Methods in Neuroscience

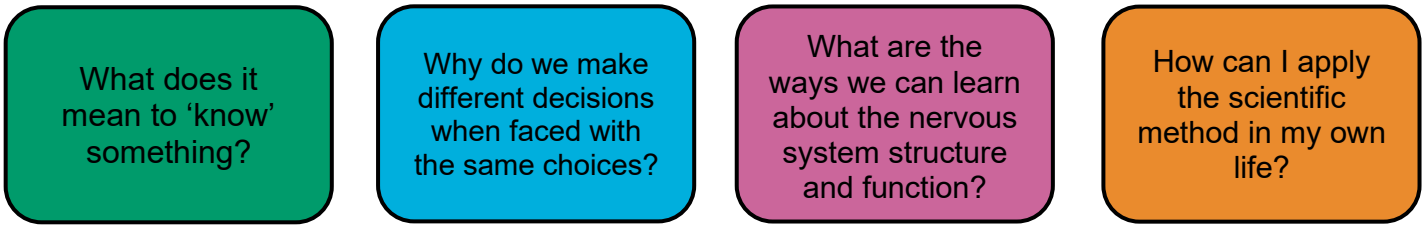
Prerequisites: *Neur 3001/3002/3003 (Grade C or above) + CS 1301/1315/1371 + Stats Elective*
Recommended Conceptual Knowledge:

- Genetic, neurodevelopmental, and neurochemical processes; brain regions and circuits; cognitive and behavioral processes
- Scientific hypotheses, statistical hypotheses, predictions

Recommended Skills:

- Graph and figure reading and evaluations
- Critical analysis and synthesis of primary articles
- Knowledge and critique of experimental methods and statistical processes

COURSE DESCRIPTION



We as scientists are only as good as our data, which we interpret to understand the natural world. At the heart of this understanding is the scientific hypothesis, which is a proposed explanation for a natural phenomenon. This course is intended to provide students with foundational knowledge in hypothesis formulation, experimental design, science communication, and neuroscience methodological techniques. Although there are many common neuroscience techniques/methodologies that we will overview in this course, the goal is not to thoroughly understand the details of every single technique and methodology available to us. New neuroscience techniques are constantly being invented and refined, making such details obsolete, so we will instead focus on the evaluation of the use of different techniques and the application of foundational knowledge of broad categories of methodologies.

"If we teach only the findings and products of science – no matter how useful and even inspiring they may be – without communicating its critical method, how can the average person possibly distinguish science from pseudoscience?" – Carl Sagan (1995), *The Demon-Haunted World: Science as a Candle in the Dark*

The general goal of this course is to help you develop the ability to think like a practicing neuroscientist. To accomplish this goal, we will use pre-class assignments (e.g., videos or readings), in-class learning activities (e.g., case studies, data analysis, and discussions), and collaborative group work to produce a grant proposal, research poster, and short presentation. We will also continue to develop skills critical for success in neuroscience or any science course: reading graphs and figures, understanding scientific literature, and writing scientifically. By the end of this course, you should gain confidence in writing hypotheses, designing experiments to effectively answer experimental questions, and critically evaluating the methodologies used in scientific papers

COURSE MATERIALS AND RESOURCES

Required Readings

All the required pre-class assignments will be posted on Perusall, which is accessed by Canvas.

Please bring paper, a pencil, and your laptop, iPad, or other electronic devices to class as we will be using these devices during our learning activities and during the quizzes.

Your device will need to support word processing (e.g., word or google doc exported as a pdf) for the writing assignments in this course. It is your responsibility that all work is readable by the instructors and/or TA.

All other materials (e.g., forms, all assignments, quizzes, and additional resources) will be made available on Canvas.

