Department of Electrical Engineering, University at Buffalo

EE 426/526 Wearable and Implantable Sensors (Spring 2017)

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<tr><td>Course Description</td><td>EE 526 Wearable and Implantable Sensors, Lecture, 3 credits
In this course, students will learn the basic sensing theory behind the wearable and implantable sensing technology. A variety of advanced sensors will be introduced, including pressure, acceleration, gyroscope, magnetometer, GPS, proximity, light, camera, touch screen, identification, acoustic, humidity, temperature, biosignal, heartbeat, gas, chemical, infrared, sweat, glucose, and biomedical sensors. In the class, students will propose and present a concept of their own unique wearable and implantable device/system using multiple sensing techniques. Recent and future trends in wearable and implantable sensor technology will be discussed too. Students will gain a broad perspective in the area of sensors and wearable and implantable technology for healthcare and appealing applications.</td></tr>
<tr><td>Time/Location</td><td>Spring 2017, M/W, 12:00 PM - 1:20 PM, Frnczk 422</td></tr>
<tr><td>Instructor</td><td>Kwang W. Oh, Ph.D., Associate Professor (kwangoh@buffalo.edu), SMALL (Sensors and MicroActuators Learning Lab), http://www.SMALL.buffalo.edu, Department of Electrical Engineering, University at Buffalo (SUNY at Buffalo), 113C Davis Hall, North Campus, Buffalo, NY 14260</td></tr>
<tr><td>Office Hours</td><td>W 1:20 PM – 2:00 PM (right after the class) or by appointment</td></tr>
<tr><td>Prerequisites</td><td>Undergraduate/Graduate standing in engineering, medicine, biomedical sciences, and natural sciences.</td></tr>
<tr><td>Objectives</td><td>
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<tr><td>Course Learning Objectives -
By the end of the course, students should be able to:</td><td>Student Outcomes</td></tr>
<tr><td>Review a variety of advanced sensors</td><td>a, c, k</td></tr>
<tr><td>Discuss recent and future trends in wearable and implantable sensors</td><td>a, c, g, k</td></tr>
<tr><td>Demonstrate creative solutions in the area of sensors and wearable and implantable technology for healthcare and appealing applications.</td><td>a, c, e, g, h, k</td></tr>
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<tr><td>Student Outcomes</td><td>a</td><td>b</td><td>c</td><td>d</td><td>e</td><td>f</td><td>g</td><td>h</td><td>i</td><td>j</td><td>k</td></tr>
<tr><td>Score</td><td>3</td><td></td><td>3</td><td></td><td>1</td><td></td><td>2</td><td>1</td><td></td><td></td><td>3</td></tr>
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* 3 – Strongly Supported, 2 – Supported, 1 – Minimally Supported
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<tr><td>(a) an ability to apply knowledge of mathematics, science, and engineering</td></tr>
<tr><td>(b) an ability to design and conduct experiments, as well as to analyze and interpret data</td></tr>
<tr><td>(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</td></tr>
<tr><td>(d) an ability to function on multidisciplinary teams</td></tr>
<tr><td>(e) an ability to identify, formulate, and solve engineering problems</td></tr>
<tr><td>(f) an understanding of professional and ethical responsibility</td></tr>
<tr><td>(g) an ability to communicate effectively</td></tr>
<tr><td>(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context</td></tr>
<tr><td>(i) a recognition of the need for, and an ability to engage in life-long learning</td></tr>
<tr><td>(j) a knowledge of contemporary issues</td></tr>
<tr><td>(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.</td></tr>
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<tr><td>Textbooks</td><td>Class notes and Handouts (see UBLearns)</td></tr>
<tr><td>TA</td><td>Mr. Domin Koh (dominkoh@buffalo.edu), Office Hrs: M/W 2 – 3 pm, 233 Davis Hall, or by appointment.</td></tr>
