

Carbon Nanotubes

EEE 6431 Section 0001

Class Periods: T | Period 7 (1:55 PM - 2:45 PM)

R | Period 7 - 8 (1:55 PM - 3:50 PM)

Location: WEB

Academic Term: Spring 2021

Instructor:

Prof. Ant Ural

antural@ece.ufl.edu

392-9753

Office Hours: WEB, TBA

Teaching Assistant/Supervised Teaching Student:

Please contact through the Canvas website

n/a

Course Description

Basic semiconductor and solid-state physics of carbon nanotubes and graphene, nanotube/graphene geometrical and electronic structure, and current nanotube/graphene research.

3 Credits

Grading Scheme: Letter Grade

Course Pre-Requisites / Co-Requisites

EEE 5400 or permission of instructor

Course Objectives

The main objectives of this course are: (1) Cover the basic solid-state physics and chemistry necessary to understand the unique geometrical and electronic structure of carbon nanotubes, graphene, and other related nanoelectronic materials, and (2) Familiarize the student with the current research in the field of carbon nanotubes, graphene, and other low dimensional nanomaterials, including growth and synthesis techniques, experimental characterization, and device applications.

Materials and Supply Fees

Not applicable

Required Textbooks and Software

- Course notes developed by the instructor

Optional Materials

- Title: Physical Properties of Carbon Nanotubes
Author: R. Saito, G. Dresselhaus, and M. S. Dresselhaus
ISBN-10 : 1860942237
ISBN-13 : 978-1860942235
Publisher : IMPERIAL COLLEGE PRESS 1998
- Title: Solid State Physics
Author: N. W. Ashcroft and N. D. Mermin
ISBN-10 : 8131500527
ISBN-13 : 978-9387067721
Publisher : Thomson Press Ltd. 2003

- Title: Quantum Mechanics
Author: B. H. Bransden and C. J. Joachain
Prentice Hall 2000 (2nd edition)
ISBN number: 978-0582356917
- Title: Electronic Structure and the Properties of Solids
Author: W. A. Harrison
ISBN-10 : 0486660214
ISBN-13 : 978-0486660219
Publisher : Dover Publications 1989
- Title: Solid State and Semiconductor Physics
Author: J. P. Mckelvey
ISBN-10 : 0898743966
ISBN-13 : 978-0898743968
Publisher : Krieger Pub Co. 1982

Course Schedule

Weeks 1:	Introduction to carbon nanotubes and graphene
Weeks 1-2:	Outline of quantum mechanics, hydrogen atom
Week 3:	Physics of the chemical bond, LCAO method, hybridization
Week 4-5:	Crystal lattices and reciprocal lattice
Weeks 6-7:	Electronic levels in a periodic potential, Bloch theorem
Weeks 8:	Tight- binding calculation of the electronic structure of graphene
Weeks 9-10:	Geometrical structure of single-walled carbon nanotubes
Weeks 11:	Electronic structure of single-walled carbon nanotubes
Weeks 12:	Experimental aspects: Synthesis, growth, purification, and materials characterization of carbon nanotubes
Weeks 13:	Device applications of carbon nanotubes and graphene
Weeks 14-15:	Current research topics on carbon nanotubes, graphene, and related low dimensional nanoscale materials and devices

Online Course Recording

Our class sessions may be audio visually recorded for students in the class to refer back and for enrolled students who are unable to attend live. Students who participate with their camera engaged or utilize a profile image are agreeing to have their video or image recorded. If you are unwilling to consent to have your profile or video image recorded, be sure to keep your camera off and do not use a profile image. Likewise, students who un-mute during class and participate orally are agreeing to have their voices recorded. If you are not willing to consent to have your voice recorded during class, you will need to keep your mute button activated and communicate exclusively using the "chat" feature, which allows students to type questions and comments live. The chat will not be recorded or shared. As in all courses, unauthorized recording and unauthorized sharing of recorded materials is prohibited.

Attendance Policy, Class Expectations, and Make-Up Policy

This class will be presented online using Zoom and requires access to a working webcam and stable internet connection. I prefer that students keep their camera on during the class so that I can see you as I would during normal face-to-face classes. Studies show that if we can see each other's faces then we will have more engagement, more student success, and more faculty success. However, this is not a requirement. I understand if on certain days you can't have your camera on due to internet bandwidth limitations, other family members, health issues, or any other reasons.

Excused absences must be in compliance with university policies in the Graduate Catalog (<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#attendance>) and require appropriate documentation.

Evaluation of Grades

Assignment	Total Points	Percentage of Final Grade
Term Paper	100	33%
Midterm Exam	100	34%
Final Oral Presentation	100	33%
		100%

Grading Policy

The following is given as an example only.

Percent	Grade	Grade Points
90.0 - 100.0	A	4.00
87.0 - 89.9	A-	3.67
84.0 - 86.9	B+	3.33
81.0 - 83.9	B	3.00
78.0 - 80.9	B-	2.67
75.0 - 79.9	C+	2.33
72.0 - 74.9	C	2.00
69.0 - 71.9	C-	1.67
66.0 - 68.9	D+	1.33
63.0 - 65.9	D	1.00
60.0 - 62.9	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at:

<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades>

Students Requiring Accommodations

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.ua.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluer.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.ua.ufl.edu/public-results/>.

University Honesty Policy

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or

implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (<https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu.
<https://lss.at.ufl.edu/help.shtml>.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. <https://www.crc.ufl.edu/>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.
<https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.
<https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: <https://care.dso.ufl.edu>.

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.