CARBON AND 2D DEVICES

EE 396N (17915)

Fall 2024 (MW 1:30 – 3:00 pm, ECJ 1.316)

Course Mode: Mostly in-person. Some lectures will be delivered by pre-recorded videos or online by guest lectures.

Instructor:

Professor Deji Akinwande (deji@ece.utexas.edu)

Office Hours: MW 3:00 – 4:00 pm, in EER 4.886 (occasionally on zoom).

Other times: By appointment in EER or MRC.

(½) **TA**: Further info during class.

Description:

Over the past decade, there has been an intense interest in all things made of carbon particularly applications employing carbon nanotubes and graphene. This course will introduce the science and technology of carbon nanomaterials and their electronic, optical, and sensor properties. The course will begin with a basic review of quantum mechanics and elementary theory of solids, and progress to contemporary topics including carbon synthesis, sensor devices, energy devices, interconnects, transistors, and circuit applications of carbon nanomaterials. ***In addition, beyond carbon two-dimensional materials and devices will be discussed, such as MoS_2 and TMDs.***

Learning Outcomes:

By the end of the course, students will be *able to derive the electronic structure of graphene and related materials, understand electronic and quantum transport, and critically evaluate the pros and cons of publications on the material properties and applications of 2D materials*.

"This course also counts toward the Graduate Portfolio in Nanomanufacturing (https://nascent.utexas.edu/nanomanufacturing-portfolio-program)"

Prerequisites:

EE339 Solid State Electron Devices, EE438 Electronic Circuits, and either PHY373 Modern Physics, Quantum Mechanics or EE396V Principles of Electronic Materials or instructor consent.

Tentative course topics:

- History of carbon, carbon fibers, carbon nanotubes, graphene and nanoelectronics
- Brief review of quantum mechanics and solid state physics in reduced dimensions
- Graphene nanomaterials and band structure
- Carbon nanotubes and band structure
- Electrical properties of carbon nanomaterials
- Carbon nanomaterial devices and transistors
- "Beyond graphene" 2D atomic sheets, e.g. MoS_2, h-BN, silicene etc
- Optical, energy and sensor applications of carbon and 2D nanomaterials
- Fabrication and characterization techniques of 2D materials

Textbooks

Main textbook

- Carbon Nanotube and Graphene Device Physics by H.-S. Philip Wong and Deji Akinwande, Cambridge University Press, January 2011. (http://ebooks.cambridge.org/ebook.jsf?bid=CBO9780511778124)

Suggest references include

- Graphene, by Mikhail Katsnelson, Cambridge University Press, 2012.
- Current literature articles
- Wikipedia and other web-based resources

Grading

30% Homework, 30% Midterm Project, 30% Final Project, 10% Class Participation

Add/Drop Policy

Graduate ECE students have the first 12 days of the semester to add and drop graduate ECE courses. Dropping a course after the 12th day of the semester must be approved by the Graduate ECE advisor and Dean of the Graduate school, among others.

Academic Honesty

Discussion of homework questions is encouraged. However, please submit your own independent homework solutions. Plagiarism of any form of academic misconduct (including but not limited to, copying another student's work, copying material directly from a book, article or web site without proper acknowledgement, falsifying data, doing someone else's work) is a violation of University rules and will result in disciplinary actions.

Students with Disabilities

The University of Texas at Austin provides upon request appropriate academic adjustments for qualified students with disabilities. For more information, contact the Office of the Dean Students at 471-6259, 471-4241, TDD, or the College of Engineering Director of Students with disabilities at 471-4382

Counseling and Mental Health

Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress. ***Keep screen time and social media usage to a minimum to avoid its negative effect on mental health.***

All of us benefit from support during times of struggle. You are not alone. There are many helpful resources available on campus and an important part of the college experience is learning how to ask for help. Asking for support sooner rather than later is often helpful.

If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support.

http://www.cmhc.utexas.edu/individualcounseling.html

Title IX Reporting

Title IX is a federal law that protects against sex and gender-based discrimination, sexual harassment, sexual assault, sexual misconduct, dating/domestic violence and stalking at federally funded educational institutions. UT Austin is committed to fostering a learning and working environment free from discrimination in all its forms where all students, faculty, and staff can learn, work, and thrive. When sexual misconduct occurs in our community, the university can: Intervene to prevent harmful behavior from continuing or escalating.

- Provide support and remedies to students and employees who have experienced harm or have become involved in a Title IX investigation.
- Investigate and discipline violations of the university's relevant policies.

Faculty members and certain staff members are considered ``Responsible Employees" or ``Mandatory Reporters," which means that they are required to report violations of Title IX to the Title IX Coordinator at UT Austin. I am a Responsible Employee and must report any Title IX

related incidents that are disclosed in writing, discussion, or one-on-one. Before talking with me, or with any faculty or staff member about a Title IX related incident, be sure to ask whether they are a responsible employee. If you want to speak with someone for support or remedies without making an official report to the university, email advocate@austin.utexas.edu. For more info about reporting options and resources, visit https://titleix.utexas.edu/campus-resources or contact the Title IX Office at titleix@austin.utexas.edu.