<tr><td>Abstract</td><td>Abstract Submission: Students will submit a technical abstract (both ".docx" and ".pdf") on the UBLearns website by the due date (4/12/2017). Students will design a concept of their own unique wearable and implantable sensor/device/system using (multiple) available sensing techniques for healthcare or appealing applications. Also they can propose a new type of sensors and/or wearable or implantable applications. You have to provide sound information on the working principle of your proposed idea. Avoid any ambiguous and/or impractical idea. Remind that you have to present both innovative and practical (not incremental) ideas that someone has not proposed yet to the world. The instructor wants to hear YOUR NEW INVENTION, in terms of SENSING technologies and/or Remind that you have to present both innovative and practical (not incremental) ideas that someone has not proposed yet to the world (Example: https://youtu.be/Jc4JbKVZYw0). The instructor wants to hear YOUR OWN & NEW INVENTION, in terms of SENSING technologies and/or HEALTHCARE or APPEALING WEARABLE/ IMPLANTABLE applications
Abstract Example: You can begin with (1) backgrounds with respect to your invention, followed by (2) working principle/design/challenges, (3) expected outcomes/impacts/applications, (4) conclusions, and (5)</td></tr>
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	references. It is important within the first few sentences to state what your primary invention is. It is also important to identify how the proposed work differs from previous work from other groups, especially work presented at recent technology news articles, journals and conference meetings. Remind that you should not present incremental ideas, you have to invent a totally-new thing and write a detailed descriptions about it. After an introduction of the basic ideas and how the work relates to other work, present detailed descriptions of working principle/design/challenges, examples of expected specific outcomes/impacts/applications, whether simple demonstration or calculation. Figures/Tables can support these. It is useful to comment on the broader impact (appealing applications) of the outcomes. Please make sure that all the figures/drawings are clearly visible in the 2nd page. **Abstract Format:** Submitted abstracts (**both "Last-1234-5678.docx" and "Last-1234-5678.pdf"**) should be two pages: one text page (500 words or less, 11 point font) and one page of figures/tables on US Standard (8.5×11 inches). If your abstract exceeds the 500-word limit, it will be ranked as #50. The title, author, affiliation and all text must fit on the first page. The second page should contain any figures or tables. References may go on either page. *A best way is to use a template for all other style formatting, such as margin, font, line spacing, etc.* **Abstract Evaluation:** The instructor will evaluate/rank the submitted abstracts. Selected students will be invited to present 10-min or 4-min oral presentation.
Presentation	**10-min Oral Presentation:** The top 40% ranked abstracts (i.e., #1 through #24) will be invited for 10-min oral presentation during the regular class. These students may have a maximum of ~65% in their grading, which will be adjusted to curve the final Total/Grading. The evaluation of the presentation will be done by an instructor (50%) and students (50%). **4-min Oral Presentation:** The other lower ranked abstracts (i.e., #25 through #58) will be invited for 4-min short oral presentation. These students will get a maximum of 50% (this is fixed).
Grading	**Grading for EE426 will be done within the pool of "undergraduate students". Grading for EE526 will be done within the pool of "graduate students". Professionalism & attendancy**: 10%; **Abstract/Presentation**: the top 40% ranked abstracts → maximum up to ~65% to ~55% (this ratio can be adjusted to curve the Total/Grading); the other 60% lower ranked abstracts → maximum up to 50% (fixed); **Final exam (60-min)**: 40% (fixed).