LEARNING OBJECTIVES

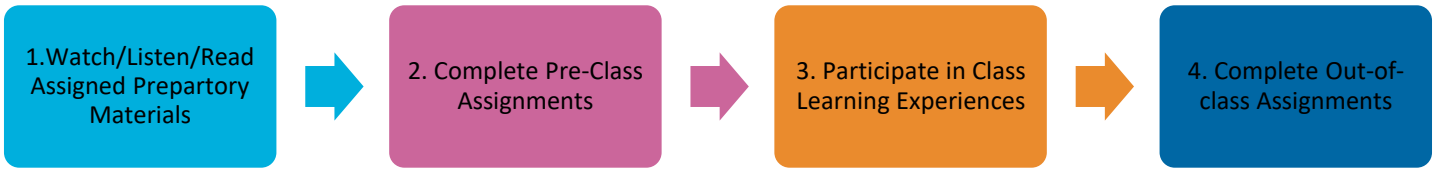
The ultimate goal of this course is for students to be able to **think like a practicing neuroscientist**; however, other skills are necessary in order to achieve this goal. Therefore, this course has several related learning objectives. After successfully completing this course, students should be able to:

- Define the concept of a hypothesis and its role in scientific inquiry, highlighting its potential to guide research questions and generate predictions
- Generate testable hypotheses and research questions based on the available scientific knowledge
- Describe common neuroscience techniques/methodologies and statistical analyses; comparing/contrasting the advantages and limitations of each
- Explain the extent to which common neuroscience techniques/methodologies and statistical analysis provide valid, unbiased, and reliable findings
- Interpret the rationale behind the use of scientific methods/techniques within journal articles and critically evaluate the strength of the research findings based on the appropriateness of the methodologies used given their research question/hypothesis/aims
- Explain why science requires open transparency with data/methods
- Identify potential sources of bias or error in experimental design and implementations
- Develop keen critical thinking, problem solving, troubleshooting, and logic skills
- Develop strong scientific communication skills (both oral and written) via a variety of media (poster, ppt, grant proposal) and for a variety of different audiences
- Display confidence and competence in finding, reading, and understanding scientific literature
- Effectively collaborate with peers to problem-solve challenges, produce larger research-based projects, critically evaluate & review each other's work, and provide targeted feedback.

COURSE FORMAT

This course will be delivered in person. Our class meetings will revolve around learning activities such as case studies, figure interpretation, discussions, small-group work, and active demonstrations and experiments. The out of class work will be i) reading or watching the listed, required pre-class assignments, ii) making comments and asking and answering questions them, iii) creating short presentations, iv) working on longer written assignments, and v) studying for quizzes. This class set-up has been shown to improve learning over a format where the instructor gives a series of lectures and students sit quietly, taking notes (Hake (1998) American Journal of Physics, Klymkowsky et al. (2003) Cell Biology Education).

What is your role as a student?



The flow chart summarizes your tasks and the order in which you should complete them for each topic area. Most importantly, you'll need to read assigned book pages or articles and complete any pre-class assignments before each class. You should take notes while engaging with these pre-class materials. During class, you can expect to build your understanding through activities and class discussion. This course format will ask you to develop skills in identifying what information you need and learning how to break down a problem into achievable parts.

Unlike many other science courses that emphasize single-sitting exams to grade student achievement, this course is primarily composed of individual/group projects and practice/engagement. As such, the traditional requirements for memorizing terms and studying numerous diverse concepts are not enough to succeed in this course. Instead, the focus is placed on critical thinking and working effectively in groups and improving their communication skills. Thus, the best way for a student to succeed is to:

