Class Number: BMEN 6V87.003
Class Title: Special Topics in Biomedical Engineering - Bioelectric Systems
Semester: Spring 2017
Meeting Times: Mon & Wed, 8:30-9:45 AM
Location: CB3 1.304

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General Course Information

Pre-& Co-requisites; Other restrictions	Either graduate student with good academic standing or upper level undergraduate with permission. Topics are interdisciplinary, so successful students will need undergraduate level background knowledge in biology and electrical engineering.
Course Description	Introduction to the theoretical and applied aspects of bioelectrical phenomena spanning cells to tissue. Beginning with a quantitative understanding of the basis of electrical excitability, the course cover bioelectrical signal propagation, the physical basis of extracellular potentials and stimulation, biopotential amplifier design and use, and clinically relevant biosignal acquisition and analyses.
Student Learning Objectives/Outcomes	• Ability to understand the basis of bioelectricity and interpret measurements from bioelectric systems. • Ability to recognize and use equivalent circuit representation of physiologic systems that produce bioelectrical behavior. • Ability to analyze and design electrical circuits for the measurement of bioelectric phenomena. • Ability to create a scholarly review and present interpretations of an advanced topic in bioelectric systems.
Texts & Materials	Lecture notes have been developed from multiple sources. Reference text book: “Bioelectromagnetism - Principles and Applications of Bioelectric and Biomagnetic Fields”, by Jaakko Malmivuo and Robert Plonsey. Oxford University Press, New York, 1995. Slides and handouts posted on the class e–learning page. This class will consist mainly of lectures, presented in seminar style, which have been created from a number of sources to provide a comprehensive introduction to bioelectric systems. The lecture notes will be the primary guide for students. Students are encouraged to prepare themselves for class by reading through the posted lecture in advance. Students are expected to complete a project which will involve a driving question relevant to bioelectric systems. For this project, students will prepare and

	deliver a presentation (~15 min powerpoint) which will be evaluated by the instructor and his/her peers.

Assignments & Academic Calendar

January 9	Class orientation
January 11	Lecture 1: Electrical Terms and Review - 1
January 16	MLK Day, no class meeting
January 18	Lecture 2: Electrical Terms and Review - 2
January 23	Lecture 3: Biological Basis of Bioelectricity
January 25	Lecture 4: Membrane Conductance and Permeability
January 30	Lecture 5: Amplifiers
February 1	Lecture 6: Biopotential Amplifiers
February 6	Lecture 7: Subthreshold Membrane Behavior
February 8	Mid Term Exam
February 13	Lecture 8: Hodgkin-Huxley Experiments
February 15	Lecture 9: Hodgkin-Huxley Modeling
February 20	Lecture 10: Patch Clamp & Markhov Modeling
February 22	Lecture 11: Volume Conductors
February 27	Lecture 12 (Guest): Neuronal Ion Channels – Dr. Bryan Black
March 1	Lecture 13: Electrodes (abstract for project due)
March 8	Lecture 14: ECG – Mean Electrical Axis
March 10	Lecture 15: Cardiac Pacing and Defibrillation
March 13, 15	UT Dallas Spring Break
March 20	Lecture 16: Electromyograms
March 22	Lecture 17: Electroencephalograms and Electrooculograms
March 27	Mid Term 2
March 29	Lecture 18: Biophysics of Neural Stimulation
April 3	Lecture 19: Nerve Stimulation – Vagal and Dorsal Root Ganglion
April 5	Lecture 20: Biophysics and Technology for Optogenetics
April 10	Lecture 21: Deep Brain Stimulation for Parkinson's Disease
April 12	Lecture 22: Electrical Safety: Macro and Microscale
April 17	Project Presentations
April 19	Project Presentations
April 24	Project Presentations
April 26	Final Review
TBD	Final Exam

Course Policies

Grading (credit) Criteria	Homework (15%), exams (25%), in-class presentation (25%), final cumulative exam (25%), attendance (10%)
Make-up Exams	There will be no make-up exams except for the most extreme of documented emergencies or through prior scheduling.
Extra Credit	As offered during lecture at discretion of the instructor.
Late Work	Credit for homework assignments that are late will be reduced by 10% each day; no late homework accepted after 1 week.

