NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

COURSE CONTENT

Academic Year	2023/2024	**Semester**	2
Course Coordinator	Prof. Chen Peng		
Course Code	BG2110		
Course Title	Bioelectricity (Core)		
Pre-requisites	BG1131/CB1131/BG1141		
No of AUs	3		
Contact Hours	*31 hours lecture, 8 hours tutorial*		
Proposal Date	*24 May 2020*		

Course Aims

As many biomedical diagnosis devices (e.g. ECG) and pharmaceutical treatments (e.g. drugs targeting on ion channels for heart diseases) are based on bioelectricity, this course will be useful for your future study (e.g. for courses such as Bioinstrumentation) and career in biomedical industry.

Intended Learning Outcomes (ILO)

By the end of this course, you (as a student) would be able to:

1. Recognize the physiological relevance of bioelectric phenomena and distinguish the differences between bioelectricity and man-made electronics
2. Recognize the governing functions for diffusion and drift, describe the similarities and difference between them
3. Explain ion transport across cell membrane and electrical models for cell membrane
4. Explain the methods to study ion channel structures and functions
5. Describe patch clamp technique
6. Interpret and analysis stochastic channel gating
7. Explain action potential and Hodgkin-Huxley model
8. Explain how an excitable cell responds to electrical stimulation
9. Explain how electrical signal is transmitted from one neuron to another
10. Explain excitation-contraction coupling at neuromuscular junction

Course Content

Introduction to Bioelectricity; Ionic current; Cell Membrane and Membrane Potential; Ion Channel Structures and Properties; Single Channel Current and Measurement; Channel Gating; Action Potential and Hodgkin-Huxley Model; Electrical Stimulation of Excitable Cells; Neural Electrophysiology; Neuromuscular Junction

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes	Weighting	Team /Individual	Assessment rubrics
1. Take home assignment 1	5	a, b, c, d, j	10 %	individual	Refer to appendix 1
2. In class Quiz	1-6	a, b	15%	individual	Refer to appendix 1
3 Take home assignment2	7	a, b, c, d, j	15 %	individual	Refer to appendix 1
4. Final Examination (2 hrs Closed Book)	1-10	a, b, c, d, f	60 %	individual	Refer to appendix 1
Total			100 %		

Mapping of Course ILOs to EAB Graduate Attributes

Course Intended Learning Outcomes	Cat	EAB's 12 Graduate Attributes*											
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)
	Core	●	●	◐	◐		◐				◐		◐

1. Recognize the physiological relevance of bioelectric phenomena and distinguish the differences between bioelectricity and man-made electronics	a, b, f
2. Recognize the governing functions for diffusion and drift, describe the similarities and difference between them	a, b
3. Explain ion transport across cell membrane and electrical models for cell membrane	a, b
4. Explain the methods to study ion channel structures and functions	a, b, c
5. Describe patch clamp technique	a, b, c, d, j
6. Interpret and analysis stochastic channel gating	a, b, c
7. Explain action potential and Hodgkin-Huxley model	a, b, c, d, j
8. Explain how an excitable cell responds to electrical stimulation	a, b, c
9. Explain how electrical signal is transmitted from one neuron to another	a, b, c
10. Explain excitation-contraction coupling at neuromuscular junction	a, b, c

Formative feedback

Examination results;
Marker's report on overall examination performance will be uploaded to NTUlearn;
Quiz answers will be discussed in class

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
Lecture	Demonstrate how to carry out a procedure such as working through a problem, use incomplete handouts which enabling students participating in class.
Tutorial	Classroom discussion sessions on tutorial questions and related topics

Reading and References

1. Bertil Hille, **Ion Channels of Excitable Membranes**, 3rd ed, Sinauer Associates, Inc.

Course Policies and Student Responsibilities

General: Students are expected to complete all online activities and take all scheduled assignments and tests by due dates. Students are expected to take responsibility to follow up with course notes, assignments and course related announcements. Students are expected to participate in all tutorial discussions and activities.

