PURDUE UNIVERSITY | College of Engineering

Engineering Faculty Document
No.: 80-23
March 2, 2023

TO: The Engineering Faculty

FROM: The Faculty of the Weldon School of Biomedical Engineering

RE: New 500-level course – BME 51000, Neural Mechanisms in Health and Disease

The Faculty of the Weldon School of Biomedical Engineering has approved the following new 500-level course. This action is now submitted to the Engineering Faculty with a recommendation for approval.

FROM:

BME 59500 Neural Mechanisms in Health and Disease

Term offered: Spring
3-credit lecture
Graduate standing OR
Prerequisite: BME 30100 or BIOL 43600 or BIOL 32800 or
Concurrent Prerequisites: BIOL 53800 or BIOL 56200
Previously offered:
Spring 2018 (14 enrolled), Spring 2019 (24 in-class + 3 online), Spring 2021 (14 in-class + 7 online), Spring 2023 (27 in-class + 4 online)

TO:

BME 51000 Neural Mechanisms in Health and Disease

Term offered: Spring
3-credit lecture
Graduate standing OR
Prerequisites: BME 30100 or BIOL 43600 or BIOL 32800 OR
Concurrent Prerequisites: BIOL 53800 or BIOL 56200

DESCRIPTION:

An examination of the mechanisms by which nervous systems process information in normal and pathologic states. Cellular and systems-level information processing will be studied with a focus on sensory and motor systems. Students will gain some hands-on experience in the analysis of neural data. Some neuroanatomy will be included to understand how nervous systems are organized. Pathological states such as Alzheimer's, autism, and aging will be

studied, both in terms of understanding the systems and cellular deficits as well as examining potential solutions to improve the outcomes for these neural disorders.

RATIONALE:

This is a systems-level neuroscience course that is more geared towards biomedical engineers and neuroscientists interested in circuit level mechanisms. BMEs interested in neuroscience require detailed knowledge of sensory motor systems in both biological and quantitative terms. For BMEs, this complements measurement and stimulation (BME 52800) as that course is more theory based and this course is more cell and circuit based. It has been offered over 4 times with growing demand and student evaluation scores ranging from 4.5-4.9. It also serves as a core BME course for engineering professional students in the online BME concentration through Purdue Engineering Online.

David M. Umulis
Dane A. Miller Head and Professor
Weldon School of Biomedical Engineering

Link to Curriculog entry: https://purdue.curriculog.com/proposal:24179/form

BME 510: Neural Mechanisms in Health and Disease
Spring 2023, noon-1:15 PM TTh, MJIS 1001 and Distance, 3 credits

Professor: Edward L. Bartlett, Ph.D.
Office: MJIS 2023 ext. 61425, or 1 765-496-1425 from off-campus
Office Hours: TBD post-survey or by appointment (via Zoom)
Zoom: https://purdue-edu.zoom.us/j/96008965217?pwd=R2E1ckZTY1R4aDd4VDhXeHJVQ1d1dz09
Email: **ebartle@purdue.edu**

TA: Yun Wen (Darren) Chu
Office:
Office Hours:
Email: chu155@purdue.edu

Course Emails:
Emails received after 9 pm will often be responded to the following day. Please call me (765-496-1425) or come to my office if something requires immediate attention.

Textbooks for reference:
I will obtain figures from a number of different sources, including some of the neuroscience books listed below, as well as journal articles.

Principles of Neural Science, Fifth or Sixth Edition. Eric Kandel et al. This is more of an encyclopedia or reference book for graduate students in neuroscience. We will not cover some of the topics, particularly those in molecular neuroscience.

Fundamental Neuroscience, Fourth or Fifth Edition. Larry Squire et al.

Upper-undergraduate/graduate texts:
From Neuron to Brain, Fifth Edition. John Nicholl et al.
Neuroscience, Fifth or Sixth Edition. Dale Purves.

More specialized texts (a couple of examples, there are many more, just ask me):
Spikes: Exploring the Neural Code. Fred Rieke et al.
Biophysics of Computation: Information Processing in Single Neurons. Christoph Koch.