Special Assignments	N/A
Class Attendance	N/A
Classroom Citizenship	Laptops, tablets, and smart phones must be turned off and put away during quizzes and exams.
Field Trip Policies	N/A
Student Conduct and Discipline	The University of Texas System and The University of Texas at Dallas have rules and regulations for the orderly and efficient conduct of their business. It is the responsibility of each student and each student organization to be knowledgeable about the rules and regulations which govern student conduct and activities. General information on student conduct and discipline is contained in the UTD publication, A to Z Guide, which is provided to all registered students each academic year. The University of Texas at Dallas administers student discipline within the procedures of recognized and established due process. Procedures are defined and described in the Rules and Regulations, Board of Regents, The University of Texas System, Part 1, Chapter VI, Section 3, and in Title V, Rules on Student Services and Activities of the university's Handbook of Operating Procedures. Copies of these rules and regulations are available to students in the Office of the Dean of Students, where staff members are available to assist students in interpreting the rules and regulations (SU 1.602, 972/883-6391). A student at the university neither loses the rights nor escapes the responsibilities of citizenship. He or she is expected to obey federal, state, and local laws as well as the Regents' Rules, university regulations, and administrative rules. Students are subject to discipline for violating the standards of conduct whether such conduct takes place on or off campus, or whether civil or criminal penalties are also imposed for such conduct.
Academic Integrity	The faculty expects from its students a high level of responsibility and academic honesty. Because the value of an academic degree depends upon the absolute integrity of the work done by the student for that degree, it is imperative that a student demonstrate a high standard of individual honor in his or her scholastic work. Scholastic dishonesty includes, but is not limited to, statements, acts or omissions related to applications for enrollment or the award of a degree, and/or the submission as one's own work or material that is not one's own. As a general rule, scholastic dishonesty involves one of the following acts: cheating, plagiarism, collusion and/or falsifying academic records (consult http://www.utdallas.edu/judicialaffairs/UTDJudicialAffairs-AvoidDishonesty.html for further information). Students suspected of academic dishonesty are subject to disciplinary proceedings. Plagiarism, especially from the web, from portions of papers for other classes, and from any other source is unacceptable and will be dealt with under the university's policy on plagiarism (see general catalog for details).

	This course will use the resources of turnitin.com, which searches the web for possible plagiarism and is over 90% effective.
Email Use	The University of Texas at Dallas recognizes the value and efficiency of communication between faculty/staff and students through electronic mail. At the same time, email raises some issues concerning security and the identity of each individual in an email exchange. The university encourages all official student email correspondence be sent only to a student's U.T. Dallas email address and that faculty and staff consider email from students official only if it originates from a UTD student account. This allows the university to maintain a high degree of confidence in the identity of all individual corresponding and the security of the transmitted information. UTD furnishes each student with a free email account that is to be used in all communication with university personnel. The Department of Information Resources at U.T. Dallas provides a method for students to have their U.T. Dallas mail forwarded to other accounts.
Withdrawal from Class	The administration of this institution has set deadlines for withdrawal of any college-level courses. These dates and times are published in that semester's course catalog. Administration procedures must be followed. It is the student's responsibility to handle withdrawal requirements from any class. In other words, I cannot drop or withdraw any student. You must do the proper paperwork to ensure that you will not receive a final grade of "F" in a course if you choose not to attend the class once you are enrolled.
Student Grievance Procedures	Procedures for student grievances are found in Title V, Rules on Student Services and Activities, of the university's *Handbook of Operating Procedures*. In attempting to resolve any student grievance regarding grades, evaluations, or other fulfillments of academic responsibility, it is the obligation of the student first to make a serious effort to resolve the matter with the instructor, supervisor, administrator, or committee with whom the grievance originates (hereafter called "the respondent"). Individual faculty members retain primary responsibility for assigning grades and evaluations. If the matter cannot be resolved at that level, the grievance must be submitted in writing to the respondent with a copy of the respondent's School Dean. If the matter is not resolved by the written response provided by the respondent, the student may submit a written appeal to the School Dean. If the grievance is not resolved by the School Dean's decision, the student may make a written appeal to the Dean of Graduate or Undergraduate Education, and the deal will appoint and convene an Academic Appeals Panel. The decision of the Academic Appeals Panel is final. The results of the academic appeals process will be distributed to all involved parties. Copies of these rules and regulations are available to students in the Office of the Dean of Students, where staff members are available to assist students in interpreting the rules and regulations.
Incomplete Grades	Per university policy, incomplete grades will be granted only for work unavoidably missed at the semester's end and only if 70% of the course work

