EE 428/528 BioMEMS & Lab-On-a-Chip (LOC) (Fall 2018)

Course Description

EE 428/528 BioMEMS & Lab-on-a-chip, Lecture, 3 credits
Covers various commonly used micro/nanofabrication techniques, microfluidics, various chemical and biochemical applications such as separation, implantable devices, drug delivery, and microsystems for cellular studies and tissue engineering. Discusses recent and future trends in BioMEMS and LOC. Students will gain a broad perspective in the area of micro/nano systems for biomedical and chemical applications.

Time/Location

Fall 2018, M/W, 12:30 PM - 1:50 PM, KNOX 14

Instructor

Prof. Kwang W. Oh, Ph.D. (kwangoh@buffalo.edu)
SMALL (Sensors and MicroActuators Learning Lab), http://SMALL.buffalo.edu
Department of Electrical Engineering/Department of Biomedical Engineering, SUNY at Buffalo
113C Davis Hall, North Campus, Buffalo, NY 14260

Office Hours

Mon 11-11:50 & Wed 10-11:50; right before/after the class; or by appointment; I usually prefer to have one-to-one conversations on any topics (e.g., course materials, research opportunities, your presentation ideas, career development, even your own personal matters, …). Taking advantage of office hours is your privilege.

Prerequisites

Senior undergraduate or graduate standing in engineering, medicine, biomedical sciences, and natural sciences

Objectives

Course Learning Objectives - By the end of the course, students should be able to:	Student Outcomes
Review BioMEMS fabrication	a, c, k
Identify miniaturization issues on life sciences	c, k
Review various microfluidic platforms	c, k
Demonstrate creative solutions at the interface of biology and technology	c, k

Student Outcomes	a	b	c	d	e	f	g	h	i	j	k
Score	1		3		2	1	1	1			3

* 3 – Strongly Supported, 2 – Supported, 1 – Minimally Supported

(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multidisciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Textbooks

Class notes and Handouts (see UBLearns).

TA

Anyang Wang (anyangwa@buffalo.edu), Office Hours: **M/W 2-4 pm, 233 Davis Hall**, or by appointment

Grading

Professionalism/Attendancy: 10% (if you miss one lecture –0.5%), Presentation 1 (4-min): 25%, Presentation 2 (6-min): 30%, Final Exam (60-min): 35%; Grading for EE428 will be done within the pool of "undergraduate students". Grading for EE528 will be done within the pool of "graduate students".

Presentations

Send your presentation files (.pptx and embedded video clips) to "kwangoh@buffalo.edu" with a title "[EE 428]" or "[EE 528]" from your buffalo.edu e-mail account at least by 10:00 am on your presentation date.

A. Presentation 1 (4-min): Students will present their works, exactly 4 min long. Pick one random noun from a dictionary. The noun must begin with the same letter that begins your last. middle or first name. For example, Kwang W. Oh would choose nouns that begin with the letter "K", "W", or "O". Now, add micro-, nano-, or bio- to the beginning of the noun, and speculate on any potential usefulness of the technology or application. Remind that you have to present innovative, creative, practical ideas that someone has not proposed yet to the world. The presentation structure could be (for example):

1. Your unique approach/design/solution. You must show your own sketch/drawing/schematic of your proposed idea. Hand-drawing is okay. If you don't know how to visualize any details, you have no idea what you are proposing.
2. What are the technical challenges and potential solutions to realize the proposed idea?
3. Detailed plan to challenge/solve the idea
4. Conclusion and impact (so what?)
5. Reference (please list all references in EACH presentation page if they (photos, images, ideas, data,…) are not from your own ones. Do not list all on the last page!!!)