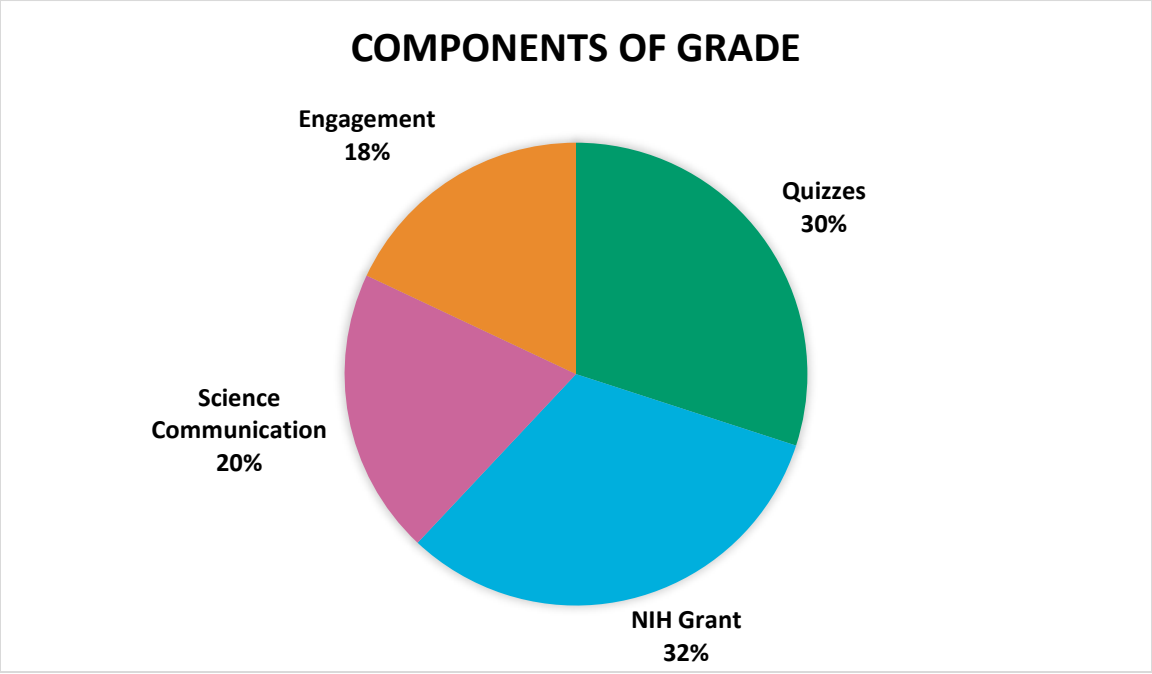
1. Focus on developing a deeper understanding rather than memorizing facts for the quizzes
2. Always produce/turn in your best work, don't just stop once you did 'enough' to get the grade
3. Understand that practicing, getting feedback, & revising is the best way to improve
4. Avoid procrastination and keep up with the recommended schedule for completing tasks
5. Set clear goals as a group, hold group members accountable, and ask for help early on!

ASSESSMENT OF YOUR LEARNING

You will be assessed by your performance on four quizzes, components of a NIH-style grant, presentations communicating science, and course engagement. Please note there is no final exam for this course, but the final exam period will be used to make up missed quizzes and/or to improve the score on two (2) quizzes.

Assessment Category	Assessment Name	Total points
Knowledge Benchmark	Quizzes (4); First 30 minutes of Class	75 pts each
NIH Style Research Grant	Group Contract & Roster*	5 pts
	Topic & Question	5 pts
	Plagiarism Activity*	10 pts
	Bibliography*	20 pts
	Hypothesis	10 pts
	Research Strategy (1 pg draft)	20 pts
	Expert Consultation	30 pts
	Final Group Draft	100 pts
	Group Proposal - Address the Reviewers	20 pts
	Final Draft Individual Aim	100 pts
Science Communication	Research Poster Presentation – Group	100 pts
	Technique PowerPoint – Individual	50 pts

	Peer Reviews (Individual Aim; Technique; Posters)	50 pts
Engagement & Professionalism	Perusall Readings; Reflections; Pre-& Post Quiz; Class Attendance and Participation	180 pts (205 pts available)
Bonus	Mid-term and CIOS evaluation	10 pts
		1000 total



Quizzes (30%): There are 4 Quizzes (75 pts each) that must be taken in person in class unless given prior approval by the instructor. Students will have 30 minutes at the beginning of class to take each quiz via Canvas. Each quiz will consist of multiple choice, mark all of the above, true/false, fill in the blank, ordering, matching, and/or short answer (<5 sentences).

1. **All quizzes must be proctored:** ODS students should take the exam before/after class at the testing center. They may then come to class 30 minutes late or work on other assignments quietly while other students complete their quiz.
2. **Quiz Replacement:** in place of a final exam, an optional alternative version of all four Quizzes will be administered. Students may select and retake up to 2 quizzes (highest score between the original and alternative quiz will be used).
3. **There are no makeup quizzes:** students will obtain a 0 for missed quizzes and can simply make them up with the replacement quizzes at the end of the semester (no need to email us about absences!). Quizzes that have a 0 due to absence will not count towards your 2 makeup quizzes. Ex: if you miss one quiz due to illness you can take 3 alternative quizzes.

Research Proposal (32%): Students will work in small groups to craft a cumulative research proposal on a topic of their choosing in the form of an NIH F31 grant. This project includes many small components that must be completed over the course of the semester. Some parts of the project are individual (*), while others are group work. Please see the Canvas assignments for rubrics and specific instructions.