Continuous assessments: Students are required to attend all continuous assessments.
Absenteeism: Continuous assessments make up a significant portion of students' course grade. Absence from continuous assessments without officially approved leave will result in no marks and affect students' overall course grade.

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	Office Location	Phone	Email
Chen Peng	N1.3-B3-08	6514 1086	chenpeng@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	Introduction To Bioelectricity	1	Face to face lecture In-class quiz
2	Ionic Current	2	Face to face lecture Tutorial 1 In-class quiz
3-4	Cell Membrane And Membrane Potential	3	Face to face lecture Tutorial 2 In-class quiz
5	Ion Channel Structures And Properties	4	Face to face lecture Take-home assignment 1 In-class quiz
6	Single Channel Current & Measurement	5	Face to face lecture Tutorial 3 In-class quiz
7	Channel Gating	6	Face to face lecture Tutorial 4 In-class quiz
8-9	Action Potential And Hodgkin-Huxley Model	7	Face to face lecture Take-home assignment 2 Tutorial 5
10	Electrical Stimulation of Excitable Cells	8	Face to face lecture Tutorial 6
11-12	Neural Electrophysiology	9	Face to face lecture Tutorial 7
13	Neuromuscular Junction	10	Face to face lecture Tutorial 8

Appendix 1: Assessment Criteria

Criteria	Unsatisfactory: <40%	Borderline: 40% to 49%	Satisfactory: 50% to 69%	Very good: 70% to 89%	Exemplary: >90%
Knowledge & Comprehension Understanding of principles of biomedical instruments and sensors	• Lacks understanding of the principles of instruments and sensors.	• Partial understanding of the principles of instruments and sensors.	• Good understanding of the principles of instruments and sensors.	• Good and comprehensive understanding of the principles of instruments and sensors.	• Very good and comprehensive understanding of the principles of instruments and sensors.
Application Applying different principles to solve problems	• Unable to understand theoretical concepts of how instruments work and apply the knowledge to design and optimize biomedical instruments and sensors	• Can read and partially understand theoretical concepts of how instruments work and apply the knowledge to design and optimize biomedical instruments and sensors	• Can read and understand theoretical concepts of how instruments work and apply the knowledge to design and optimize biomedical instruments and sensors	• Can read and understand theoretical concepts of how instruments work and apply the knowledge to design and optimize biomedical instruments and sensors	• Can read and understand theoretical concepts of how instruments work and apply the knowledge to design and optimize biomedical instruments and sensors
Evaluation Able to solve numerical problems in designing instruments and sensors	• Calculations are attempted but are both unsuccessful and are not comprehensive.	• Calculations are attempted but represent only a portion of the calculations required with some comprehensive to solve the problem.	• Calculations attempted are mostly successful and sufficiently comprehensive to solve the problem.	• Calculations attempted are all successful and sufficiently comprehensive to solve the problem.	• Calculations attempted are all successful and fully comprehensive to solve the problem; calculations are also presented elegantly
Analysis Able to analyze problems, make reasonable assumptions, and choose appropriate methods.	• Unable to make reasonable assumptions and judgment according to the nature of the problems, uncertain about drawing any conclusions.	• Can make reasonable assumptions and judgment, but the choice of methods are not appropriate, uncertain about the accuracy of the outcome.	• Can make reasonable assumptions and judgment, can choose appropriate methods and predict the outcome mostly, but not necessarily the best choice.	• Can make reasonable assumptions and judgment, can choose appropriate methods and predict the outcome, can draw reasonable conclusions.	• Can make correct assumptions, can choose appropriate methods to solve the problem and draw conclusions. Can identify potential problems and tailor the process accordingly.

Appendix 2: The EAB (Engineering Accreditation Board) Accreditation SLOs (Student Learning Outcomes)

a) **Engineering knowledge:** Apply the knowledge of mathematics, natural science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems
b) **Problem Analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c) **Design/development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
d) **Investigation:** Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e) **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations
f) **The engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g) **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for the sustainable development.
h) **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i) **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
j) **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k) **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and economic decision-making, and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l) **Life-long Learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change