Fundamental Principles of Calculus Syllabus

University of Southern California

Table of contents (For videos explaining the syllabus, visit our course YouTube playlist.)

Course and instructor information

Course ID: MATH 118xg
Section: 39400R
Units: 4
Term: Summer 2021

Prerequisite: MATH 108 or MATH 117
Classroom: Online (Zoom room)
Lecture: MTWThF 10:30am-11:20am
Discussion: MTWThF 11:30am-12:20pm

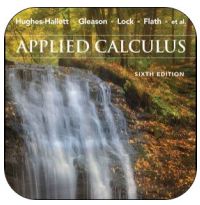
Instructor: Jared Warner
Office: Zoom room
Office hours: MWF 12:30-1:30pm, TTh 9-10pm
E-mail: hjwarner@usc.edu

Teaching Assistant: Debtanu Sen
Office: Math Center
Office hours: ?
E-mail: dsen@usc.edu

Course Description: Derivatives; extrema. Definite integral; fundamental theorem of calculus. Extrema and definite integrals for functions of several variables. Not available for credit toward a degree in mathematics. Prerequisites: MATH 108 or MATH 117 or placement exam in MATH.

Course materials and resources

Textbook (recommended)



Hughes-Hallett. *Applied Calculus*, Sixth Edition (for USC). You should purchase the book by accessing the WileyPLUS online practice problem platform linked on our course Blackboard.

Gradescope (required)

gradescope

All course assessments will be submitted through Gradescope. We will learn how to use Gradescope together in class, but you can familiarize yourself by watching this video or reading this guide.

Desmos (recommended)

desmos

We will use a free and very powerful online math program called Desmos quite a bit in class. Click here to sign-up for a Desmos account and register for our Desmos class. Our class code is 29XS55.

Blackboard (recommended)

Bb Blackboard

All course announcements and content will be posted on Blackboard. You should make sure to read all Blackboard announcements to receive current information about our course.

Course snapshot

(Read this page for a quick overview of the course structure. The rest of the syllabus fills in all of the details.)

This is a learning **outcome** (our first one!):

> **A1 - Functions:** I can use and interpret function notation, and identify properties of function families (eg. linear, exponential, polynomial) from formulas and graphs.

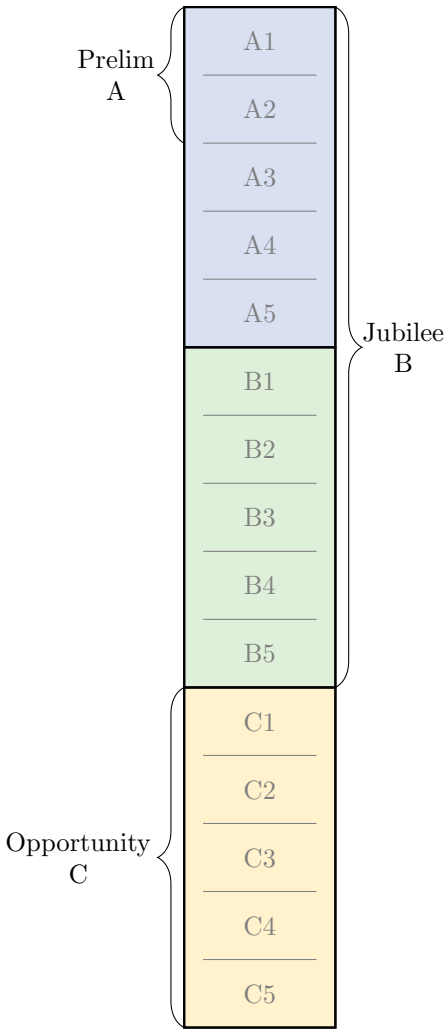
You have a score for each outcome ranging from 0 to 4 indicating how well you've demonstrated that outcome. A score of 4 means you've **mastered** the outcome. There are 15 outcomes in total, split into Units A, B, and C.

You can improve your outcome scores initially by taking prelims and opportunities.

- **Prelims** are like quizzes, and they cover the first two outcomes of a unit. For example, Prelim A covers outcomes A1 and A2. The highest outcome score you can earn on a prelim is 2 out of 4.
- **Opportunities** are like midterms, and they cover one unit. For example, Opportunity C covers Unit C. You can master outcomes on opportunities. Higher outcome scores on opportunities replace lower scores on prelims.