Oral Science Communication Presentations (20%): Collaboration and communication are important skills for many future careers. As such students will:

1. Work individually to develop and present an informative & individual 3-minute PowerPoint presentation video on a neuroscience technique of choice (100 pts)
2. Work collaboratively as a 'research team' to prepare a research poster presenting a recent neuroscience journal article (chosen from a curated list) as though this were your own research being presented at a conference (100 pts). Note: there will be an assignment in Canvas to select the poster that is ungraded and is used for organizational purposes only.
3. Complete a series of Peer Reviews for the proposal (20pts), 3-minute PowerPoint (15pts), and poster presentations (15pts).

Engagement & Professionalism (18% - 180 pts maximum): To best support student learning there are three types of engagement/professionalism activities that students are expected to engage in. As there are 205 possible points in this category students can complete additional assignments to compensate for poor scores/absences/late assignments.

1. **Reflections (PCAs) (15 pts) –** at various points throughout the semester there will be brief moments for short (1 page) reflections on your learning in this course.

2. **Perusall/Reading (120 pts) –** For students to learn best in an active learning environment they need to come to class prepared. As such there will be reading assignments, homework, and/or reading checks/quizzes incorporated throughout the semester to encourage student preparedness using the Perusall system (5-10 pts per assignment). Perusalls are due at 10:00am the day of class and will take approximately 20-40 minutes to complete.
    - **Late Perusalls:** Due to the way the Perusall system works there is no way to submit quizzes/comments late. Late work will receive a 0%.

3. **Pre & Post Quiz (15 pts)** – Students will gain 5 pts each for completion of a pre and post quiz. Students can then earn an additional 5 pts for demonstrating an improvement of more than 20% from pre to post quiz in scores: (aimed at ensuring students take these activities seriously).

4. **Attending Class & Participating in Group Work (50 pts) –** Because half of all classes will have 15-30 minutes devoted to group proposal/poster work time, attending class is important to your group's ability to work together and a mark of professionalism. As such, students will gain 2 pts points for each day of attendance (excluding quiz days).

Peer Evaluations: At various points throughout the semester there will be opportunities for students to provide feedback on how their group is working together. There will be optional assignments on Canvas that will allow students to evaluate the proposal project group and the poster group. During these midpoints students who receive particularly poor group evaluation scores (e.g., ≤6/10) on multiple categories and/or by multiple group members will be informed that they have received poor scores and should work to improve them. If students receive poor scores at the end of the semester this can result in a deduction of up to 100% (100pts) off an individual's final grade for group work if the instructors deem any individual's contribution to be insufficient or severely lacking as a result of these evaluations and/or class attendance and/or other evidence provided. Details in the rubric will clearly discuss what criteria will be used to assess this and determine the points deducted.

Note: it is possible to miss 100% of classes and still not receive a point deduction if you keep up with your group work and your group is aware/okay with this situation.

COURSE POLICIES

Georgia Tech Inclusive Values Statement

At Georgia Tech, we see different backgrounds and perspectives as essential to learning, discovery, and creation. We strive to remove barriers to student success, and to build a welcoming community where everyone has the opportunity to contribute to our mission. As outlined in our strategic plan, we want to create an environment of holistic learning where all individuals can grow and learn to lead healthy, purposeful, impactful lives.

We will work together to set classroom climate and norms on the first day of the course.

Criteria to Determine Course Grade

This course is graded on a straight scale – you are not competing against anyone else for your grade. Your final grade will be assigned as a letter grade according to the following scale:

A	90 – 100 %	900+ pts
B	80 – 89.99 %	800 – 899 pts
C	70 – 79.99 %	700 – 799 pts
D	60 – 69.99 %	600 – 699 pts
F	0 – 59.99 %	< 600 pts

We highly recommend that you keep track of your own scores. The grade estimates in Canvas are often inaccurate.

Grade Changes & Regrade: Grades are not negotiable commodities. However, mistakes can and do occur. If you feel an assignment or quiz has been incorrectly scored, notify your instructor by email as soon as possible. Any requests for adjustment of grades must be submitted in writing within seven (7) days of the grade posting. In all cases, the entire assignment will be re-evaluated and a final, revised grade (higher or lower) will be assigned, if warranted. In addition, the instructor reserves the right to re-evaluate and re-assess previous assignments, if warranted.

Final grades are determined based upon the criteria outlined above. Requests for grade rounding or exceptions are not considered in fairness to all students. Requests to alter the academic grade or rating so as to obtain unearned academic credit is a violation of the Academic Honor Code.

