University of Macau

Faculty of Science and Technology

Department of Electrical and Electronics Engineering

Part A: Course Outline

<table>
<tr><td>Course Title:</td><td colspan="4">Introduction to Biomedical Engineering</td></tr>
<tr><td>Course Code:</td><td colspan="2">ELEC483</td><td>Year of Study:</td><td>4</td></tr>
<tr><td>Course Mode:</td><td colspan="4">Theoretical with substantial laboratory/ practice content</td></tr>
<tr><td>Compulsory/Elective:</td><td colspan="4">Elective</td></tr>
<tr><td>Course Prerequisites:</td><td colspan="4">CPTG300, ELEC352, ELEC261</td></tr>
<tr><td>Prerequisite Knowledge</td><td colspan="4">Biology, Physiology, Physics, Calculus, Electronics, Circuit Analysis, Microprocessors, Instrumentation, Digital Signal Processing</td></tr>
<tr><td rowspan="2">Class/Laboratory Schedule:</td><td>U102 (Lec)</td><td rowspan="2">Time</td><td colspan="2">Tue, 09:30-11:30 (Lec)</td></tr>
<tr><td>NG06 (lab)</td><td colspan="2">Wed, 08:30-09:30 (Lec), 14:30-16:30 (Lab)</td></tr>
<tr><td>Duration</td><td colspan="2">One semester</td><td>Credit Units</td><td>3.5</td></tr>
<tr><td>Text Books and References:</td><td colspan="4">[1] John D. Enderle and Joseph D. Bronzino, Introduction to Biomedical Engineering, 3rd edition, Academic Press, 2012
[2] Joseph J. Carr, Introduction to Biomedical Equipment Technology, 4th edition, Prentice Hall, 2001
[3] Pascal Verdonck, Advances in Biomedical Engineering, Elsevier, Inc., 2009
[4] John G. Webster, Medical Instrumentation Application and Design, Wiley, 4th edition, 2009
[5] Jerry L. Prince and Jonathan M. Links, Medical Imaging Signals and Systems, Prentice Hall, 2006
[6] Arthur Vander, James Sherman and Dorothy Luciano, Vander’s Human Physiology: The Mechanisms of Body Function, McGraw-Hill, 10th edition, 2006</td></tr>
<tr><td>Course Description:</td><td colspan="4">This is an introductory course to the fundamentals of Biomedical Engineering from the view point of Electrical and Electronics Engineering for senior undergraduate students. It emphasizes general concepts and techniques of biomedical engineering. Topics include overview of human anatomy and physiology, biomedical electrodes, sensors and transducers, biomedical signals and its measurement techniques, biomaterials and tissue engineering, with special focus in medical imaging techniques.</td></tr>
<tr><td>Topics Covered</td><td colspan="4">1. Introduction
2. Basic human physiology
3. Biomedical sensors, electrodes and amplifiers</td></tr>
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	4. Bioelectricity 5. Biomedical signal analysis 6. Examples of biomedical signals 7. Medical ultrasound 8. Projection radiography 9. Computed tomography (CT) 10. Radionuclide imaging 11. Magnetic resonance imaging (MRI)
Course Objectives:	1. To prepare students the basic human physiology background and introduce them the concept of biomedical signals, [a, e, h, k] 2. To introduce students the theory and principles of engineering for biomedical applications, [a, e, k] 3. To prepare students to know the characteristics of different medical imaging systems, [a, b, e, j]
Course Assessment:	Assignment: 15% Lab: 15% Quiz :15% Mid-term Exam. : 25% Final Exam. : 30%
Relationship to Program Objectives and Outcomes	This course primarily contributes to EEE program outcomes that develop students abilities to: b. Ability to design and conduct experiments. c. Ability to design a system, component or process to meet desired needs. d. Ability to function on multidisciplinary teams. f. Understanding of professional and ethical responsibility. j. Knowledge of contemporary issues. This course secondarily contributes to EEE program outcomes that develop students abilities to: a. Ability to apply knowledge of mathematics, science and engineering. e. Ability to identify, formulate and solve engineering problems. g. Ability to communicate effectively. h. Broad education necessary to understand the impact of engineering solutions in global and societal context. i. Recognition of the need for and an ability to engage in life-long learning. k. Ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