Description:

An examination of the mechanisms by which nervous systems process information in normal and pathologic states. Cellular and systems-level information processing will be studied with a focus on sensory and motor systems. Students will gain some hands-on experience in the analysis of neural data. Some neuroanatomy will be included to understand how nervous systems are organized. Pathological states such as Alzheimer's, autism, and aging will be studied, both in terms of understanding the systems and cellular deficits as well as examining potential solutions to improve the outcomes for these neural disorders.

Learning Objectives:

1. Describe the organization of the mammalian nervous system, cellular neurophysiology, and neural plasticity
   Methods of evaluation: Exams, assignments
2. Apply neural information processing principles to determine how external and internal variables drive neural activity and behavior
   Methods of evaluation: Exams, neural coding project
3. Design experiments by selecting appropriate techniques and measurements in order to address an experimental question or hypothesis
   Methods of evaluation: Exams, modern techniques, research proposal
4. Analyze and interpret neural data to answer questions about neural coding and with respect to an experimental hypothesis
   Methods of evaluation: Neural coding project, assignments, modern techniques
5. Develop preliminary therapeutic solutions to neural disorders based on understanding neural mechanisms and devices used to measure or treat these disorders
   Methods of evaluation: Exams, assignments, disease mini-review
6. Craft effective written documents and oral presentations to explain a research narrative, a research topic, or a research technique.
   Methods of evaluation: Modern Techniques, Disease mini-review

Website: There is a web site for Bio/BME 595 on Brightspace. The Bio/BME 595 course website will have essential information related to the course, such as lecture slides, syllabus, problem sets, problem set answers, lecture recordings and useful neuroscience sites. You will log onto the site with your Purdue career account that has been assigned to you. For problems accessing the website please contact me.

Classes: Tuesdays, Thursdays noon-1:15 pm in MJIS 1001 and via EPE Distance Learning
Class slides: Preliminary class slides will probably be available in the late evening or early morning before class only. The class slides that are actually delivered during class will be posted on Brightspace following the class.

Exams. There will be two take home exams during the semester.
Exam dates:
Assigned February 10. Due February 24
Assigned April 6. Due April 20

Modern Neuroscience Techniques Teams of 3 people will create a technical summary and synthesis regarding what is known about innovative techniques in neuroscience. Full details TBA. This will be due **February 10.**

Neural coding project: This assignment will be to conduct analysis of neural data, either provided to you or from a project in your lab. Further details will be given during the semester. The proposed experiment topics will be due **Feb 13**, and the report based on the experiments is due **March 9**.

Research Grant Proposal: You will write the specific aims for one grant proposal in the format of an NIH F31 grant (NRSA pre-doctoral fellowship). After review of the aims by myself and peers, a

revised aims, experimental methods/design, and predicted data/figures will be submitted. The preliminary aims will be due **Feb 28**. The revised aims and the methods are due **March 28**.

Neural disease mini-review Teams of 3 people will create a technical summary and synthesis regarding what is known and what outstanding questions there are for a neurological disease, disorder or pathology. Full details TBA. This will be due **April 28.**

Re-grade: A graded exam will be considered for re-grades. You must submit a written request to the instructor within **one week** of receiving the graded document. Your request must contain a justification for the re-grade request. Keep in mind that the entire question being considered will be re-graded, so it is possible that the score for the re-graded question could be higher or lower than the original. The final exam will not be re-graded.

Grading. Grades will be based upon the scores acquired on exams and assignments.

Exams I-II	17.5% each
Research Grant Proposal preliminary and final report	12.5%
Neural disease mini-review, oral presentation, Q/A	12.5%
Modern techniques in Neuroscience, oral presentation, Q/A	12.5%
Homeworks, smaller assignments/participation	15%
Neural data analysis project	12.5%
Total	100%

Grades will be guaranteed for the following scores, but may be curved by the instructor.

A+	>95 %
A	>91-95 %
A-	>88-91%
B+	>84 - 88 %
B	>80 - 84%
B-	>77- 80 %
C+	>74- 77 %
C	>70 - 74 %
C-	>67 - 70%
D	>60-67 %

Attendance and Participation Attendance is strongly recommended for those on-campus. All materials will be posted on Brightspace. Participation in class activities is included in the course grade, but it can take a variety of forms, including but not limited to in-class discussion or discussions on Slack or Brightspace, and providing feedback to recorded oral presentations.

