



Engineering Physiology I

BME 502 (U Sections)

School of Engineering and Science
Fall 2023

Instructor: George McConnell, Ph.D.

Course Schedule: Mondays 3-5:30 pm

Meeting Location: McLean 211

See lab-specific canvas for lab information

Contact Info: gmcconne@stevens.edu 201-216-3716

Office Hours: Mondays 11:00 am – 12:00 pm in McLean 303, additional by appointment, & virtual by appointment

Teaching Assistant: Erfan Sarhaadei

Contact Info: esarhaad@stevens.edu

Office Hours: Fridays 4-5 pm Gateway North, room 308

Prerequisite(s): MA 221 and Junior/Senior Status

Corequisite: BME 512 (Physiology Lab class)

COURSE DESCRIPTION

The theme of this course is homeostasis and the nature of feedback control in maintaining homeostasis, including open loop and closed loop responses, changes in process dynamics and set points. A study of the physiological functions of major organ systems from a systems engineering point of view is the primary focus. Systems covered include neurophysiology (Central and Peripheral Nervous Systems, receptors, afferent and efferent pathways, reflexes); and muscles (skeletal, cardiac, and smooth muscles). Functional anatomy and physiology will be covered as well as quantitative methods for the analysis of organ function and their interaction to obtain homeostasis.

STUDENT LEARNING OUTCOMES

This course will prepare students and future engineers who:

1. Solve problems and model physiological processes related to homeostasis regulated by neural control and muscle function.
2. Identify relationships between structure and function in the central and peripheral nervous system by learning engineering principles underlying human physiology.

3. Compare the design aspects of devices that improve or restore central and peripheral system functions across different populations with respect to the societal need.
4. Design computational models of control mechanisms in the neuromuscular system.
5. Discuss the societal, ethical, global, environmental, and economic impacts of biomedical solutions (e.g., diagnostic devices and treatments) that address nervous and muscular system pathologies.

COURSE FORMAT AND STRUCTURE

This course is on campus. To access the course, please visit stevens.edu/canvas. For more information about course access or support, contact the Technology Resource and Assistance Center (TRAC) by calling 201-216-5500.

Course Logistics

The lecture will take place in person, with some exceptions with advanced notice, as needed. Assignments will be due on Friday and will be posted on Canvas at least a week before they are due. **Missing lectures or late submission of assignments without prior written approval will result in receiving zero points.**

Though I want to challenge you to develop and practice professional skills like timeliness and being active in your learning experiences, I am committed to being accommodating and empathetic. Please note that accommodations can be made if you or those you are in close contact with have contracted COVID-19, if you have flu-symptoms, or if you have challenging life events. Please let me know if something is going on sooner rather than later, if possible. You do not need to disclose details if you are not comfortable doing so, but being proactive by sharing what you are comfortable with sharing as soon as possible, is greatly appreciated. If you are not comfortable telling me what is going on directly, please reach out to the proper support systems at Stevens, and/or our BME advisor, Amy Mattare, and/or our Department Chair, Dr. Jennifer Kang-Mieler.

Instructor's Online Hours

I will be available via email during business hours and respond as soon as I am available (generally within 2 business days). When emailing me, please place in the subject line the course number/section and the topic of the email (e.g., BME 482 – section A – HW 2 Question). This will help me tremendously in locating your emails more quickly when I scan the emails in my inbox.

Office Hours

Office hours will be held Mondays from 11:00 am -12:00 pm EST and the TA has office hours as well (see top of document). If it is preferred to meet on zoom, please let me know ahead of time, and I will log into zoom. If you would like to request an office hour or meeting, please let me know as soon as possible.

Etiquette Guidelines

Your instructor and fellow students wish to foster a safe learning environment. No matter how different or controversial they may be perceived, all opinions and experiences must be respected in the tolerant spirit of academic discourse. You are encouraged to comment, question, or critique an idea, but you cannot attack an individual. Our differences, some of which are outlined in the University's inclusion statement below, will add richness to this learning experience.

Please consider that sarcasm and humor can be misconstrued in interactions and generate unintended disruptions. Working as a community of learners, we can build a polite and respectful course ambiance. Please read the etiquette rules for this course:

- Do not dominate any discussion. Allow other students to join in the discussion.
- Do not use offensive language. Present ideas appropriately.
- Be cautious in using Internet language. For example, do not capitalize all letters since this suggests shouting.
- Avoid using vernacular and/or slang language as it could lead to misinterpretation.
- Keep an "open-mind" and be willing to express even your minority opinion.
- Think and edit before you push the "Send" button.
- Do not hesitate to ask for feedback.