Course Contents and Relationship to Program Criteria:	

Week no.	Topics	Program Criteria
1	**Introduction** What is biomedical engineering, fundamental background, recent advances, overview of the human body	BS, ES
1.5	**Basic human physiology** Cardiovascular, respiratory, musculoskeletal and nervous systems	BS
0.5	**Biomedical sensors, electrodes and amplifiers** Various kind of biomedical sensors, sensor requirements and classifications, electrode potential, medical surface electrodes, different types of electrodes, electrode potentials cause recording problem, recording of biopotentials, biopotential amplifier	PS, DIC, BS, ES, DE, LA, CV
0.5	**Bioelectricity** Nature of bioelectricity, excitable cell, Nernst potentials, action potentials, membrane bioelectrical models, propagation of action events	BS, ES,
1.5	**Biomedical signal analysis** Origin of biomedical signals, common biomedical signals, classification of biosignals, time domain analysis, frequency domain analysis, time-frequency domain analysis, spectral estimation, filters, optimal filtering	PS, DIC, BS, CS, ES, DE, LA, CV, DM
2	**Biomedical signals** Electrocardiogram (ECG), electromyogram (EMG), electroencephalogram (EEG), blood Pressure and blood oximetry	DIC, BS, ES
1	**Biomedical instrumentations overview** Spirometers, pacemakers, and defibrillators	BS
1	**Medical ultrasound** Physics of ultrasound, ultrasound transducer, beamwidth and resolution, absorption and attenuation, fundamentals of ultrasound imaging	DIC, BS, CS, ES
1	**Projection radiography** X-ray physics, x-ray tube, conventional x-ray imaging, computed radiography (CR), digital radiography (DR)	DIC, BS, CS, ES
1	**Computed tomography (CT)** Different generations of CT, system overview, introduction to image reconstruction	DIC, BS, CS, ES
1	**Radionuclide imaging** Conventional planar imaging, single photon emission computed tomography (SPECT), positron emission tomography (PET)	DIC, BS, CS, ES
1	**Magnetic resonance imaging (MRI)** Physics of MRI, system over-view, basic pulse sequences	DIC, BS, CS, ES

Contribution of Course to meet the professional component:	This course prepares students to enter the professional world in the Biomedical Engineering related fields. Students should be able to understand the Biomedical Engineering issues by applying knowledge of Electrical and Computer Engineering
Course Instructor(s):	Dr. Greta S.P. Mok
Prepared by:	Dr. Greta, S.P. Mok

Part B: General Course Information and Policies

Instructor: Dr. Greta S.P. Mok Office: B1-B706 Phone: 8465
TA: Ms. Qu Xiao Ting

Office Hour: Monday 3:00~5:00 p.m. or by appointment
e-mail: gretamok@umac.mo
mb15532@umac.mo

Programme Educational Objectives

1. **Problem Solving:** Graduates have the ability to think in a critical and evaluative manner and to consider a broad perspective, in order to solve technical and nontechnical problems.
2. **Leadership and Communication:** Graduates will provide effective leadership, act in an ethical manner and skills will include the ability to communicate well and to work successfully within diverse groups.
3. **Market Acceptance:** Graduates will have successful careers in the academic environment, industrial and government organizations.
4. **Technical Competence:** Graduates will be technically competent and have a thorough grounding in the fundamentals of math and science in electrical and electronics engineering and experience in engineering design. They will be able to use modern engineering techniques, skills, and tools to fulfill societal needs.

Scale: 1 (Highest) to 4 (Lowest)

	Problem Solving	**Leadership and Communication**	**Market Acceptance**	**Technical Competence**
Introduction to Biomedical Engineering	1	3	2	2

Remark:

- Objective for “Problem Solving” can be achieved by assignments, quizzes, mid-term exam, final exam and lab projects.
- Objective for “Leadership and Communication” can be achieved by lab report writing and presentation. However, leadership training is not given by this course.
- Objective for “Market Acceptance” can be achieved by the course subject that is related to designs of biomedical instrumentations and medical imaging modalities.
- Objective for “Technical Competence” can be achieved by using fundamentals of

math and science in electrical and electronics engineering and experience in engineering project design and computer simulation.