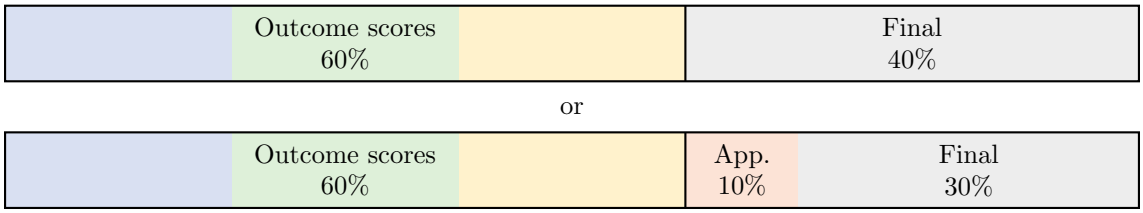
What if you don't master an outcome on an opportunity? No worries! Take a jubilee!

- **Jubilees** are like re-takes, and they cover all previous outcomes. For example, Jubilee B covers Units A and B. You can master outcomes on jubilees. Higher outcome scores on jubilees replace lower previous scores.



You earn the right to see previous outcomes on opportunities and jubilees by completing **practice problems** and **Desmos labs**.

Your outcome scores are 60% of your grade. The remaining 40% is a combination of your scores on the final and Applications. **Applications** are mini-assignments that explore how calculus is applied to the real-world and are completed at your own pace outside of class. Your grade will be calculated using whichever of the following two distributions gives you a higher score.



Notice that completing Applications is optional, because if you choose not to do them, your final will just be worth more.

That's it! As you read the details in the rest of the syllabus, keep this course snapshot in mind.

Learning outcomes

The course will focus on the following 15 learning outcomes. Each learning outcome is a statement of what you will do through a successful completion of the course. The outcomes are split into three units (Units A, B, and C), and each unit will take approximately two weeks of class time.

Outcome	Textbook section(s)
A1 - Functions: I can use and interpret function notation, and identify properties of function families (eg. linear, exponential, polynomial) from formulas and graphs.	1.1, 1.2, 1.4-1.7, 1.9
A2 - The derivative: I can describe the first derivative and second derivative of a function in reference to average and instantaneous rates of change.	1.3, 2.1, 2.2, 2.4
A3 - Interpreting the derivative: I can interpret the meaning of the derivative of a function in various contexts, and use the derivative to estimate a function's values.	2.3, 2.5
A4 - Differentiation techniques: I can use differentiation formulas for basic functions in conjunction with the chain, product, and quotient rules to compute derivatives.	1.8, 3.1-3.4
A5 - Extrema of functions: I can use a function's derivatives to find and classify its extrema and inflection points, and interpret these values within a given context.	4.1-4.4
B1 - The integral: I can describe the definite integral of a function in reference to signed area, and use Riemann sums to estimate the integral of a function.	5.1-5.3
B2 - Interpreting the integral: I can interpret the meaning of a function's integral in various contexts, and use the integral to find a function's average value on an interval.	5.4, 5.6
B3 - The Fundamental Theorem of Calculus: I can explain how the derivative and the integral are related, and use this relationship to compute integrals.	5.5, 6.1-6.3
B4 - Integration techniques: I can use anti-differentiation formulas for basic functions in conjunction with integration by substitution and by parts to compute integrals.	6.6, 6.7
B5 - Income streams: I can use integrals to answer questions about income streams, including finding their present and future values.	6.5
C1 - Multivariable functions: I can use and interpret multivariable function notation, and identify properties of such functions from formulas, tables, and contour diagrams.	8.1, 8.2
C2 - Partial derivatives: I can define, interpret, and compute partial derivatives of multivariable functions given their formulas, tables, and contour diagrams.	8.3, 8.4
C3 - Extrema of multivariable functions: I can use a multivariable function's partial derivatives to find, classify, and interpret its extrema and saddle points.	8.5
C4 - The double integral: I can describe the double integral of a multivariable function in reference to volume, and use Riemann sums to estimate double integrals.	16.1
C5 - The iterated integral: I can use iterated integrals to compute double integrals of multivariable functions over rectangular and non-rectangular regions.	16.2

Throughout the term, you will take various in-class assessments to demonstrate your grasp of these outcomes. Each outcome is graded on a scale from 0 to 4, with a 4 representing mastery of the outcome. Each outcome can be assessed multiple times so that a low outcome score on an early assessment can be replaced with a higher score on a later assessment. Your grade at the end of the semester will be determined partially by your outcome scores.