Statement of Academic Integrity

The commitment of acts of cheating, lying, and deceit in any of their diverse forms such as: the use of substitutes for taking examinations, use of illegal cribs, plagiarism and copying during homework, projects, or examinations is dishonest and will not be tolerated.

Definition of Academic Dishonesty

Purdue University prohibits dishonesty in connection with any University activity. Cheating, plagiarism or knowingly furnishing false information to the University are examples of dishonesty. Students caught cheating will receive a zero for the assignment or exam and possibly additional punishments depending on the severity of the infraction. If a student is caught violating the academic

integrity code a second time, then the student will automatically receive a failing grade in the course. Furthermore, individual case(s) may be referred to the Dean of Students office.

Accessibility: Purdue University strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let me know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247.

Nondiscrimination Statement: Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life.

Emergency Information

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances. Here are ways to get information about changes in this course: 1. Message via the Blackboard site for the course. 2. Email.

MJIS specific instructions: In case of fire, evacuate the building preferably via the EAST doorways (towards So. Russell St.) if they are free of hazards. DO NOT use the West doorways as a primary exit as those will be the doors accessed by emergency responders and fire personnel. In case of a tornado warning, proceed to the basement hallway via the East stairwell, nearest the classroom. In the case of a civil disturbance, such as an active shooter, seek a safe location, preferable a room without windows that can be locked or secured by barriers. Lab areas (second and third floors) or basement animal facilities, which are both locked, could be used.

Covid and general illness guidelines: *If you are feeling ill, in order to be mindful and courteous of your peers and instructors, please do not come to class.* Along the same lines, if you have tested negative for COVID and are not feeling ill but have a persistent cough, please wear a mask to class. Although participation is an important component of the course, there are many ways that one can participate. If you must quarantine or isolate at any point in time during the semester, please reach out to me via email so that we can communicate about how you can continue to learn remotely. Importantly, if you find yourself too sick to progress in the course, notify your academic case manager and notify me via email or Brightspace. We will make arrangements based on your particular situation.

Mental Health/Wellness:

If you find yourself beginning to feel some stress, anxiety and/or feeling slightly overwhelmed, try WellTrack**.** Sign in and find information and tools at your fingertips, available to you at any time.

If you need support and information about options and resources, please contact or see the Office of the Dean of Students. Call 765-494-1747. Hours of operation are M-F, 8 am- 5 pm.

If you find yourself struggling to find a healthy balance between academics, social life, stress, etc. sign up for free one-on-one virtual or in-person sessions with a Purdue Wellness Coach at RecWell. Student coaches can help you navigate through barriers and challenges toward your goals throughout the semester. Sign up is completely free and can be done on BoilerConnect. If you have any questions, please contact Purdue Wellness at evans240@purdue.edu.

If you're struggling and need mental health services: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS office on the second floor of the Purdue University Student Health Center (PUSH) during business hours.

Prof. Bartlett reserves the right to alter the course as needed during the semester in order to fulfill course learning objectives and to further student understanding.

BME 510 *Neural Mechanisms in Health and Disease* Spring 2023
Outline of topics

Week	Date	Topics
Weeks 1-2	Jan 10-19	Introduction: Levels of organization Review of basic neuronal elements and signaling Single neuron plasticity and computation
Weeks 3-4	Jan. 24-Feb. 2	Organization of nervous system Analysis of neuroanatomy data
	Jan. 24	**Modern Techniques topic due**
Week 5-9	Feb. 6–Mar. 9	Sensory processing: Physical and chemical senses Feature extraction of sensory information Higher order sensory processing From sensory coding to perception Motor coding Sensorimotor integration
	Feb. 10	**Modern Techniques due**
	Feb. 10	**Take home exam 1: Neuron properties and organization of the nervous system, and sensory transduction. *Due Feb. 24***
	Feb. 13	**Neural coding topic due**
	Feb. 28	**Research proposal preliminary aims due**
	March 9	**Neural coding project due**

SPRING BREAK - NO CLASSES MARCH 13-17

Week 10	Mar. 21-23	Neuromodulation
Weeks 11-15	Mar. 28-Apr. 27	When brains attack: Neural disorders and neurodegeneration
	March 28	**Research grant final proposal DUE**
	April 6	**Take home exam on sensory/motor systems assigned. Due April 20**
	Disease/disorder mini-review due April 28	