The Honor Code states, "*Students are expected to act according to the highest ethical standards. The immediate objective of an Academic Honor Code is to prevent any Students from gaining an unfair advantage over other Students".*

Grade Repair Opportunities Summarized (285 pts or 28.5%):

1. **Quizzes (0 – 150 pts):** You may retake up to 2 alternative versions of the quizzes during the last week of class (7/18). Your highest score will be used for your final grade.

2. **Proposal Project (100 pts) –** Group portions of the project are to be submitted during the latter half of the semester for feedback. We will then give you a 'mock' score of this

submission, allowing you to then edit/fix your scores before the final submission is due. Please take this opportunity seriously!

3. **Engagement (25 pts) –** Because students only need to complete 180 out of 205 possible pts in this category, the extra 25 pts can be used to improve their score. Points beyond 180 are not used.

4. **CIOS Evaluation / Midsemester Course Feedback (10 pts):** a 1% bonus will be given if 80% of the students enrolled in this course complete the mid-semester evaluation (5 pts) and final CIOS evaluation (5 pts).

Extension, Late Work, and Make-ups: Generally, all due dates are final without prior instructor approval, and all extensions/re-scheduling must be done in advance of the assignment due date (a minimum of 7 days before the due date for pre-planned events, but earlier is always better!). Late work will result in a 10% grade reduction for every 24 hours it is late.

For sudden and unexpected extended absences/illness/ death in the family/etc. if possible, please provide a letter from the Dean of Students. Please do not feel pressured to attend class in-person if you experience any symptoms of any illness. Your health is personal, and you do not need to inform your instructor or TA about missing class except for a few exceptions:

1. **Excessive (5+) absences** due to ODS/athletics/Dean of Students accommodations/extreme illness
2. **Major project extensions** (ex: proposal or techniques ppt) due to unforeseen and unanticipated circumstances preventing timely submission (ex: illness/death in family)
3. **Missing the poster presentation or final exam period** (ex: illness/death in family/interviews)
4. **Needing accommodation on all assignments/attendance** due to ODS/Dean of Students/TitleIX reasons (documented physical/mental health illness or unexpected life event that is keeping you from doing your best in the course). If this is the case, please contact us ASAP (even doing so before going to the Dean of Students/ODS is fine) so that we can discuss accommodations and/or make an action plan to get you caught up.

It is always better to ask for help early on/before the due date even if you do not yet have formal accommodations yet!!

Engagement & Projects: Perusall readings are due **at the start of class on** their due dates; late Perusall readings are not accepted. All other outside of class assignments are due at **11:59 p.m. on Canvas** and are considered late at 12:00 a.m. the next day (resulting in a 10% grade reduction for every 24 hours it is late). Multiple submissions are accepted.
Please don't wait until the last hour to submit.

- Corrupted/unreadable assignments that cannot be opened will receive a 10% late penalty.
- If you have extenuating circumstances/ODS accommodations that are documented, I'm more than happy to extend due dates on individual assignments to help accommodate you but you must seek prior approval/contact me before the due date if it is possible to do so!

Quizzes: There are no makeup quizzes. However, you may retake an alternative version of any missed quizzes during the exam period, no documentation/reason for absence needed.

Submitted Work Policy: It is your responsibility to ensure that the instructional team is able to grade your work. In addition, all work needs to be accessible for screen readers; this means that screenshots of the work are not acceptable. You should submit your work in the form of .doc/.docx or .pdf. Check the formatting of your work after you submit it in Canvas. If your work is blank, the document converted your text into symbols, the file format is corrupted or unreadable, etc., that work cannot be assessed and will be scored as a zero (0). If you submit a replacement file after the deadline, it will be subject to the late policy.

Academic Integrity: Georgia Tech seeks to cultivate a community based on trust, academic integrity, and honor. This Honor Code helps maintain an optimal learning environment that fosters academic and scholastic integrity. These include respecting the intellectual property of others, submitting your own individual work unless otherwise allowed by an instructor, and protecting your own academic work from misuse by others. All students are assumed to have read the GT Academic Honor Code and consented to be bound by it.