Grading system

This course will use a mastery-based grading system that is designed to keep our focus on the learning outcomes, emphasize deep understanding of concepts, provide multiple opportunities for students to demonstrate mastery of concepts, and accommodate students with varying mathematical backgrounds.

Below is a description of the various assessments that will determine your grade: prelims, opportunities, jubilees, applications, and the final. All in-class assessments are completed individually, with no help from another person, but you may use your notes, the textbook, a calculator, and the internet.

Prelims (like quizzes): In the middle of each unit, you can take a prelim to gauge your progress. Prelims have two questions corresponding to the first two outcomes of the unit (e.g. Prelim A has a question for Outcome A1 and a question for Outcome A2). Even though outcomes are measured out of 4 points, the highest you can score on each prelim question is 2.

Opportunities (like midterms): At the end of each unit, you can take an opportunity to demonstrate mastery of that unit's learning outcomes. Opportunities have 5 questions (1 per outcome) and each question is scored from 0 to 4. A higher outcome score on an opportunity will replace a lower prelim score.

Jubilees (like re-takes): About one week after an opportunity, you can take a jubilee to improve your scores on outcomes you haven't mastered yet. A higher outcome score on a jubilee will replace your current outcome score. The questions your jubilee contains depend on how many practice credits you've earned (see the section on "Practice problems, Desmos labs, lecture participation and credits" on the next page).

Assessment schedule: The tables below have all of the dates for in-class assessments.

Date	Assessments
5/24	Prelim A
6/2	Opportunity A
6/9	Jubilee A

Date	Assessment
6/8	Prelim B
6/16	Opportunity B
6/23	Jubilee B

Date	Assessment
6/22	Prelim C
6/30	Opportunity C
7/2	Jubilee C

To illustrate how your outcome scores change throughout these assessments, suppose your scores for Outcome A1 on Prelim A, Opportunity A, Jubilee A, and Jubilee B are 2, 1, 3, and 4. The 2 from Prelim A is not replaced by the 1 from Opportunity A, but it is replaced by the 3 from Jubilee A, which in turn is replaced by the 4 from Jubilee B. You've now mastered A1 and won't see it on any subsequent assessments.

Applications (like mini-assignments): Applications are longer problems completed at your own pace outside of class, that explore real-world applications of calculus. Completing applications is optional, and can be worth up to 10% of your grade. See the section below on applications for more details.

Final: The final will be comprehensive and is either worth 40% of your grade, or 30% with your applications score worth the other 10% (whichever of these two options gives you a higher grade). The final will take place on the last day of class, July 6th. You must take the final to pass the class.

Grade: Your total score (out of 100) will be the sum of your outcome scores as achieved on prelims, opportunities, and jubilees (out of 60) and your applications + final score (out of 40). The table below shows the lowest letter grade you can receive for a given total score. For example, if your score is an 83, you are guaranteed a B, and perhaps a higher grade depending on your performance relative to other MATH 118 students.

A 93 to 100	A- 90 to 92	B+ 87 to 89	B 83 to 86	B- 80 to 82	C+ 77 to 79
C 73 to 76	C- 70 to 72	D+ 67 to 69	D 63 to 66	D- 60 to 63	F 0 to 59