Program Criteria Policy:

Course VS Program Criteria

Scale: 5 (Highest) to 1 (Lower)

Course	PS	DIC	BS	CS	ES	DE	LA	CV	DM
Introduction to Biomedical Engineering	1	2	4	3	4	1	1	1	1

Terms:

Probability and Statistics (PS), Differential and Integral Calculus (DIC), Basic Science (BS), Computer Science (CS), Engineering Science (ES), Differential Equation (DE), Linear Algebra (LA), Complex Variables (CV), Discrete Mathematics (DM)

Program Outcome Policy:

Course VS Course Outcomes

(H= Highly Related, S = Supportive, N = None)

Course	a	b	c	d	e	f	g	h	i	j	k
Introduction to Biomedical Engineering	S	H	H	H	S	H	S	S	S	H	S

The electrical and electronics engineering program outcomes are:

a. Ability to apply knowledge of mathematics, science and engineering.
b. Ability to design and conduct experiments.
c. Ability to design a system, component or process to meet desired needs.
d. Ability to function on multidisciplinary teams.
e. Ability to identify, formulate and solve engineering problems.
f. Understanding of professional and ethical responsibility.
g. Ability to communicate effectively.
h. Broad education necessary to understand the impact of engineering solutions in global and societal context.
i. Recognition of the need for and an ability to engage in life-long learning.
j. Knowledge of contemporary issues.
k. Ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

Curriculum Detail

ELEC 483 Introduction to Biomedical Engineering

Timetabled work in hours per week			**No of teaching weeks**	**Total hours**	**No /Duration of exam papers**	**Max marks available from:**	
Lecturer	**Tutor**	**Practice**				**Exams**	**Course**
3	0.5	1.5	14	70	2/5 hours	50	50

Term: 7th

Hours			**Percentage content of**					
Lecturer	Lab/tut	Other	Maths	Basic Science	Engineering Science	Engineering Design and Synthesis	Complementary Studies	Computer Studies
42	15/8	0	20	20	35	15	0	10

Design Elements

% of Design Content	**Design Content in Course Work**	**Design Project**	**Design Content in Laboratories**
35%	X	0	X

Course Assessment Policy:

Graduate students are governed by academic ethics code that faculty and students share a responsibility for ensuring integrity. The main principle is: no person should represent the ideas and contributions of others as his or her own. Copying others' homework, quizzes and exam solutions fall into this category. Similarly, the

submission of term papers drawing on other's ideas and publications seriously violates academic ethics.

Attendance: Although no attendance will be marked, students are encouraged to make their best efforts to attend the lectures on time. Faculty and students should show basic courtesy and respective to each other. Laptops and other electronic devices are only allowed for taking notes. Smoking and cell phone usages are prohibited in class.

Homework assignments: One presentation assignment will be given to students. One to three students form one group (student number in a group is subject to be approval) and they need to present the assignment on schedule. No late homework is accepted and will be given zero score.

Quizzes: Three quizzes are closed book and closed notes, lasting 10 minutes and cannot be retaken. The quizzes will be randomly assigned in the beginning or in the end of the classes without advance notifications. PDA's, cell phones, pagers and other electronic devices or storage (except standard calculators) are prohibited during the quizzes. The problems will be fairly based on the notes or assigned reading chapters.

Labs: Five lab projects will be performed during the semester. One to three students form one group (student number in a group is subject to be approval) for 1 selected lab project and group report should be submitted before deadlines. Presentations or demonstrations may be required.

Exams: Two exams are closed book and closed notes, lasting 2.5 hours each and cannot be retaken, unless sufficient proof can be provided. PDA's, cell phones, pagers and other electronic devices or storage (except standard calculators) are prohibited during the exams. The problems will be fairly based on the notes or assigned reading chapters.