

BME 271: Introduction to Bio-electricity and Bio-photonics

Credits: 4

Prerequisites: AMS 161 or MAT 127 or 132 or 142 or 171; PHY 127/134 or PHY 132/134 or PHY 142

Course Instructor: Professor M. Hassan Arbab, PhD
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Meeting Times/place: Tuesdays, Thursdays, 5:30 – 6:50 PM; recitations: Fridays 11-11:50 AM in Javits 111.

Course Description: BME 271, is an introductory course to two key areas of modern biomedical engineering discipline: bioelectricity and bio-photonics. In the first part of the class, we begin with fundamental theory of circuit analysis, including lumped time-invariant models of resistors, capacitors, inductors, Ohm's Law, Kirchoff's Laws, nodal and mesh analysis for electric circuits, two-port equivalent circuits, steady-state AC circuits, phasor and transient analysis using Laplace Transform. The applications of basic circuit analysis techniques in biological circuitry will be discussed throughout the first part of the class. In the second part of the course, the principles of cell electrophysiology, bio-potentials and electrical interactions with tissue will be studied. Finally, in the third part, we will cover ray optics, including reflection, refraction, lenses and image formation, and wave optics for introduction to bio-photonics.

General Goal: The class provides the foundations for, and an introduction to, key topics in Bio-electricity and Bio-photonics. As a first course of a 3-class series in the bioelectricity track of the BME undergraduate curriculum (leading to BME 301), the course constitutes **three modules**:

1. Electrical circuit analysis (approximately 70% of the course, including midterms 1 and 2)
2. Bio-electricity and cell electrophysiology
3. Introduction to bio-photonics (introducing the wave nature of light)

Specific Objectives: By the end of the class, the students should be able to:

1. To introduce the alphabets of electrical circuits, and apply Kirchoff's current and voltage laws,
2. To simplify circuits using series and parallel equivalents and perform node and mesh analysis,
3. To understand and analyze first and second order linear time-invariant (LTI) circuits,
4. To perform AC analysis and build frequency-domain models of basic electric systems,
5. To understand the origins of bio-potentials and apply circuit analysis techniques to problems in cell electrophysiology,
6. To Understand the wave nature of light and apply optical ray tracing techniques to solve problems of image formation in bio-photonics.

Course Material:

Required Textbook: Nilsson and Riedel, "Electric Circuits," 10th Edition, 2014.

Optional: Saleh and Teich, "Fundamentals of Photonics," (any edition, this book will be used in BME 301 too).

Other relevant materials, specially related to Module 2, will be provided as assigned reading including all lectures notes and assigned readings will be made available through blackboard.

Grading

40% mid-term exams (2 exams, 20% each)

30% Homework assignments (10 HW assignments, 3% each)

25% Final Exam

5% Portfolios

Tentative Schedule: The course schedule is subject to change throughout the semester. Updated versions of changes will be posted to blackboard. The students are expected to have studied the topic from the textbook, or the reading assignment prior to the class. Recitations will take place on 2nd half of Thursdays.

