EK481 2019 Spring
Introduction to Nanotechnology and Nanomaterials

Description
Nanotechnology is the field of understanding and manipulation of matter with at least one characteristic dimension measured in nanometers with novel size-dependent physical and chemical properties. The *objective* of this course is to introduce concepts and experimental methods in major developments of nanotechnology and nanomaterials, including synthesis, fabrication, characterization and applications. So students acquire the background to understand the related current research work published in literature and to establish perspectives on nanotechnology and nanoscience in general. Key nanomaterials to be covered are nanoparticles, carbon nanotubes and nanowires, graphene and other 2D nanomaterials.

Prerequisites
This course does not have any specific prerequisites. As a junior level course students are expected to have an adequate mathematical background for differential equations. Students are also expected to be familiar with basic electrical knowledge such as concepts of electrical field, voltage, basic laws, and complex notation. PY 313 Modern physics is not required as a prerequisite. However, it will be easier for you if you are already familiar with some of the PY313 material.

Lectures	Tue and Thu 9:00-10:45 AM EPC 203
Labs	Location PHO 701 Register to one of following sessions Wed 10:10-11:55 AM Wed 12:20-2:05 PM Fri 10:10-11:55 AM Fri 12:20-2:05 PM
Instructor	Prof. Chen Yang E-mail: cheyang@bu.edu Phone: (617) 358-4837 Faculty website: https://www.bu.edu/eng/profile/chen-yang/
Teaching Fellow	Sean Gorsky (Ph.D student in ECE) E-mail: gorskysd@bu.edu
Office Hour	Wed 9:30-10:30 AM PHO 829 or by email appointment (Prof. Yang) Wed 3-4 PM PHO 207or by email appointment (Sean)
Course Web Site	Blackboard (Learn.bu.edu)
Text book	Nanotechnology, the whole story Rogers CRC Press (Free PDF available through BU library. Hard copy on Mugar Library Reserve or available at Barnes & Noble)

Class Structure:
This course will have the three components, including lectures, lab, assignment and assessment (homework, in-class quizzes, student presentations and proposals, a project and mid-term and final).

Lectures: The lectures will be used to introduce key concepts as well as new materials. PPT and chalk/blackboard will be both used. PPT slides will be posted to Blackboard after the class. Students are

encouraged to take their own notes. Active participation in the class discussion is required. Bonus points are assigned to evaluate discussion performance.

Labs

There will be 4 labs. First Lab is in the week of **Feb 5**.

1. Nanostructure optical characterization (one section, Lab report 20 pts)
2. Quantum dots: synthesis and absorption (two section, Lab report 40 pts)
3. Plasmonics: synthesis and characterization (three sections, Lab report 40 pts)
4. Penciled Graphene Device (one section, Lab report 20 pts)

Lab preparation**:** In order to be able to finish a lab in the allotted time slot, you are required to prepare for the lab by reading the Pre-Lab material, the Lab instruction and completing a pre-lab report. You will not be allowed to do the lab without a pre-lab report.

Lab work: You will work in groups of 2-3 students per group. You are expected to rotate the leader role for different labs. You should be well acquainted with the theory and procedures of the lab before the start of the lab. The labs will require efficient use of time in order to be completed in your time slot. Use a dedicated lab notebook and bring a memory stick in order to save your data.

Lab reports: After the lab each student will complete a lab report which are due at the posted time. All lab reports are required to follow the posted lab report format, and should be typed, with accompanying data included in numbered and labeled figures plotted by scientific graphing software (for example, Origin, Igor). No hand drawn figures will be accepted. If your data was poor, you are allowed to include data from another lab group in addition to your own for comparison. The borrowed data has to be clearly labeled as borrowed (and from whom) in figure captions, figure labels and in text. Failure to acknowledge borrowed data constitutes cheating, and will be dealt with according to the BU rules on academic conduct.

Lab grades: Each lab grade will be based on your attendance/performance of the lab judged by results and observation of the TF and on the quality of your lab report submitted on time.

Homework, discussion board assignment and project In-class quizzes

Homework: There will be 5 homework and 20 points for each. Homework will be posted in Blackboard. It will be due in class with dates specified.

Discussion board assignment: Short descriptive questions will be assigned and posted in the discussion board on blackboard. 2 points for each entry of answers will be given.

Project Together with a partner, a project with multiple assignments will be performed by each student. The project is to encourage students to develop critical thinking and problem solving skills within the class context through team work.

In-class student quizzes and presentations

In-class quizzes will be given in the class periodically. This is to encourage engagement of all students during lecture time and to establish conceptual understanding of the topics.

Article presentation: Each student is required to give a 20 min presentation (including a 5 min Q&A) based on a research article assigned in advance. The order of the presentation follows the alphabetical order of students' last names. Presentation dates will be scheduled and PDF of articles will be posted on Blackboard a week before the presentation date.

Proposal presentation: Together with a partner, each student is required to write a final proposal related to the topics discussed in the class, i.e. nanotechnology and nanomaterials. A half page abstract of the proposal (5 pts) is due on **Apr 18**. Presentations on the proposals shall be given in **the weeks of Apr 22 and Apr**

29, depending on total number of students. A 3 page written proposal including figures is due on **May 2**. The evaluation of the proposal is based on the abstract, full proposal as well as the performance of the proposal presentation.

Midterm The midterm will be a closed book in-class exam on **March 7**.

Final exam: Final will be closed book and cumulative.

Late submission and absence policy

Late submission of homework and lab reports within a week will result in 50% partial credit. No homework or lab reports will be accepted after more than a week. Late submission of in-class quizzes, exams, presentation, proposal abstract or full proposal is NOT accepted. There is no make-up in-class quizzes, exams or labs. Unexcused absences for in-class quizzes, exams or labs will be assigned a zero score. Excused absence according to University policy needs approval by Prof. Yang in advance. Such circumstance will resulted in an excused grade, which will be replaced by an average grade in the same category in the end of the semester. **Missing the final exam cannot be excused**.

Grading:

Homework	100 pts
Lab	120 pts
Article presentation	20 pts
Proposal abstract, paper and presentation	50 pts
In class quiz and discussion board assignment	40 pts
Project	20 pts
Mid-term	100 pts
Final	150 pts
Total	**600 pts**
Active participation in the class	bonus points

Grade scale:

A	510	(85% of 600)
A-	480	(80%)
B+	450	(75%)
B	420	(70%)
B-	390	(65%)
C+	360	(60%)
C	330	(55%)
C-	300	(50%)
D	240	(40%)
F	< 240	

We implement the above absolute grading scale in the class. You are encouraged to check your total points on blackboard and to estimate your grade at any point during the course. It also provides an incentive for working together, rather than competing for grades.

Academic conduct

Discussion with your peers of concepts covered in lectures, homework and labs are encouraged. However, homework solutions and reports needs to be fully done by yourself. Copying homework or lab-reports is considered cheating.

Please see the university policy on proper academic conduct and what constitutes academic misconduct. In the case of academic misconduct in this class, established academic discipline procedures will be followed.

http://www.bu.edu/ceit/university-policies/academic-conduct/

Reference books

Stuart Lindsay, *Introduction to Nanoscience*, Oxford

John H. Davies, *The Physics of Low Dimensional Semiconductors: An Introduction*, Cambridge (1998)

Oxtoby, *Principles of Modern Chemistry* Chap 4 (provides some simple math description for QM)

Shankar, *Principles of Quantum Mechanics* Chap 3-5