Abstract	Oral Presentation				Exam		Grading	
Rank	Oral Type	Ratio	Point	%	Point	%	Total	Grading
#1-rank	10-min	0.65	90	58.5	90	45	104	90 ≤ A
#2-rank	10-min	0.645	85	54.825	85	42.5	97.3	90 ≤ A
#3-rank	10-min	0.64	90	57.6	20	10	67.6	65 ≤ C+ < 70
...	10-min	...						
#19-rank	10-min	0.56	55	30.8	50	25	55.8	55 ≤ D < 60
#20-rank	10-min	0.555	85	47.175	85	42.5	89.7	85 ≤ A- < 90
#21-rank	4-min	0.5	85	42.5	80	40	82.5	80 ≤ B+ < 85
#22-rank	4-min	0.5	50	25	50	25	50	F < 55
...	4-min	0.5	70	35	55	27.5	62.5	60 ≤ C < 65
#48-rank	4-min	0.5	75	37.5	70	35	72.5	70 ≤ B- < 75
#49-rank	4-min	0.5	80	40	70	35	75	75 ≤ B < 80
#50-rank	4-min	0.5	95	47.5	100	50	97.5	90 ≤ A

The grading (instructor: 50%, students: 50%) for the presentation 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? This is most important part. Breakthrough idea and innovative (your own) approach is required. Please google/search **articles, journals, patents, products**,…, if someone already did similar things you propose or not. An incremental approach might be acceptable, but a totally-new approach will be better if you want to have higher points.

(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**". So you may be able to realize your ideas within 2 years (or 4-5 years). I don't want to hear broad ideas or concepts.

(3) presentation skills (presentation structure, easy understanding, references, exact 10-min or 4-min length, questions/answers,…) (30%): Does he/she **entertain, inform, persuade, and/or sell the proposed idea effectively within the given time (10-min or 4-min)**? You have to convince your idea to students and of course entertain them too.

Electronic Files	You should submit your technical abstract (both ".docx" and ".pdf") on the UBLearns website by the due date for the technical abstract (4/12/2017) and your presentation (".pptx" only) file on the UBLearns website at least by 11:59 pm one day before your presentation date. If you want to send any email, send it *to* "kwangoh@buffalo.edu" with a title "[EE 426/526] …" *from* your buffalo.edu e-mail account (no google or other e-mails). Do not send your technical abstract and presentation files to my email. You need to upload the files on UBLearns. So I will not lose your e-mails into Junk E-mail directory. And we can save a lot of time for loading your files on screen in class.

Schedule

Lecture	Date		Title	
[01]	01/30/17	M	Syllabus / Introduction	
[02]	02/01/17	W	Sensors Characteristics	
[03]	02/06/17	M	Pressure Sensors	
[04]	02/08/17	W	Accelerometers	
[05]	02/13/17	M	Gyroscopes	
[06]	02/15/17	W	Magnetometers / GPS	
[07]	02/20/17	M	Proximity Sensors / Light Sensors / Cameras	
[08]	02/22/17	W	Touch Screen and ID Sensors	
[09]	02/27/17	M	Acoustic Devices	
[10/11]	03/01/17	W	Humidity / Temperature / Electrochemistry	
[11]	03/06/17	M	Biosignal	
[12]	03/08/17	W	Batteries / Wireless Charging	
[13]	03/13/17	M	Chemical / Gas Sensors	
[14]	03/15/17	W	E-Nose / Electroanalytical Methods	
	03/20/17	M	No Class (Spring Recess)	
	03/22/17	W	No Class (Spring Recess)	
[15]	03/27/17	M	Bio Sensors	
[16]	03/29/17	W	Nanobiosensors / Glucose Sensors / POCT	
[17]	04/03/17	M	IoT, Wireless Technologies and	
[18]	04/05/17	W	Wearable Technology	
[19]	04/10/17	M	Google Glass / Medical Patch Wearable	
[20]	04/12/17	W	Implantable / Ingestible Sensors (1)	Due: Abstract Submissior
[21]	04/17/17	M	Implantable / Ingestible Sensors (2)	
[22]	04/19/17	W	Implantable / Ingestible Sensors (3)	
[23]	04/24/17	M	Oral Presentation (10 min)	1,2,3,4,5,6
	04/26/17	W	Oral Presentation (10 min)	7,8,9,10,11,12
	05/01/17	M	Oral Presentation (10 min)	13,14,15,16,17,18
	05/03/17	W	Oral Presentation (10 min)	19,20,21,22,23,24
	05/08/17	M	4 min. Oral (2 hrs)	25 through 41
	05/10/17	W	4 min. Oral (2 hrs)	41 through 58
			Final Exam	