Practice problems, Desmos labs, lecture participation, and credits

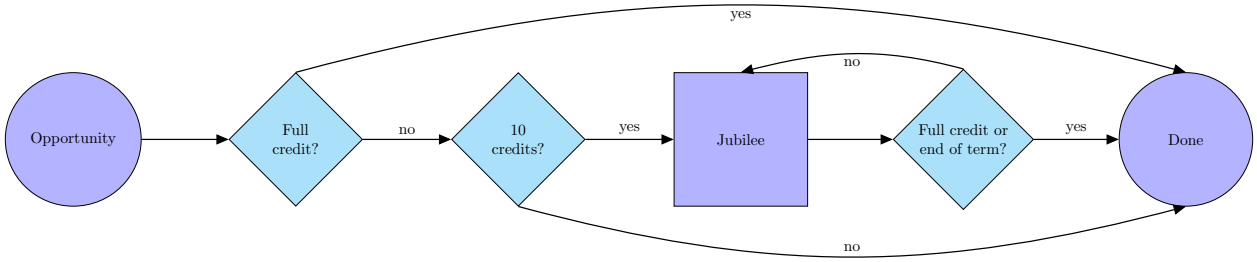
Like most skills, mathematical proficiency is gained through practice. Each outcome is paired with 15 practice problems and 1 Desmos lab. The practice problems and the lab are designed to help prepare you for our assessments. Practice problems and Desmos labs contribute nothing to your grade, but they allow you to earn credits which give you extra chances to master outcomes you missed on previous opportunities. Participating at certain points in lecture is another way to earn credits.

Practice problems: Practice problems are accessed through our online WileyPLUS platform, via the link on Blackboard. You have unlimited attempts to get these problems correct, and they are graded automatically. Each problem you get correct is worth 1 credit.

Labs: Labs are available on Blackboard, and require you to illustrate some course concept by creating a Desmos graph. Make sure that you are logged into your Desmos account when completing the lab, so that you can save the graph you create. To submit your lab for grading, you only need to copy and paste the link to the graph in the appropriate Gradescope assignment. Labs can only receive one of two grades: 5 credits or 0 credits. If your lab receives 0 credits, it will include comments indicating how to fix your graph and resubmit for full credit. Labs will be graded every Tuesday and Friday evening (after 10pm), and you can resubmit as many times as you'd like for full credit.

Lecture participation: At certain points in lecture you will work individually for approximately 10 minutes on some instructional task. After individual work, we will discuss the task as a class and you can volunteer to share your work. Doing so will earn you 5 credits toward the outcome for that class.

Credits and extra chances for mastery: If you have earned at least 10 credits for a particular outcome you haven't mastered yet, you will have an extra chance to master that outcome on all future jubilees (recall that you've mastered an outcome when your score for that outcome is 4). The flow chart below illustrates this process.



Due dates: You can complete practice problems and Desmos labs whenever you'd like for full consideration (i.e. there are no due dates and no late penalties). However, if you want your credits to count towards getting extra chances on your jubilees, you should submit your work by 10pm the night before the jubilee. Be aware that even if you submit your labs by this deadline, if the grader doesn't award you a full 5 credits, you will not be able to redo and resubmit them in time for the jubilee, so plan accordingly.

Applications (optional)

Applications are a selection of problems the textbook has labeled "Projects" at the end of each chapter. These problems are selected for those students who wish to see the abstract theory of calculus put to use in real-world applications. Working on Applications is optional. Your grade will be calculated by weighting your final at 40%, or by weighting your final at 30% and your Applications work at 10%, whichever weighting gives you a higher grade.

If you would like to work on Applications, choose five problems from the table below, write up solutions to those problems (including screenshots of a Desmos graph for each problem as described in the table) and submit your written solutions and graphs to Gradescope.

Here are some guidelines to keep in mind if you choose to work on Applications.

- Each problem is worth up to 2% toward your grade.
- For your reference, the problems are colored according to our course units. In other words, the color of a problem indicates the unit in which the content required to solve that problem is covered.
- Applications solutions are graded for correctness and quality.
- You may use any resource for help, but your solutions should represent your own work and understanding. If asked, you should be able to explain your thought process.
- Applications solutions will be graded every Friday throughout the semester, and you can edit and resubmit solutions for regrading if you don't get full credit.
- You don't have to submit all five solutions at once. You can submit a few solutions for grading at a time.
- For full credit, the axes of your graphs should be labeled, the windows of your graphs should be appropriately adjusted, and the domain of the function should be restricted to reasonable values. For example, if a function's input variable cannot be negative given the context of the problem, then the window should not show much of the negative horizontal axis, and the domain of the function should be restricted to non-negative numbers. You can watch this video for a brief tutorial on how to make Desmos graphs.