This Academic Honor Code prevents any students from gaining an unfair advantage through academic misconduct. For this class, specific examples of academic misconduct and dishonesty include:

- Plagiarism: the unattributed use of words and/or ideas of another person. Examples include but are not limited to: words written by another person (including yourself for a previous class) or lifted from the internet with and without proper citation; ideas taken from another person without proper citation.
- Unauthorized collaboration: working with someone else on graded work (e.g., assignments, quizzes, or presentations) without explicit permission from the instructor
    - Note: Individual vs. group work will be clearly distinguished in rubrics/assignments.
    - When assignments are marked as individual, that means there should not be any unauthorized collaboration and the final submissions for each student should be unique. This is true even if the students are originally allowed to work together in groups for some part of the assignment (the final submission must be unique/individual if marked as an individual assignment). Failure to submit individual work constitutes plagiarism.
- Use of unauthorized aids (including, but not limited to, online 'homework' help sites) during quizzes
- Unauthorized use of any previous semester course materials, such quizzes, homework, projects, documents written for other courses, and any other coursework, is prohibited in this course. Using these materials will be considered a direct violation of academic policy and will be dealt with according to the GT Academic Honor Code.
- Submission of an attendance/participation assignment by a student not in the class session or sharing the PointSolution session ID with someone not in the class session without prior permission of the instructor.
- Not submitting the quizzes prior to leaving the classroom and continuing to edit your responses.
- Unauthorized use of generative AI in which students copy and paste from the AI-based assistance on graded work (see Policy on Use of Generative AI below).

In short, produce your own work unless you are told otherwise. You are more than welcome to use your notes and work with others for pretty much every aspect of the course except the quizzes; you just need to make sure that the writing and presentations you submit are ultimately your own.

Students who admit to plagiarism/academic dishonesty/etc. in a Faculty Resolution Conference (FCR) or who are found responsible for academic misconduct via OSI investigation will at a minimum receive a zero for that assignment AND become ineligible to repeat/makeup the assignment or to receive the class 1% bonus.

Policy on Use of Generative AI for class work:

In this class we treat AI-based assistance, such as ChatGPT and Copilot, the same way we treat collaboration with other people: for individual assignments, you are welcome to talk about your ideas and work with other people, both inside and outside the class, as well as with AI-based assistants. Students are welcome to use AI in their writing/projects as appropriate (for feedback on writing structure, generating sources or ideas, etc.) but ultimately, the student's work shall be their own and to use AI to generate work is considered plagiarism.

You should never include in your assignment anything that was not written directly by you without proper citation (including quotation marks and in-line citation for direct quotes). Including anything you did not write in your assignment without proper citation will be treated as an academic misconduct case. If you are unsure where the line is between collaborating with AI and copying AI, we recommend the following heuristics:

Heuristic 1: Never hit "Copy" within your conversation with an AI assistant. You can copy your own work into your own conversation, but do not copy anything from the conversation back into your assignment.

Instead, use your interaction with the AI assistant as a learning experience, then let your assignment reflect your improved understanding.

Heuristic 2: Do not have your assignment and the AI agent open at the same time. Similar to the above, use your conversation with the AI as a learning experience, then close the interaction down, open your assignment, and let your assignment reflect your revised knowledge.

This heuristic includes avoiding using AI directly integrated into your composition environment: just as you should not let a classmate write content or code directly into your submission, so also you should avoid using tools that directly add content to your submission.

Deviating from these heuristics does not automatically qualify as academic misconduct; however, following these heuristics essentially guarantees your collaboration will not cross the line into misconduct.

Institute Approved Absences (including accommodations for religious observances):

Any letter for Institute approved absences (e.g., conference presentations, athletic events or competitions, religious absences, and/or health emergencies) should be given to the instructor as soon as possible. If you are requesting an absence due to religious observations, those could be made informally with the instructor or via the request form submitted to the registrar. These religious absences should be requested within the first two weeks of the semester. Please see the registrar's page for more information about approved absences.

Learning Accommodations: We have designed this course with principles of Universal Design for Learning in mind to try to make this course accessible for all. If there are aspects of the instruction or design of this course that result in barriers to your inclusion or accurate assessment of achievement,

please notify us as soon as possible so we can resolve the issue. Students with disabilities should also contact the Office of Disability Services (ODS), whose purpose is to collaborate with students, faculty, and staff to create a campus environment that ensures all students have an equal opportunity to access the Georgia Tech community. ODS can be reached at 404.894.2563, dsinfo@gatech.edu, or https://disabilityservices.gatech.edu. Please contact me ahead of time to discuss any issues related to disabilities. We are happy to work with you.