	has been completed. An incomplete grade must be resolved within eight (8) weeks from the first day of the subsequent long semester. If the required work to complete the course and to remove the incomplete grade is not submitted by the specified deadline, the incomplete grade is changed automatically to a grade of F.
Disability Services	The goal of Disability Services is to provide students with disabilities educational opportunities equal to those of their non-disabled peers. Disability Services is located in room 1.610 in the Student Union. Office hours are Monday and Thursday, 8:30 a.m. to 6:30 p.m.; Tuesday and Wednesday, 8:30 a.m. to 7:30 p.m.; and Friday, 8:30 a.m. to 5:30 p.m. The contact information for the Office of Disability Services is: The University of Texas at Dallas, SU 22 PO Box 830688 Richardson, Texas 75083-0688 (972) 883-2098 (voice or TTY) Essentially, the law requires that colleges and universities make those reasonable adjustments necessary to eliminate discrimination on the basis of disability. For example, it may be necessary to remove classroom prohibitions against tape recorders or animals (in the case of dog guides) for students who are blind. Occasionally an assignment requirement may be substituted (for example, a research paper versus an oral presentation for a student who is hearing impaired). Classes enrolled students with mobility impairments may have to be rescheduled in accessible facilities. The college or university may need to provide special services such as registration, note-taking, or mobility assistance. It is the student's responsibility to notify his or her professors of the need for such an accommodation. Disability Services provides students with letters to present to faculty members to verify that the student has a disability and needs accommodations. Individuals requiring special accommodation should contact the professor after class or during office hours.
Religious Holy Days	The University of Texas at Dallas will excuse a student from class or other required activities for the travel to and observance of a religious holy day for a religion whose places of worship are exempt from property tax under Section 11.20, Tax Code, and Texas Code Annotated. The student is encouraged to notify the instructor or activity sponsor as soon as possible regarding the absence, preferably in advance of the assignment. The student, so excused, will be allowed to take the exam or complete the assignment within a reasonable time after the absence: a period equal to the length of the absence, up to a maximum of one week. A student who notifies the instructor and completes any missed exam or assignment may not be penalized for the absence. A student who fails to complete the exam or assignment within the prescribed period may receive a failing grade for that exam or assignment.

	If a student or an instructor disagrees about the nature of the absence [i.e., for the purpose of observing a religious holy day] or if there is similar disagreement about whether the student has been given a reasonable time to complete any missed assignments or examinations, either the student or the instructor may request a ruling from the chief executive officer of the institution, or his or her designee. The chief executive officer or designee must take into account the legislative intent of TEC 51.911(b), and the student and instructor will abide by the decision of the chief executive officer or designee.
Off-Campus Instruction and Course Activities	Off-campus, out-of-state, and foreign instruction and activities are subject to state law and University policies and procedures regarding travel and risk-related activities. Information regarding these rules and regulations may be found at http://www.utdallas.edu/BusinessAffairs/Travel_Risk_Activities.htm. Additional information is available from the office of the school dean

Project Presentations: The following are examples of key questions for developing topics for projects. Projects can either be literature review based (as long as summary interpretations and future outlook is integrated into the presentation) or computer modeling based. The following are only examples, and not intended to be a comprehensive list of all possible topics. You are encouraged to develop your own key questions.

1. Compare and contrast different types of cortical microelectrode arrays. Is the long term performance any different between these devices?
2. Compare and contrast different types of peripheral nerve interfaces. Is the long term performance any different between these devices?
3. How can ultrasound be used for neural stimulation and recording? What is the biophysical basis for ultrasound – neural activity transduction?
4. Is there a strain, sex, or rodent species dependence to the longevity of neural recordings with implantable cortical probes?
5. Compare and contrast the effects and timing of a cortical electrode implantation with the neurodegenerative cascade or neural injury cascade?
6. Using computer modeling, is the extracellular potential that is recorded any different depending on whether or not it is propagating towards or away from an electrode site?
7. Using computer modeling, explore the parameter sensitivity of channelrhodopsin induced excitation in a mammalian neuron model or cardiac cell type. How does the effect of light stimulation depend on consistent channelrhodopsin expression?
8. Using computer modeling, explore how changes in tissue electrical characteristics changes resulting from chronic implantation, changes the region of excitation.
9. Identify a temperature or capsaicin sensitive channel or receptor, model its dynamics, and incorporate it in a computational model of a mammalian neuron or cardiac cell type. Explore the dose-response characteristics of temperature or capsaicin in the model on activity.