Project	Topic	Description of graph to include in your solution
§3, 1	Coroner's Rule of Thumb	Graph $T(t)$ for the value of k found in part (a). Include points on $T(t)$ corresponding to $t = 0, 1, 24$ and the solution to part (b). Also include the tangent line relevant to part (b).
§3, 2	Air Pressure and Altitude	Graph $P(h)$ as well as the tangent line at $h = 0$. Choose an altitude at which the rule of thumb in part (c) ceases to "work" (this is subjective), and label the corresponding point on the tangent line and on $P(h)$.
§3, 4	Keeling Curve: Atmospheric Carbon Dioxide	Include two graphs: one of the three models, and one of their derivatives. Refer to the models in your answer to part (c), and to their derivatives in your answer to part (d).
§4, 1	Average and Marginal Costs	Create a graph that verifies the economist's rule using the cost function in Example 1 of §4.5. Your graph should include the average cost, the marginal cost, and the two lines shown in the figure for $q_0 = 40$.
§4, 2	Firebreaks	On the same pair of axes, graph the functions representing the area lost as a function of the number of firebreaks found in parts (a)(i) and (b). Label the minimum point for each.

§4, 3	Production and the Price of Raw Materials	Solve the problem symbolically (with variables), but for your graph let $f(x) = 3\sqrt{x}$ be the production function, and let $w = 2$ and $p = 8$. Find x^*, and graph $f(x)$ and $\pi(x)$ on the same axes, including the tangent line at x^* for each.
§5, 3	Medical Case Study: Flux of Fluid from a Capillary	Graph the expression you find for part (b), and shade the signed areas related to the integral in part (c).
§5, 4	Medical Case Study: Testing for Kidney Disease	Graph the function you find in part (a), and shade the signed areas related to the integral in part (b).
§6, 2	Distribution of Resources	The function $F(x)$ described in the introduction is about $F(x) = x^3$ for the distribution of household income in the United States. Graph $F(x)$, and shade the region corresponding to the Gini index for the United States.
§6, 3	Yield from an Apple Orchard	Solve the problem symbolically (with variables), but for your graph let $F(M) = -\frac{5}{9}(M - 33)^2 + 500$. Graph $F(M)$ and $a(M)$ on the same pair of axes and label the maximum point of $a(M)$.
§8, 2	Optimizing Relative Prices for Adults and Children	After finding the price of an adult ticket relative to the price of a child ticket, graph the profit as a function of the price of a child ticket. Use $r = 2488320$, $s = 29160$, and assume that the movie theater's costs are \$9 per ticket sold. Label the maximum point of this profit function.
§8, 3	Maximizing Production and Minimizing Cost: "Duality"	Use the budget constraint to write P as a function of x_1 alone. Graph this function and label its maximum point.

Tips for success

Pay attention to your progress reports: You will regularly receive a progress report in your email inbox to help you keep track of your outcome scores, your credits, and what questions you'll see on your next jubilee. Make sure you know how to read this progress report so you can maintain progress toward achieving the grade you want.

Learn from your mistakes: When you get back a graded assessment, make sure you understand every mistake you made, and practice solving those problems again to be ready for the next assessment.

Attend discussion and/or office hours for help with practice problems: The practice problems are challenging, but along with the problems from lecture they represent the best way to prepare for the opportunities and jubilees. Working through them alone can be very frustrating if you make little progress. Avoid this frustration by attending discussion and/or office hours to work on these problems with classmates or an instructor.

Devote the appropriate amount of time outside of class: According to the USC Curriculum Office's policy on contact hours, for every one hour of in-class contact time per week, students are expected to complete two hours of out of class work per week. Since we have lecture for 5 hours each week, this policy suggests you spend 10 hours each week working on this course outside of class. This time can be spent reviewing lecture material, completing practice problems and/or applications, and studying for in-class assessments.

Work and study in groups: Learning can be both an individual and social endeavor. Given the nature of remote learning, individual study will happen naturally, but you'll need to be intentional to benefit from learning in groups. To this end, you are encouraged to work with a group in a breakout room to solve problems in class. Even better, form a study group that meets regularly outside of class to work on math.

Get off to a good start: Try to do well on early assessments. The grading system provides for flexibility but the course will move fast. If you save too many outcomes for later, they will accumulate. If you improve your scores as much as you can in the beginning, then you will have fewer outcomes to focus on later in the semester.