Mobile Technology Usage: As research on learning shows, unexpected noises and movement automatically divert and capture people's attention, which means everyone's learning experience is affected if a cell phone, laptop, etc. makes noise or is visually distracting during class. In addition, the literature also demonstrates that students recall information better if they take notes by hand. Therefore, it is highly encouraged that you put your electronic devices away and take your notes using pen and paper.

That said, there will be times in which you will need your electronic device to take quizzes, answer poll questions, or conduct some research on the internet, so please bring your laptop, phone, iPad, or other electronic devices to class. I will let you know when we will be using the devices and provide sufficient time for you to get started.

Email Policy: Please email us using our direct gatech email address. You should expect a response within 24 – 48 business hrs. In addition, please make sure to include 'NEUR 3010' in the subject line for all communications sent to instructors. Please direct all absence requests, accommodations, and concerns to the instructors.

Please email the TA for general questions, minor gradebook errors, general advice, etc. Additionally, if you have a knowledge/ concept/project logistics question, please post it on Piazza so that everyone can learn with you! Please do not use the Canvas email platform or Canvas messages.

Modified Campus Operations / Digital Learning Days:

In the event of incremental weather or other reasons for campus shutdown students should expect to move to a virtual class session (using the instructor's zoom link found above) at the regularly scheduled class time, unless otherwise specified via Canvas Announcement. Depending on the day(s) that campus is closed we may choose to hold class via zoom, assign an alternative assignment for students to work on (replacing an in-class activity), or give students free time to work on their group projects. In the unlikely event that an exam/quiz is scheduled for that time/day then we will move it to the next in-person class.

Recordings of Class Sessions and Required Permissions:

Classes may **not** be recorded by students without the express consent of the instructor unless it is pursuant to an accommodation granted by the Office of Disability services. Class recordings, lectures, presentations, and other materials posted on Canvas are for the sole purpose of educating the students currently enrolled in the course.

Students may not record or share the materials or recordings, including screen capturing or automated bots, unless the instructor gives permission. Students who participate with their camera engaged or utilize a profile image are agreeing to have their video or image recorded.

STUDENT-FACULTY EXPECTATIONS

At Georgia Tech, we believe that it is important to strive for an atmosphere of mutual respect, acknowledgement, and responsibility between faculty members and the student body. See the Student-Faculty Expectations for an articulation of some basic expectations that you can have of me and that I have of you. We strive to remove barriers to access and success, and to build a learning community where people of all backgrounds have the opportunity to learn and contribute to our mission. As outlined in our strategic plan, we want to create an environment of holistic learning where all individuals can grow and learn to lead healthy, purposeful, impactful lives.

Therefore, we encourage you to remain committed to the ideals of Georgia Tech while in this class. In the end, simple respect for knowledge, hard work, and cordial and professional interactions that assume best intentions of each other will help build a learning community and environment in which we handle the stressors of a semester with tolerance, compassion, and mutual respect.

ON ACADEMIC & PERSONAL SUPPORT

Undergraduate Student Academic Success Resources

A list of resources for undergraduate students' academic success and information about advising can be found at Success at Tech.

Student Well-Being

At Georgia Tech, we are concerned about your overall physical, social, and mental well-being. You are recognized as a human being navigating life's ups and downs. You may experience stressors that can impact both your academic journey and your personal wellness. These may include academic pressure and challenges associated with relationships, mental health, alcohol or other drugs, finances, etc.

If you are experiencing disruptive challenges, seeking help is a courageous thing to do for yourself and those who care about you. A comprehensive list of wellness related resources has been compiled and maintained by the Office of the Vice President for Student Engagement and Well-being.

- In an emergency, please call Georgia Tech Police Department at (404) 894-2500 or 911.
- For immediate mental health support, you can call the Center for Mental Health Care and Resources at (404) 894-2575.
- You can call or text 988 or chat at 988lifeline.org for yourself of if you are worried about a loved one who may need crisis support.

SYLLABUS CHANGE

Minor elements of course content, the day-to-day schedule, and readings are subject to change from what is shown here in the syllabus to best meet the needs of the class and final project due dates will not and cannot change. Changes will always be conducted to fairly and equitably benefit all students.