教学大纲 Course Syllabus (New Course)

FLEXIBLE ELECTRONICS: FROM MATERIALS TO DEVICES

Spring 2021

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Course Credit: 3

Course Description:

Graduate course in flexible electronics that addresses fundamentals including material design, device working principle, and emergent practical applications.

Course Goals and Objectives:

The objective of this highly interdisciplinary course is to provide a comprehensive overview of the materials and processes used to design and manufacture flexible electronics, optoelectronics, sensors and actuators. After taking this course, the students should be able to demonstrate theoretical knowledge on flexible materials and the relevant device engineering. Further, latest developments in wearable electronics and optoelectronics, soft robotics, bioelectronic technology, and implications for health-care applications will be thoroughly introduced. Flexible materials, novel approaches and methodologies are expected to open up exciting avenues for the delivery of personalized health care and the connection with internet of things (IoT), as the core idea to be delivered to the students.

Students completing this course should be able to

- Understand the structural foundations of flexible materials
- Interpret the performance of flexible devices in terms of fundamental processes
- Estimate the order of magnitude of physical effects occurring in the flexible systems
- Elaborate a topic in the field of flexible devices
- Design an integrated system based on elemental electronics, sensors or actuators for practical application

Textbooks and Bibliography:

[1] *Wearable Bioelectronics*, O. Parlak, A. Salleo, A. Turner, 2020 Elsevier Ltd.
[2] *Flexible Electronics: from Materials to Devices*, Guozhen Shen, Zhiyong Fan, 2016 World Scientific Publishing Co. Pte. Ltd.
[3] *Flexible Electronics: Materials and Applications (Electronic Materials: Science & Technology)*, W. S. Wong and A. Salleo, 2010 Springer
[4] *Bioinspired Photonics*, V. Greanya, 2016 CRC Press.
[5] *Materials Science and Engineering: An Introduction 8th*, W. D. Callister, D. G. Rethwisch, 2010, Wiley.
[6] *Soft Robotics: Transferring Theory to Application*, A. Verl, A. Albu-Schäffer, O. Brock, A. Raatz, 2015 Springer.

Course Outline:

Unit 1. Introduction to Flexible Electronics

- The development history
- Overview and outlook of the technology

Unit 2. Key Concepts and Fundamentals in Flexible Electronics

- Structural fundamentals of flexible materials
- Smart and self-healing materials for stretchable electronics
- Interfaces in flexible electronics and optoelectronics
- Mechanical theory of the film-on-substrate-foil structure

Unit 3. Engineering the Fabrication Processes

- Solution processes and nanopatterning methods
- Micro/Nano fabrication on flexible substrates
- Fully printed stretchable electronic systems
- Coatings and encapsulation

Unit 4. Soft Robotics

- Sensors, soft actuators and control
- Soft interactions
- Soft robot assistants: potential and challenges

Unit 5. Flexible and Stretchable Bioelectronics

- Substrates and the electronic materials
- Epidermal bioelectronics and the electronic skin
- Implantable bioelectronics

Unit 6. Application Scenarios of Integrated Flexible Systems

- Toward the wearable health monitoring system
- Wireless applications and the IoT sensors
- Human-machine interfaces

Tentative Course Schedule: Monday & Friday morning, 8 weeks in total

- **Unit 1**. Introduction to Flexible Electronics (*Week 1&2*)
- **Unit 2**. Key Concepts and Fundamentals in Flexible Electronics (*Week 3&4*)
- **Unit 3**. Engineering the Fabrication Processes (*Week 5&6*)
- Seminar and Individual Presentation, midterm literature survey (*Week 7&8*)
- **Unit 4**. Soft Robotics (*Week 9&10*)
- **Unit 5**. Flexible and Stretchable Bioelectronics (*Week 11&12*)
- **Unit 6**. Application Scenarios of Integrated Flexible Systems (*Week 13&14*)
- Seminar and Group Presentation, final repot-project design (*Week 15&16*)

Course Grading:

Grading summary	Point Value
Homework Assignment	20
Presentation	80 (total)
Midterm Presentation (Literature Survey)	30
Final Repot and Presentation (Project Design)	50
Total	100

For the *Individual Presentation-Midterm Literature Survey:*
Students are required to give a group presentation on the literature survey of flexible materials and elementary device units after learning Unit 1-3.

For the Group Presentation-Project Design & Final Report:
Students are required to give a group presentation on the proposal of a novel **Integrated flexible System** (on the basis of elemental electronics, optoelectronics, sensors, actuators, etc.**)** for practical applications. The flexible materials involved, the working principle for each device component, the rationale behind the integration, and the targeted functionality should be introduced thoroughly.

Course Policy:
Attendance: Class attendance is a must. Absences are not positively regarded. Students are expected to be prepared to discuss reading for each week, and complete all assignments for this course during the semester.
Class format: This course will be managed as a lecture/seminar, expected to be engaging, informative, process built upon reading, discussion, and a project design at the end.
Crisis Contingency: In the event of the university closing for weather-related reasons or illness outbreak, e.g. flu or virus, I will provide instructions on how to turn in assignments and how the class will proceed via online tools.