TENTATIVE COURSE SCHEDULE

To facilitate your learning, we suggest developing a habit to read the textbook a little bit each day, or at some regular frequency (vs. trying to read a whole chapter in one sitting).

****Due dates for Homework will be posted on Canvas with at least one week notice. Estimated due dates are included in the below table. Homework will be due Friday nights, at 11:59 pm EST.***

Changes to the course schedule will be communicated in class, as needed.

Week	Topic(s)	Homework Due
Week 1 M 9/11	Course overview Chapter 1: Systems Approach to Physiology Chapter 3	
Week 2 M 9/18	Chapter 3	HW Ch3
Week 3 M 9/25	Chapter 4: Principles of Neural and Hormonal Communication	
Week 4 M 10/2	Chapter 4	HW Ch 4
Week 5 T 10/10*	Chapter 5: The Central Nervous System: Brain and Spinal Cord <i>*Tuesday uses Monday schedule</i> <i>I will travel for department so instruction mode TBD</i>	
Week 6 M 10/16	Chapter 5	HW Ch 5
Week 7 M 10/23	Midterm	HW BioEthics
Week 8 M 10/30	Chapter 6: The Peripheral Nervous System: Afferent Division; Special Senses	
Week 9 M 11/6	Chapter 6	
Week 10 M 11/13	Chapter 7: The Peripheral Nervous System: Efferent Division	HW Ch 6
Week 11 M 11/20	Chapter 7	

Week 12 M 11/27	Chapter 8: Muscle Physiology	HW Ch 7
Week 13 M 12/4	Chapter 8: Simulink Muscle Reflex	HW Design
Week 14 M 12/11	Chapter 8	HW Ch 8
Finals 12/15-22	Finals dates not yet published	Final Exam

Specific “study guide” topic list:

1. What is homeostasis? Define the properties of negative, positive and anticipatory control? What are the outcomes of a positive feedback control system and how can it be homeostatic? The results of positive feedback (without additional regulation mechanisms) are always unstable.
2. Calculate the resting membrane potential for an excitable cell (e.g., nerve) from Na⁺ and K⁺ ion concentrations inside and outside the cell.
3. Explain the differences between an action potential and post synaptic potentials.
4. Diagram the organization of the Central Nervous System and the processes that allow 2-way communication between the central and peripheral nerves.
5. Outline the processes by which memory is converted from short-term to long-term and the role of the reticular activating system.
6. Describe the processes at the neuro-muscular junction that only allow one-way transmission of the action potential.
7. Explain how the existence of a small number of neurotransmitters can produce a large and varied number of organ/cellular responses.
8. Explain the action of various peripheral sensors and show how they are interpreted in the Central Nervous System.
9. Show the differences between a reflex response and a learned response, including the pathways involved and their controllers.
10. Explain the functions of various areas of the brain such as the primary motor area, Broca's area the Hypothalamus, Thalamus, etc.
11. Explain the roles of actin, myosin, Ca²⁺ and ATP in muscle contraction.
12. Explain the differences and similarities between skeletal, smooth and cardiac muscle in terms of anatomy, calcium mobilization and ATP utilization.
13. Diagram the interaction of afferent and efferent neural signals and explain how their interaction alters “reality” in all individuals.
14. Explain the similarities and differences between a positive, negative and anticipatory feedback control system

COURSE MATERIALS

Textbook(s):

1. **Required:** Lauralee Sherwood, Human Physiology from Cells to Systems, 9th edition, Brooks/Cole Cengage Learning, 2015
ISBN 10: 1-337-07873-5, ISBN 13: 978-1-337-07873-3(REQUIRED).

2. **Optional:** MindTap -Can be bundled with Textbook or purchased separately.

Note: If the textbook and MindTap are not available at the Barnes and Noble or Amazon, they can be leased for 12 months or purchased as a bundle directly through CANVAS.

Note: The textbook will be used for both BME 502 and BME 503.

Other Readings: Supplemental readings will be posted on Canvas

Suggested Optional Textbook: Principles of Neural Science by E.R. Kandel and J.H. Schwartz

Suggested Optional Textbook: Physiological Control Systems: Analysis, Simulation, and Estimation by M. Khoo

Peer-reviewed review articles and manuscripts of your choosing to prepare your review article.

Materials: Other notes and slides on canvas

COURSE REQUIREMENTS

Attendance: Attendance will be taken manually **at the start** of class meetings. Late attendance or missing class without prior written approval will result in a score of zero for that day. Your attendance will be used for your participation score, if you are not present, you will receive a zero score for participation that day.

