week 13 Topics. Students should be able to:
Understand the definition of an antiderivative as a differentiable function whose associated derivative function is a specified function.
Recognize many antiderivative functions from derivatives studied in this course.
Understand the statement of the Fundamental Theorem of Calculus, including the formulation as the "Net Change Theorem".
Define functions in terms of definite integral, and understand the derivatives of these functions.

Combine definite integral functions with other functions, e.g., via composition, and use derivative rules and the Fundamental Theorem of Calculus to compute the derivative of the resulting functions.
Given the graph of a function, answer questions about the graph of the associated definite integral function.
Set up integrals to evaluate areas and signed areas.
Estimate distance and displacement from velocity information in a graph or table.

• Week 14, November 23 November 26
Section 5.5 Substitution, p. 588
Section 4.9 Newton's method, p. 477
No WebAssign homework due this week. No paper homework due this week.
No class on November 24-26.

• Week 14 Topics. Students should be able to:
Compute simple integrals involving standard functions, including trigonomentric and exponential functions.
Compute integrals which result in logarithms and inverse trigonometric functions.
Compute integrals using substitution.
Use definite integrals and antiderivatives to solve simple initial-value differential equations.

• Week 15, November 29 December 3
REVIEW
Paper Homework 11 due in recitation.

Disability Support Services: If you have a physical, psychological, medical, or learning disability that may impact your course work, please contact the Student Accessibility Support Center, Stony Brook Union Suite 107, (631) 632-6748, or at sasc@stonybrook.edu. They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential. Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and the Student Accessibility Support Center. For procedures and information go to the following website: https://ehs.stonybrook.edu//programs/fire-safety/emergency-evacuation/evacuation-guide-disabilities and search Fire Safety and Evacuation and Disabilities.

Academic Integrity: ach student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty is required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty please refer to the academic judiciary website at http://www.stonybrook.edu/commcms/academic_integrity/index.html

Critical Incident Management: Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Student Conduct and Community Standards any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Until/unless the latest COVID guidance is explicitly amended by SBU, during Fall 2021 "disruptive behavior" will include refusal to wear a mask during classes.