



Course Syllabus: Biomaterials and Biomedical Devices - B 390J

Division	Biological and Environmental Sciences & Engineering Division
Course Number	B 390J
Course Title	Biomaterials and Biomedical Devices
Academic Semester	Spring
Academic Year	2017/2018
Semester Start Date	01/28/2018
Semester End Date	05/24/2018
Class Schedule (Days & Time)	10:30 AM - 12:00 PM Tue , 01:00 PM - 02:30 PM Mon

Instructor(s)				
Name	Email	Phone	Office Location	Office Hours
Sahika Inal	sahika.inal@kaust.edu.sa	+966128082501	4276, 2, Ibn Al-Haytham (bldg. 2)	every Monday between 14:30 and 15:30

Teaching Assistant(s)	
Name	Email

Course Information	
Comprehensive Course Description	<p>This course is about materials and electronic devices that are used in diagnosis of diseases and their therapy. It contains concepts ranging from cell biology to materials science and electrical engineering, focusing on materials that can be implanted in the body to restore a malfunctioning part of an organ and the devices that can electrically communicate with the human body. With this course, while providing basic cell biology, physiology, anatomy knowledge to the students, we introduce what kind of solutions have been provided by engineers to change the way how healthcare is delivered or diagnostics are performed. We address in detail how certain tools and devices have been designed by engineers and how they operate at the interface with living organisms.</p> <p>Specifically, the course provides the necessary background to understand, firstly, the field of biomedical engineering, then basic cell biology and biophysical phenomena, followed by the design, function and engineering of biomedical devices. It introduces biomaterials and tissue engineering concepts with a broad overview of bioactive and biomimetic materials which are used to construct architectures that interface with the human body such as skin substitute, tissue engineered bone, contact lenses, heart valves and prosthetics. The course then shifts to electronic biomedical devices (sensors and actuators) that constitute the core area of biomedical engineering. The students will learn how bio(chemical) sensors, biopotential measurements (such as EEG, ECG, EMG) and brain-machine interfaces (neural stimulators, prosthetics) operate. This is followed by the fabrication and scaling approaches: structuring of materials and micro/nano fabrication of a variety of biomedical devices with a particular focus on electrical devices that can sense/stimulate biological signals. The course finally introduces the basics of integrated circuit components, transistors and circuit architectures, which are fundamental to build a biomedical device.</p>

Course Description from Program Guide	The course is about the biomedical implants, the materials used in biomedical devices, and the operation and fabrication of electrical devices such as sensors or stimulators that are designed to communicate with human body. It will provide an overview of the research highlights in the field of biomedical engineering and design principles of the materials/devices currently employed in the clinic.
Goals and Objectives	At the end of this course, the students will be able to describe 1) the characteristics of the materials (both active and passive components) that are used at the interface with biological systems and associated with biomedical devices 2) different classifications of biomedical sensors and actuators, and the operation principles of these devices. 3) the micro/nano fabrication techniques utilized in the development of biomedical devices, the circuit components, their function and rational design 4) the advances in the field of Medical Electronics
Required Knowledge	Pre-approval from the instructor to validate general engineering background
Reference Texts	Introduction to Biomedical Engineering, J.D. Enderle and J. Bronzino, 2012, Elsevier Molecular Biology of the Cell, B. Alberts, ISBN10 0815341067 Introductory Bioelectronics, R. Pethig and S. Smith, ISBN 9781119970873 Implantable Medical Electronics, V. K. Khanna, ISBN 978-3-319-25446-3
Method of evaluation	20.00% - Scientific review article presentation 80.00% - Quiz(zes)
Nature of the assignments	Project presentation (in depth investigation of current research highlights in biomedical engineering)
Course Policies	None.
Additional Information	The course is co-instructed by Prof. Jurgen Kosel and Prof. Khaled N. Salama.

Tentative Course Schedule

(Time, topic/emphasis & resources)

Week	Lectures	Topic
1	Mon 01/29/2018 Tue 01/30/2018	Introduction to Biomaterials and Biomedical Devices
2	Mon 02/05/2018 Tue 02/06/2018	Implantable and wearable electronic devices, the case study on the evolution of neural prosthetics
3	Mon 02/12/2018 Tue 02/13/2018	Basics of cell biology, building blocks of cells, plasma membrane and its electrical properties, biophysical concepts at cellular level
4	Mon 02/19/2018 Tue 02/20/2018	Probing electrical properties of cells, a closer look into neurons
5	Mon 02/26/2018 Tue 02/27/2018	Micro/Nano Fabrication Techniques (Prof. Jurgen Kosel)
6	Mon 03/05/2018 Tue 03/06/2018	Bionanotechnology (self-assembly and micro-nanostructuring of materials), Scaling Laws in Biomedical Devices (Prof. Jurgen Kosel)
7	Mon 03/12/2018 Tue 03/13/2018	Microfluidics and Implantable Microdevices (Prof. Jurgen Kosel)
8	Mon 03/19/2018 Tue 03/20/2018	Biomaterials, Cell/Material Interactions and Tissue Engineering Scaffolds
9	Mon 03/26/2018 Tue 03/27/2018	Electrochemical Principles and Electrode Reactions
10	Mon 04/02/2018 Tue 04/03/2018	Diagnostics and biosensors Neural Interfacing (sensors, stimulators- brain-machine interfaces)
11	Mon 04/09/2018 Tue 04/10/2018	Integrated Circuit Components (Prof. Khaled N. Salama)
12	Mon 04/16/2018 Tue 04/17/2018	Basic Transistor Operation (Prof. Khaled N. Salama)
13	Mon 04/23/2018 Tue 04/24/2018	Sensor Circuit Architectures (Prof. Khaled N. Salama)
14	Mon 04/30/2018 Tue 05/01/2018	Advanced Topics in Biomedical Engineering
15	Mon 05/07/2018 Tue 05/08/2018	Recent Developments in Biomedical Engineering
16	Mon 05/14/2018 Tue 05/15/2018	Bridging Electronics to Biology with Organic Materials
17	Mon 05/21/2018 Tue 05/22/2018	
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Note

The instructor reserves the right to make changes to this syllabus as necessary.