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Scoring Rubric for Oral Presentations. Presentations will be evaluated by the instructor(s) and peers. Adapted from Brewer, C.A., and D. Ebert-May. 1998. Hearing the case for genetic engineering: breaking down the barriers of anonymity through student hearings in the large lecture hall. Journal of College Science Teaching 28 (2): 97-101.

Presenter: _____ **Title:** _____ **Evaluator:** _____

Level of Achievement	Clarity	Content	Style/Delivery	Use of Visual Aids	Integration of Knowledge	Ability to Answer Questions
Excellent **4 Points**	• Well thought out • Use of proper language • Significance clearly stated and compelling • Bibliography provided for audience in proper format	• Identifies the research question or work • Has advanced understanding of the experimental approach and significance • Critically evaluates findings and clearly states limitations • Scientifically rigorous and well researched	• Uses time wisely • Logical progression • Speaks with good pacing • Makes eye contact with audience consistently • Uses engaging tone and vocabulary	• Well placed images • Charts summarize data and/or conclusions • Size and labels are clear • Very little text • Figures and images explained and described well • No issues with Powerpoint setup and execution	• Integrates research findings to broader context • Understands implication of data or method • Identifies future avenues of investigation • Supports arguments or explanation with references	• Anticipates audience questions • Understands audience questions • Can integrate knowledge to answer questions • Thoroughly responds to questions
Good **3 Points**	• Well thought out • Use of proper language • Significance stated adequately • Bibliography provided for audience but not in proper format	• Identifies the research question or work •Has basic understanding of the experimental approach • States findings and identifies few limitations • Well researched	• Spends too much time on introduction • Speaks well, but often back tracks • Makes good eye contact most of the time • Uses good vocabulary and tone	• Excellent images but not always well placed • Size and labels are clear • Very little text • Figures and charts are explained well • Powerpoint issues resolved	• Supports arguments or explanation with references • Minimally integrates research findings to broader context • Has some understanding of the implications of data or method • Identifies some future avenues of investigation	• Does not anticipate audience questions • Understands the audience questions • Can integrate knowledge to answer the question • Thoroughly responds to most questions
Adequate **2 Points**	• Talk is somewhat disorganized • Shows some effort to use proper language • Significance a bit unclear • Bibliography provided is not well formatted	• Research question a bit unclear • Description of experimental approach a bit confusing • Results and conclusions stated but not critically evaluated • Limited use of outside readings	• Presentation poorly timed • Presentation jumping from different topics • Some hesitation and uncertainty are apparent • Makes little eye contact • Monotone and non-engaging delivery	• Labels and legends are a bit unclear • Size might be a bit too small • Too much detail • Blocks of text on handouts or slides • Figures are explained well • Powerpoint issues resolved	• Does not integrate the work or method into the broader context • Supports argument or explanation with few references • Makes some errors in interpretation and application of data or method • Makes few connections between data, method, and conclusions	• Does not anticipate audience questions • Makes an effort to address question • Can address some questions • Overlooks obvious questions • Often responds poorly to questions
Inadequate **1 Points**	• Talk difficult to follow • Unclear language • Does not understand significance of paper • Incomplete bibliography	• Does not understand research or work • Does not understand experimental approach • Does not understand conclusions or recognize implications for future work	• Presentation poorly timed • Jumbled with no logical progression • Makes no eye contact and reads from notes • Hesitation and uncertainty are apparent	• Labeling is not clear • Too small to see • No logical placement • Mostly text and very few images • Figures are not explained • Powerpoint issues unresolved	• Does not integrate the work or method into the broader context • Makes little effort to use data to support arguments • Misinterprets information Makes no connections between data, method, and conclusions • Lacks logic	• Either makes no effort to respond to questions or does so poorly
No effort **0 Points**						

These descriptions and timelines are subject to change at the discretion of the Instructor.