Day	Date	Lecture topic, reading assignment	Assignments
Tue	8/29/ 17	Module 1 Circuit Analysis: Introduction, electrical charge, voltage and current, energy, power, voltage and current sources	Chapter 1
Thu	8/31/	ideal circuit element, Resistors, ohm's law, Kirchhoff's laws	Ch. 2
Tue	9/5	No class in session (University Holiday)	
Thu	9/7	Series and parallel resistors, voltage & current division, Wheatstone bridge	Ch. 3, HW#1
Tue	9/12	Node-voltage Analysis	Ch. 4.1-4.8
Thu	9/14	Mesh-current Analysis	HW #2 due
Tue	9/19	More on Nodal and Mesh Analysis, source transformation	Ch. 4.9-4.13
Thu	9/21	Thevenin and Norton equivalent circuit	HW #3 due
Tue	9/26	Maximum power transfer, superposition	Ch. 4
Thu	9/28	Operational Amplifiers (part 1)	Ch. 5, HW#4
Tue	10/3	Mid-term Exam 1 (covering chapters 1-4)	
Thu	10/5	Operational amplifiers (part 2); Inductors, Capacitors, first order circuits	Ch. 6
Tue	10/10	RL, RC (1 st order) circuits, natural and step response	Ch. 7
Thu	10/12	RLC Circuits, natural and step response	Ch. 8, HW#5
Tue	10/17	Sinusoidal Source, Phasors, KVL and KCL in frequency domain,	Ch. 9.1-9.6
Thu	10/19	Nodal and Mesh analysis, Thevenin and Norton equivalent circuits in Frequency domain, Transformer	Ch. 9.7-9.12, HW#6 due
Tue	10/24	Instantaneous power, average and complex power	Ch. 10
Thu	10/26	Laplace transform; step and impulse functions	Ch. 12, HW #7
Tue	10/31	Applying Laplace transform, Poles and Zeros	Ch. 12.6-12.9
Thu	11/2	Circuit analysis in s-domain, transfer functions	Ch. 13, HW #8
Tue	11/7	Frequency response and bode plots	Ch. 13.6-13.8
Thu	11/9	Mid-term Exam 2 (covering chapters 5-10)	
Tue	11/14	Module 2 Bio-electricity: Origins of bio-potentials, Rs and Cs in biology	handouts
Thu	11/16	bio-amplifiers, introduction to cell electrophysiology	HW #9 due
Tue	11/21	Module 3: bio-photonics: introduction to Ray Optics, Reflection, Refraction, geometrical optics, image formation in a simple microscope	Lecture notes
Thu	11/23	Thanksgiving holiday	
Tue	11/28	When KVL and KCL break down...!!! Voltage and current as a wave	handouts
Thu	11/30	Light as a wave, wave propagation	HW #10 due
Tue	12/5	Course review	handouts
Thu	12/7	Final EXAM IN CLASS: 5:30-6:50 PM	

Program Outcomes and Assessment (ABET)

The following list describes particular skills you are expected to learn based on course material: (e) Students gain the ability to identify, formulate, and solve problems at the interface of engineering and biology.

LATE WORK POLICY: For work submitted after the deadline (24 hours max) without serious excuse and note in advance, the student gets 50% credit.

DISABILITY SUPPORT SERVICES (DSS): If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Disability Support Services, ECC (Educational Communications Center) Building, room128, (631) 632-6748. They will determine with you what accommodations, if any, are necessary and appropriate. All information and documentation is confidential. Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and Disability Support Services. For procedures and information go to the following website:

<http://www.stonybrook.edu/ehs/fire/disabilities>

ACADEMIC INTEGRITY: Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty are required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website:

<http://www.stonybrook.edu/uaa/academicjudiciary/>

CRITICAL INCIDENT MANAGEMENT: Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures.

RECORDING OF LECTURES: Audio or video recording of lectures by students requires prior permission of the individual lecturer. (Stony Brook University Policy 512).

Electronic Communication Statement: Email and especially email sent via Blackboard (<http://blackboard.stonybrook.edu>) is one of the ways the faculty officially communicates with you for this course. It is your responsibility to make sure that you read your email in your official University email account. For most students that is Google Apps for Education (<http://www.stonybrook.edu/mycloud>), but you may verify your official Electronic Post Office (EPO) address at

<http://it.stonybrook.edu/help/kb/checking-or-changing-your-mail-forwardingaddress-> in-the-epo. If you choose to forward your official University email to another off campus account, faculty are not responsible for any undeliverable messages to your alternative personal accounts. You can set up Google Mail forwarding using these DoIT-provided instructions found at

<http://it.stonybrook.edu/help/kb/setting-up-mail-forwarding-in-google-mail>.

If you need technical assistance, please contact Client Support at (631) 632-9800 or orsupportteam@stonybrook.edu.