Engineering Summer Academy at Penn (ESAP) Nanotechnology 2019

Date: July 7th - 27th, 2019

Lecture: Glandt Forum in Singh Center for Nanotechnology

Lab: Quattrone Nanofabrication Facilities and sample preparation room (both in Singh Center for Nanotechnology)

Instructor: Gyuseok Kim

Lab instructor: David Jones

Lab TA: Francisco Fernandez, Jeff Wu

RTA: Amy Shen, Andy Zhao, Francesca Cimino, Danlin Zuo, Liujian Wang

Course Description:

This course is designed to give ESAP students an overview of the nanotechnology. The course consists of lectures, invited lectures, lab sessions, challenge projects, group presentations and field trips. Students will learn fundamentals of nanotechnology and fabrication methods from lectures. Students will also gain hands-on processing and characterization experiences through three lab sessions; microfluidic channels (top-down process), quantum dot synthesis (bottom-up process) and fabrication of microletters. Many invited lecturers from different areas (faculty, engineer, and entrepreneur) will share their leading-edge research, real-world engineering and industrial startup experiences with students. Each student will have a public speech opportunity to present their lab experimental results and a challenge project. Additionally, students will have a field trip to Dow Chemical, as well as Nanoscale Characterization Facilities/Scanning and Local Probe Facilities for demos and tours.

Reference Texts (Optional):

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- William Callister, “Fundamentals of Materials Science and Engineering: An Integrated Approach,” John Wiley and Sons. (2001). This text is available from Amazon in both hard copy and e-copy form.
- Andrew Sarangan, “Nanofabrication, Principles to Laboratory Practice”. CRC Press (2017). An e-copy form is available through the library.

Exams:

Two quizzes will be held in the first and second weeks, and the final exam will be held on the third week. The format of the quizzes will be closed book. You may bring one sheet of notes, where 'sheet' is defined as a piece of paper no larger than 8.5 by 11 inches in area, no thicker than 1 millimeter, with information written on any two sides. Any means of recording the information on the sheet may be used, but no artificial means (other than ordinary eyeglasses or contact lenses) may be used to read the information. Partial credit will be given on all exams. Neither calculators nor computers will be allowed for the exams. The *tentative* quizzes and exam dates are:

- Quiz 1, Friday, July 12
- Quiz 2, Thursday, July 18
- Final Exam, Wednesday, July 24

Please understand that these dates are tentative and subject to change. In all cases it is your responsibility to show up at the appropriate times for exams.

Please note that academic honesty is of paramount importance to ensure that the class and grading is fair to all students. Academic dishonesty will not be tolerated. **You are expected to abide by the Penn Code of Academic Integrity for all conduct in this course, including exams.**

Laboratories, Challenge Projects and Presentations:

We will be conducting three laboratory modules in this course; each laboratory will comprise three sessions. You will be divided into groups of three or four for these laboratories. Each laboratory will require both poster and oral presentations. The template for presentation will be provided. The challenge projects do not comprise lab sessions. Creative and logical thinking and integration of what you learned over the course will be needed to complete this challenge project.

Grading:

Your grade will depend on two quizzes (10% each), a final exam (15%), three laboratory oral presentations (5% each), three laboratory poster (5% each), a final presentation (20%), a participation grade (15%), which will be based on your attendance, level of engagement, and participation in the laboratory and lecture sessions. Laboratory posters and oral presentations will be a team effort; quizzes, exams and laboratory participation will be individual efforts.

Mon 7/8	Tue 7/9	Wed 7/10	Thu 7/11	Fri 7/12
	HW1 - Letter or Poem			
9 – 10:30 Welcome Assembly **10:30 – 12p** Lecture 1 - Introduction **12p – 1:30p** Lunch **1:30p – 3p** Prof. Mark Allen (Nanotechnology) **3p – 4p** Lecture 2 - Atom, Quantum numbers **4p – 5p** Lecture 3 - Band gap	**9 – 10** Lecture 4 - Light and Color **10 – 11** Lecture 5 - Quantum Dot **11 – 12p** ISSS Raisler Lounge **12p – 1p** Lunch **1p - Lecture 6 - QD Lab** **1:30p – 3p** Orientation I **3p – 4:30p** Orientation II **4:30p - Orientation Quiz**	**9 – 10** Lecture 7 - Lithography **10 – 11** Lecture 8 - Softlithography - Mr. Eric Johnston **11 – 12p** Prof. Daeyeon Lee (Surface Texturing - Wettablility) **12p – 1p** Lunch **1p - Lecture 9 - Microletter Lab** **1:30p – 5p** Lab I	**9 – 10:30** Lecture 10 - Etch/Deposition **10:30 - Lecture 11 - Microfluidic** **11 – 12p** Prof. Lee Bassett (Quantum Engineering) **12p – 1:30p** Lunch **1:30p – 5p** Lab I	**9 – 10** Quiz I **10 – 11** Lecture 12 - Characterization I **11 – 12p** Prof. Flavia Vitale (Biosensors) **12p – 1:30p** Prof. Jeff Babin (IP/Entrepreneurship) **1:30p – 5p** Lab I

Mon 7/15	Tue 7/16	Wed 7/17	Thu 7/18	Fri 7/19
Poster I due				
9 – 10 Lecture 13- Characterization II **10 – 11** Prof. Marc Miskin (Micro/Nano Robots) **11 – 12p** Prof. Firooz Aflatouni (IC and Nanophotonics) **12p – 1p** Mr. Anup Singh - Entrepreneur (Innamed) **1p - Break** **1:30p – 5p** Lab II	**9 – 12p** Presentation - Lab module I **12p – 1:30p** Lunch **1:30p – 5p** Lab II	**9 – 10** Lecture 14- Devices I **10 – 11** Lecture 15 - Devices II **11 – 12p** Group discussion **12p – 1:30p** Lunch **1:30p – 5p** Lab II	**9 – 10** Quiz II **10 – 12p** Group Discussion **12p – 5p** Field trip to Dow Chemical **5p – 7p** Dinner at Han Dynasty	**9 – 12p** Presentation - Lab module II **12p – 1:30p** Lunch **1:30p – 5p** Lab III

Mon 7/22	Tue 7/23	Wed 7/24	Thu 7/25	Fri 7/26
Poster II due		Poster III due		
9 - Group discussion **9:30 – 11** Characterization and Scanning&probe facilities **11 – 12p** Admissions workshop Meyerson B1 **12p – 1:30p** Lunch **1:30p – 5p** Lab III	**9 – 11** Group Discussion **11 – 12p** Dr. Pat Watson (EUV lithography) **12p – 1p** Mr. Kao and Ms. Jiang - Entrepreneur (Avisitech) **1p - Break** **1:30p – 5p** Lab III	**9 – 10** Final Exam **10 – 12:30p** Poster submission **12:30p – 2p** Lunch **2p – 5p** Presentation - Lab module III	**9 – 10** Mr. Dave Jones - Design of Experiment **10 – 11** Prof. Eric Stach (Electron Microscopy) **11 – 12p** Practice presentation **12p – 1p** Lunch **1p – 2p** Prof. Shu Yang (Smart Materials) **2p – 6p** Practice Presentations	**9 – 11:30** Presentation **11:30 - Poster** **12p – 1p** Lunch **1p – 3p** Presentation **3p - Poster** **4p – 7p** Graduation Tse Sports Ctr