Schedule of classes

Below is a tentative schedule for the course. On most days, the first hour of class will be the lecture hour in which new concepts will be introduced, and the second hour will be the discussion hour in which these concepts are practiced by solving the practice problems or attempting the Desmos labs. Prelims, opportunities, and jubilees always take place during the discussion hour, and opportunities are preceded by a review. Amendments to this schedule will be announced on Blackboard.

Dates	Topic
5/19, 5/20	Course introduction and functions
5/21, 5/24	The derivative
5/25	Interpreting the derivative
5/26, 5/27	Differentiation techniques
5/28, 6/1	Extrema of functions
6/2	Review Unit A and take Opportunity A
6/3, 6/4	The integral
6/7, 6/8	Interpreting the integral
6/9, 6/10	The Fundamental Theorem of Calculus
6/11, 6/14	Integration techniques
6/15	Income streams
6/16	Review Unit B and take Opportunity B
6/17, 6/18	Multivariable functions
6/21, 6/22	Partial derivatives
6/23, 6/24	Extrema of multivariable functions
6/25	The double integral
6/28, 6/29	The iterated integral
6/30	Review Unit C and take Opportunity C
7/1	Review
7/2	Jubilee C
7/6	Final

Policies and statements

Zoom etiquette: At times throughout the course you will have the option to attend a breakout room to discuss your answers on in-class work with your classmates. You can choose to attend these breakout rooms or not, but if you do attend, you are strongly encouraged to interact with others in your breakout room by turning on your camera and/or unmuting your microphone and speaking. While in the main room, it is helpful if you keep your microphone muted while you are not speaking to minimize outside noise.

No makeups or late submissions: There are no makeup prelims, opportunities, or jubilees. The course is already designed to give many chances to demonstrate mastery of course outcomes, so if you miss one chance you should focus on taking advantage of the next one.

Statement on academic integrity: USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. SCampus, the Student Guidebook, contains the University Student Conduct Code (see University Governance, Section 11.00), while the recommended sanctions are located in Appendix A.

Statement for students with disabilities: Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to the instructor (or the teaching assistant) as early in the semester as possible. DSP is located in GFS 120 and is open 8:30 a.m.–5:00 p.m., Monday through Friday.
Website: https://dsp.usc.edu/
Contact information: (213) 740-0776 (Phone), (213) 740-6948 (TDD only), (213) 740-8216 (FAX) dspfrontdesk@usc.edu.

Support resources

Office hours
Please "stop by" to visit me! Office hours are a time for your to ask me about any misunderstandings you have about the course. You can ask for help on practice problems, on Applications, and on preparing for prelimss, opportunities, and jubilees. I will be in my personal meeting room on Zoom.

Math Center
The USC Math Center is a place to go if you want help with your math classes. Please visit the USC Math Center website for information about consulting hours and Zoom room links.

Counseling and Mental Health
Phone: (213) 740-9355 (available 24/7)
Website: studenthealth.usc.edu/counseling
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

National Suicide Prevention Lifeline
Phone: 1 (800) 273-8255 (available 24/7)
Website: suicidepreventionlifeline.org/
Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

Relationship and Sexual Violence Prevention Services (RSVP)
Phone: (213) 740-9355 (24/7, press "0" after hours)

Website: studenthealth.usc.edu/sexual-assault
Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

Office of Equity and Diversity (OED)
Phone: (213) 740-5086, Title IX - (213) 821-8298
Website: equity.usc.edu, titleix.usc.edu
Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

Reporting Incidents of Bias or Harassment
Phone: (213) 740-5086 or (213) 821-8298
Website: usc-advocate.symplicity.com/care_report
Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity —Title IX for appropriate investigation, supportive measures, and response.

The Office of Disability Services and Programs
Phone: (213) 740-0776
Website: dsp.usc.edu
Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

USC Campus Support and Intervention
Phone: (213) 821-4710
Website: campussupport.usc.edu
Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

Diversity at USC
Phone: (213) 740-2101
Website: diversity.usc.edu
Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

USC Emergency
Phone: UPC: (213) 740-4321, HSC: (323) 442-1000 (available 24/7)
Website: dps.usc.edu, emergency.usc.edu
Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

USC Department of Public Saftey
Phone: (213) 740-6000 (available 24/7)
Website: dps.usc.edu
Non-emergency assistance or information.