



University of Pretoria

ELECTRICAL, ELECTRONIC AND COMPUTER ENGINEERING
BIO-ENGINEERING: BIOELECTRICITY
AND ELECTRONICS EBE732
STUDY GUIDE
2009

Prepared by
Prof. Johan J. Hanekom

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1. Lecturer and secretary

Lecturer: Prof. Johan J. Hanekom
Office: Room 13-21
Engineering 1 Building
Main Campus
Telephone: (012) 420-2461 (w)

Mail address: Dept. of Electrical, Electronic and Computer Engineering
University of Pretoria
Pretoria, 0002

Fax: (012) 3625000
E-mail: johan.hanekom@up.ac.za
Consulting hours: By appointment

Secretary: Mrs Hanneljie van Aswegen
Office: 14-6 Engineering 1 Building
Telephone: (012) 420-3757

2. References

2.1 Prescribed

[1] **Plonsey, R. and Barr, R.C.**, Bioelectricity: a quantitative approach (preferred 2nd ed), Kluwer Academic/ Plenum Publishers, New York, 2000.

Books may be ordered through the campus bookstore, other bookstores or one of the local or international internet bookshops.

Kindly note that this module will include development of computer simulations. These must be coded in Matlab or Simulink. It is required that students have access to Matlab and/or Simulink.

2.2 Recommended

- [2] Reilly, J. P., Applied bioelectricity: from electrical stimulation to electropathology, Springer, New York, 1998
- [3] Rattay, F., *Electrical Nerve Stimulation*, Springer Verlag, Vienna & New York, 1990
- [4] Marieb, E., *Human Anatomy and Physiology*, Benjamin Cummings (any edition)

At least some of the discussions will be based on these recommended textbooks, especially the textbook of Rattay. All of these are available in the University library. The book of Marieb may be replaced by any other good anatomy and physiology textbook.

2.3 Recommended journals

These are journals (not an exhaustive list) that contain many bio-engineering articles that may be used as valuable resources for studies in bio-engineering. Most of these are available electronically through the University library website.

- IEEE Engineering in Medicine and Biology Magazine
- IEEE Transactions on Neural Systems and Rehabilitation Engineering
- IEEE Transactions on Biomedical Engineering
- Journal of the Acoustical Society of America
- Hearing Research
- Journal of Biomedical Engineering
- Journal of Medical Engineering and Physics
- Annals of Biomedical Engineering
- Medical Engineering and Computing
- Neural Computation
- Biological Cybernetics

3. Module objectives and study themes

This module is an introduction to the field of bioelectricity. Bioelectricity as a field of study includes the study of the electrical characteristics of neural tissue and the electrical stimulation of nerves fibres. It encompasses aspects from the traditional disciplines of neuroscience, neurophysiology, computational neuroscience, functional electrical stimulation, electrical nerve stimulation, psychophysics, prosthetic and orthotic device technology and environmental adaptations and controllers. Not all of these are discussed in this module.

The topics to be studied in the module were chosen to provide a focussed introduction to bioelectricity, rather than a wide overview. Knowledge and principles will be taught by theoretical development and by practical examples. Most of the module will focus on the study of physiology from an engineering perspective and on the theory and practice of electrical nerve stimulation.

The outcomes of the module will be the following.

- (1) The student (a graduate engineer or scientist) will learn to use engineering tools to understand electrophysiology.
- (2) The student will gain understanding of the role that engineers can play in rehabilitation of disabled people.
- (3) The student will learn how to apply the theory and practice of electrical nerve stimulation.

Where material in addition to the prescribed book is required, references given in [2-4] may be helpful, and the journals given in the reference list should also be consulted.

The module is divided into four syllabus themes.

Syllabus theme 1: Theoretical approach to basic electrophysiology

- 2.1 Bioelectric potentials [1, ch. 3; 2, ch 1, 2, 3, 4]
- 2.2 Membrane channels [1, ch. 4]
- 2.3 Action potentials and the Hodgkin-Huxley model [1, ch. 5]
- 2.4 Action potentials propagation [1, ch. 6]

Syllabus theme 2: Electrical nerve stimulation theory

- 3.1 Electrical stimulation of excitable tissue [1, ch. 7; 2, ch 7, 8]
- 3.2 Simulations using the Hodgkin-Huxley model [3]

Syllabus theme 3: Electrophysiology of muscle fibre

- 4.1 The neuromuscular junction [1, ch. 10; 2, ch 8]
- 4.2 Skeletal muscle [1, ch.11; 2, ch 8]

Syllabus theme 4: Electrical nerve stimulation practice

- 5.1 Functional electrical stimulation [1, ch.12; 2, ch 8; 2, ch 9]
- 5.2 Practical aspects of electrical nerve and muscle stimulation: stimulation parameters, choice of electrode, stimulation waveform [class notes]
- 5.3 Introduction to the biomechanics of standing and walking; functional electrical stimulation for standing and walking [class notes]
- 5.4 Placement of electrodes; motor and sensory feedback [class notes]

4. Assessment

4.1 Policy

A number of assignments (that may include problems from the prescribed book) will be given throughout the semester. Also, a written test may be taken at the mini-block weeks. The module will include practical work, which may be completed during the mini-blocks. The examination will consist of a number of assignments, including computer simulations.

Attendance of scheduled contact time is compulsory. Students are encouraged to participate in discussions and to share knowledge with each other.

Communication outside of scheduled contact time will be by e-mail. Students are required to check their e-mail regularly. Details of assignments will also be announced by e-mail.

4.2 Composition of marks

Final mark

The semester mark and the examination mark will each contribute 50 % towards the final mark.

Semester mark

The semester mark is based on the marks for the assignments.

The completion of each assignment is compulsory to receive entrance into the examination. No handwritten assignments will be accepted.

4.3 Examination refusal

Students with semester marks below 40% will not be allowed to attempt the final examination.

4.4 Ethics

Students are encouraged to discuss module work with each other. *However, each student should hand in his/her own work for assignments. Note the University policy on plagiarism. Plagiarism, including copying the work of another student and copying from the Internet, is absolutely unacceptable. Dishonesty such as plagiarism during assignments, tests and exams can be punished by expulsion from the University.*

In addition, please note the following (provided by the University's Legal Services Department):

“Under the definitions of misconduct a student is guilty of misconduct if he/she is guilty of any conduct that infringes copyright or any other form of the law of immaterial property and such conduct proves to be detrimental to the University.

The inclusion of the work of other authors (literacy works) in dissertations and theses has to be done in accordance with the provisions of the Copyright Act, 98 of 1978. This Act states that the copyright in a literary work (also if made available electronically) shall not be infringed by a short quotation therefrom provided that the source shall be mentioned as well as the name of the author. Non-compliance with these provisions will therefore not only be a contravention of the Rules of the University, but also a crime in terms of the South African Law”.

5. Assignments

Assignments will be distributed via e-mail.

6. Student activity schedule

The student will work through much of the prescribed material on his/her own during the module. This work and assignments will be discussed at scheduled contact times. Written tests on the work that had to be completed may be taken at the mini-blocks.

The module will commence with an introductory lecture in February. Additional contact time for this module will be scheduled during the two mini-block weeks as necessary.

Date	Action	References
Before mini-block 1	Assignments and reading work will be made available via e-mail. You will read up to chapter 5 of the textbook.	
At mini-block 1	To be announced	
Between the block weeks	To be announced	
At mini-block 2	To be announced	
After mini-block 2	To be announced	
12 June	Exam assignment due	