B. Presentation 2 (6-min): All students present the following assignments, approximately 6 min long. Pick one COMPANY and research their MICROFLUIDIC PLATFORM TECHNOLOGY. For example, a company called "Siloam Biosciences" developed a new microfluidic platform technology called "Optimiser" [http://siloambio.com/optimiser_platform_technology]. (1) Then, briefly explain the principle of their technology introduced in the website(s) + research article(s) + US patent(s) (https://patents.google.com/). (2) Figure out Pros and Cons in their technology. (3) Then come up with a solution(s) of a device/system/application that the students might think works better than existing solutions. The presentation structure could be (for example):

1. Summary/description of the technology (company name, website, research papers, patents,…)
2. Pros and Cons in their technology. You have to discuss these in details and please be specific, not be general.
3. What is your unique approach/design/solution to overcome the Cons?
4. What are the technical challenges and potential solutions to realize the proposed idea?
5. Detailed plan to challenge/solve the idea
6. Conclusion and impact (so what?)
7. Reference (please list all references in EACH presentation page if they (photos, images, ideas, data,…) are not from your own ones. Do not list all on the last page!!!)

The grading (instructor: 50%, students: 50%) for the two presentations will be based on

(1) the uniqueness and originality of your selections (40%): *Is the proposed idea unique and original? Did he/she propose it for the first time as far as you know? Is it really useful in some applications?* Please google/search articles, journals, patents, products,…, if someone already did the thing you propose or not. If you want to have higher points, propose a quantum jump thing, not an incremental idea.

(2) realistic and detailed approach (30%): *Are there enough discussions on challenges and solutions to be able to make/fabricate/realize the idea?* The topic should be "narrow and specific". I don't want to hear broad ideas or concepts. You can hand-draw your proposed idea as detailed as possible.

(3) presentation skills (presentation structure, easy understanding, reference, exact 4-min or 6-min length, questions/answers,…) (30%): *Does he/she follow the suggested presentation structure? Does he/she entertain, inform, persuade, and/or sell the proposed idea effectively within the given time (4-min or 6-min)?* You have to convince your idea to students and of course entertain them too.

Schedule

The schedule is subject to change and changes to the published schedule will be announced in class. Schedule for the two presentations will be announced.

W	Lecture	Date		Title	Presentation
1	[01]	08/27/18	M	Syllabus / Introduction to MEMS	
	[02]	08/29/18	W	Introduction to BioMEMS	
2		09/03/18	M	No Class (Labor Day)	
	[03]	09/05/18	W	MEMS Fabrication	
3	[04]	09/10/18	M	BioMEMS Fabrication	
	[05]	09/12/18	W	Introduction to Microfluidics	
4	[06]	09/17/18	M	PDMS-Based Integrated Fluidic Circuits	
	[07]	09/19/18	W	Pressure-driven Microfluidics	
5	[08]	09/24/18	M	Electric Circuits and Microfluidic Circuits	
	[09]	09/26/18	W	Capillary-driven Microfluidics	
6	[10]	10/01/18	M	Electrokinetic-driven Microfluidics	
	[11]	10/03/18	W	Droplet-based Microfluidics	
7	[12]	10/08/18	M	Electrowetting-based Microfluidics	1,2,3,4 (4 min)
	[13]	10/10/18	W	Centrifugal-driven Microfluidics	5,6,7,8
8	[14]	10/15/18	M	Ultrasonic-based Microfluidics	9,10,11,12
	[15]	10/17/18	W	Microfluidics Components	13,14,15,16
9	[16]/[17]	10/22/18	M	Microvalve/Micropump	17,18,19,20
	[18]	10/24/18	W	Miniaturization in Life Sciences	21,22,23,24
10	[19]	10/29/18	M	Particle Manipulation	25,26,27,28
	[20]	10/31/18	W	Cell Manipulation/Treatment	29,30,31,32
11	[21]	11/05/18	M	Cell Lysis/Analysis	33,34,35,36
	[22]	11/07/18	W	MicroPCR	37,38,39,40
12	[23]	11/12/18	M	Drug delivery	41,42,43,44
	[24]	11/14/18	W	Wearable/Implantable devices	
13	[25]	11/19/18	M	Point-of-Care Test (POCT)	
		11/21/18	W	No Class (Fall Recess & Thanksgiving)	
14		11/26/18	M		1,2,3,4,5,6,7,8,9,10,11 (6 min)
		11/28/18	W		12,13,14,15,16,17,18,19,20,21,22
15		12/03/18	M		23,24,25,26,27,28,29,30,31,32,33
		12/05/18	W		34,35,36,37,38,39,40,41,42,43,44
16	Final	12/12/18	W	Final (Knox 14) (11:45 AM - 2:00 PM)	