Participation: Participation in class and on canvas discussions account for **10%** of your course grade. During lectures, I will randomly pull names to prompt your participation in addition to students volunteering questions and answers. This practice aligns with best practices in pedagogy and is related to real-world situations.

Homework: Homework will account for **30%** of your course grade. You will complete assignments and submit them via Canvas. You can collaborate for these assignments in groups of 2-3, and submit the same work as your partner(s), so long as their name(s) is/are included with the submission.

Exams: There will be a midterm and final. Each will have a portion to take within Canvas and a different in-person component. Portions of each exam will be open book, open notes, but no internet, messaging, texting, or other forms of communication are permitted (see exam condition section below). The in-person portion of each exam will require a single reference page 8.5" x 11". The midterm will account for 30% of your course grade and the final exam will account for 30% of your course grade.

TECHNOLOGY REQUIREMENTS

Baseline technical skills necessary for online courses

- Basic computer and web-browsing skills
- Navigating Canvas
- Live web conferencing using Zoom (as needed)

Technology skills necessary for this specific course

- Computer: current Mac (OS X) or PC (Windows 7+) with high-speed internet connection
- Webcam: built-in or external webcam, fully installed (when using zoom)
- Microphone: built-in laptop or tablet mic or external microphone (when using zoom)

GRADING PROCEDURES

For writing-style homeworks and the review article, a rubric will be provided.

Grades will be based on:

Class Participation	10%
Homeworks	30%
Midterm	30%
Final	30%

Late Policy

Without prior written approval from the instructor, late submissions of homework, lab reports, or exams will receive a score of zero.

ACADEMIC INTEGRITY

Generative AI Technologies

You may use AI programs e.g. ChatGPT to help generate ideas and brainstorm. However, you should note that the material generated by these programs may be inaccurate, incomplete, or otherwise problematic. Beware that use may also stifle your own independent thinking and creativity.

You may not submit any work generated by an AI program as your own. If you include material generated by an AI program, it should be cited like any other reference material (with due consideration for the quality of the reference, which may be poor).

Any plagiarism or other form of cheating will be dealt with under relevant Stevens policies.

Undergraduate Honor System

Enrollment into the undergraduate class of Stevens Institute of Technology signifies a student's commitment to the Honor System. Accordingly, the provisions of the Stevens Honor System apply to all undergraduate students in coursework and Honor Board proceedings. It is the responsibility of each student to become acquainted with and to uphold the ideals set forth in the Honor System Constitution. More information about the Honor System including the constitution, bylaws, investigative procedures, and the penalty matrix can be found online at <http://web.stevens.edu/honor/>.

The following pledge shall be written in full and signed by every student on all submitted work (including, but not limited to, homework, projects, lab reports, code, quizzes and exams) that is assigned by the course instructor. No work shall be graded unless the pledge is written in full and signed.

"I pledge my honor that I have abided by the Stevens Honor System."

Students who believe a violation of the Honor System has been committed should report it within ten business days of the suspected violation. Students have the option to remain anonymous and can report violations online at www.stevens.edu/honor.

Special Provisions for Undergraduate Students in 500-level Courses

The general provisions of the Stevens Honor System do not apply fully to graduate courses, 500 level or otherwise. Any student who wishes to report an undergraduate for a violation in a 500-level course shall submit the report to the Honor Board following the protocol for undergraduate courses, and an investigation will be conducted following the same process for an appeal on false accusation described in Section 8.04 of the Bylaws of the Honor System. Any student who wishes to report a graduate student may submit the report to the Senior Vice Provost for Graduate Education or to the Honor Board, who will refer the report to the senior vice provost. The Honor Board Chairman will give the Senior Vice Provost for Graduate Education weekly updates on the progress of any casework relating to 500-level courses. For more information about the scope, penalties, and procedures pertaining to undergraduate students in 500-level courses, see Section 9 of the Bylaws of the Honor System document, located on the Honor Board website.

EXAM CONDITIONS

The following procedures apply to quizzes and exams for this course. As the instructor, I reserve the right to modify any conditions set forth below by printing revised Exam Conditions on the quiz or exam.

One portion of the exam will be open-book, open notes, except that there is no access to the Internet except for the Canvas classroom or if you have purchased an electronic copy of the text book. Another portion of the exam will include a reference sheet and will be completed in-person.

1. Students may use the following materials **during the open-book open notes component of the midterm and final**. Any materials that are not mentioned in the list below are not permitted.

Material or Method	Permitted?	
	Yes	No
Handwritten Notes Conditions: i.e. size of note sheet	X	
Typed Notes Conditions: i.e. size of note sheet	X	
Textbooks (online or physical) Conditions: i.e. specific books	X	
Readings Conditions: i.e. specific documents	X	

2. Students may use the following materials **during the closed-book component of the midterm and final**. Any materials that are not mentioned in the list below are not permitted.

Material or Method	Permitted?
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	Yes	No
Single-sided 1 reference page of notes that are typed or hand-written on a 8.5" x 11" paper	X	

3. **Students are not allowed to work with, text, message, or talk to other students during exams.**

ACCOMMODATIONS

Stevens Institute of Technology is dedicated to providing appropriate accommodations to students with documented disabilities. The Office of Disability Services (ODS) works with undergraduate and graduate students with learning disabilities, attention deficit-hyperactivity disorders, physical disabilities, sensory impairments, psychiatric disorders, and other disabilities to help students achieve their academic and personal potential. They facilitate equitable access to the educational programs and opportunities offered at Stevens and coordinate reasonable accommodations for eligible students. These services are designed to encourage independence and self-advocacy with support from the ODS staff. The ODS staff will facilitate the provision of accommodations on a case-by-case basis.

For more information about Disability Services and the process to receive accommodations, visit <https://www.stevens.edu/student-diversity-and-inclusion/disability-services>. If you have any questions please contact the Office of Disability Services at disabilityservices@stevens.edu or by phone: 201.216.3748.

Disability Services Confidentiality Policy

Student Disability Files are kept separate from academic files and are stored in a secure location within the Office of Disability Services. The Family Educational Rights Privacy Act (FERPA, 20 U.S.C. 1232g; 34CFR, Part 99) regulates disclosure of disability documentation and records maintained by Stevens Disability Services. According to this act, prior written consent by the student is required before our Disability Services office may release disability documentation or records to anyone. An exception is made in unusual circumstances, such as the case of health and safety emergencies.

INCLUSIVITY

Stevens Institute of Technology believes that diversity and inclusiveness are essential to excellence in academic discourse and innovation. In this class, the perspective of people of all races, ethnicities, gender expressions and gender identities, religions, sexual orientations, disabilities, socioeconomic backgrounds, and nationalities will be respected and viewed as a resource and benefit throughout the semester. Suggestions to further diversify class materials and assignments are encouraged. If any course meetings conflict with your religious events, please do not hesitate to reach out to your instructor to make alternative arrangements.

You are expected to treat your instructor and all other participants in the course with courtesy and respect. Disrespectful conduct and harassing statements will not be tolerated and may result in disciplinary actions.

Name and Pronoun Usage

As this course includes group work and class discussion, it is vitally important for us to create an educational environment of inclusion and mutual respect. This includes the ability for all

students to have their chosen gender pronoun(s) and chosen name affirmed. If the class roster does not align with your pronouns and/or name, please inform the instructor of the necessary changes.

Religious Holidays

Stevens is a diverse community that is committed to providing equitable educational opportunities and supporting students of all ethnicities and belief systems. Religious observance is an essential reflection of that rich diversity. Students will not be subject to any grade penalties for missing a class, examination, or any other course requirement due to religious observance. In addition, students will not be asked to choose between religious observance and academic work. Therefore, students should inform the instructor at the beginning of the semester if a requirement for this course conflicts with religious observance so that accommodations can be made for students to observe religious practices and complete the requirements for the course.

MENTAL HEALTH RESOURCES

Part of being successful in the classroom involves a focus on your whole self, including your mental health. While you are at Stevens, there are many resources to promote and support mental health. The Office of Counseling and Psychological Services (CAPS) offers free and confidential services to all enrolled students who are struggling to cope with personal issues (e.g., difficulty adjusting to college or trouble managing stress) or psychological difficulties (e.g., anxiety and depression). Appointments can be made by phone (201-216-5177), online at <https://stevensportal.pointnclick.com/confirm.aspx>, or in person on the 2nd Floor of the Student Wellness Center.

EMERGENCY INFORMATION

In the event of an urgent or emergent concern about your own safety or the safety of someone else in the Stevens community, please immediately call the Stevens Campus Police at 201-216-5105 or on their emergency line at 201-216-3911. These phone lines are staffed 24/7, year-round. For students who do not reside near the campus and require emergency support, please contact your local emergency response providers at 911 or via your local police precinct. Other 24/7 national resources for students dealing with mental health crises include the National Suicide Prevention Lifeline (1-800-273-8255) and the Crisis Text Line (text “Home” to 741-741). If you are concerned about the wellbeing of another Stevens student, and the matter is *not* urgent or time sensitive, please email the CARE Team at care@stevens.edu. A member of the CARE Team will respond to your concern as soon as possible.