

ECE 595 – ST: CHARACTERIZATION TECHNIQUES FOR SEMICONDUCTOR MATERIALS AND DEVICES

Instructor: Prof. Daniel Feezell
Office Location: CHTM 112B
Office Hours: by appointment
Class Meeting Day(s): Tu/Th
Class Location / Room: CHTM 103

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Course Credits: 3
Class Time: 2:00 – 3:15 pm
Term / Semester: Fall 2021

Class Website:

<https://learn.unm.edu>

I will post the syllabus, lecture slides, papers for literature review, guest lecture presentations, homework assignments and solutions, and other course materials. The website requires you to login using your UNM NetID.

Topics Covered:

This special topics course will cover a variety of characterization techniques for semiconductor materials and devices. The focus will be on techniques that you are likely to use in your research at CHTM. Topics covered (in rough order of presentation) include: resistivity, contact resistance, TLMs, Schottky barrier height, carrier and doping density, C-V, DLOS/DLTS, carrier lifetime using PL and small-signal RF, Hall effect, time-of-flight mobility, scanning probe microscopy (STM and AFM), optical microscopy, ellipsometry, transmission/reflection/absorption, photoluminescence, Raman spectroscopy, SEM/TEM/FIB, SIMS/RBS, X-ray diffraction, electronic device characterization, solar cell characterization, gain and loss measurements, diode laser and LED characterization. Depending on how the course progresses, some changes in the topic coverage may be necessary.

*There will be several guest lectures from topic experts throughout the semester.

Required Text:

“Semiconductor Material and Device Characterization,” Dieter K. Schroder, John Wiley & Sons, Inc., 3rd edition (2006), Print ISBN: 9780471739067, Online: ISBN:9780471749097, DOI:10.1002/047174909.

Reference Text:

Any undergraduate or graduate semiconductor materials and devices text will work. For example: “Semiconductor Physics and Devices: Basic Principles,” D. A. Neamen, McGraw Hill, 4th edition (2012), ISBN: 978-0-07-352958-5.

Prerequisites:

The course is intended for graduate students and has a prerequisite of a semiconductor materials and devices course, such as ECE 371 at UNM. A basic optics or optoelectronics course is also recommended.

Grading:

Attendance and Participation	25%
Homework (5 assignments)	25%
Literature Reviews (5 papers)	25%
Presentation	25%

Attendance and Participation: Regular and punctual attendance is required. The participation grade will be based on your engagement with class discussion and your meaningful contribution to that discussion. *Reading the assigned material before class and participation in the discussion during guest lectures is critical to achieving a high participation grade.*

Homework: There will be five homework assignments from the Schroder text throughout the semester. The assignments will aim to reinforce the material covered in class. Homework should be neatly written, with each problem labeled and the pages stapled together. Show your work in a logical fashion in order to get maximum credit and *please box your final answers!* If the problem says “plot” you should use Excel, Matlab, or some other numerical tool, if the problem says draw or sketch, you can do it by hand.

Literature Reviews: There will be five papers assigned for literature review throughout the semester. Please read the paper assigned and provide a *two-page* (single-spaced, Times New Roman, 12 point font, 1 inch margins) literature review that should include the following in the discussion:

- Title and full citation information for the paper.
- What problem does the paper address and why is it important?
- What are the main results and primary novelties in the paper?
- What are the technical aspects of the paper, including the basic principles and the technical findings?
- What are the impact and relevance of the work?
- How would you apply the characterization techniques presented to your own research?
- What technical or conceptual arguments, if any, are unclear to you?
- How could the paper be improved? Are there any flaws in the technical presentation or arguments?

Presentation: Each student will choose a characterization technique that was not covered in class and give a 20-minute presentation to the class about the chosen technique. More information about the requirements for the presentation will be given later in the semester. The presentations will be held during the last two class periods of the semester (Thursday, December 2nd and Tuesday, December 7th).

UNM Administrative Mandate on Required Vaccinations: All students, staff, and instructors are required by [UNM Administrative Mandate on Required Vaccinations](#) to be fully vaccinated for COVID-19 as soon as possible, but no later than September 30, 2021, and must provide proof of vaccination or of a UNM validated limited exemption or exemption no later than September 30, 2021 to the [UNM vaccination verification site](#). Students seeking medical exemption from the vaccination policy must submit a request to the [UNM verification site](#) for review by the UNM [Accessibility Resource Center](#). Students seeking religious exemption from the vaccination

policy must submit a request for reasonable accommodation to the [UNM verification site](#) for review by the [Compliance, Ethics, and Equal Opportunity Office](#). For further information on the requirement and on limited exemptions and exemptions, see the [UNM Administrative Mandate on Required Vaccinations](#).

UNM Requirement on Masking in Indoor Spaces: All students, staff, and instructors are required to wear face masks in indoor classes, labs, studios and meetings on UNM campuses, see [masking requirement](#). Students who do not wear a mask indoors on UNM campuses can expect to be asked to leave the classroom and to be dropped from a class if failure to wear a mask occurs more than once in that class. Students and employees who do not wear a mask in classrooms and other indoor public spaces on UNM campuses are subject to disciplinary actions.

Communication on change in modality: The President and Provost of UNM may direct that classes move to remote delivery at any time to preserve the health and safety of the students, instructor and community. The instructor will provide any updates about our class and please check <https://bringbackthepack.unm.edu> regularly for general UNM updates about COVID-19 and the health of our community.

Accommodation Statement: : In accordance with University Policy 2310 and the Americans with Disabilities Act (ADA), academic accommodations may be made for any student who notifies the instructor of the need for an accommodation. It is imperative that you take the initiative to bring such needs to the instructor's attention, as I am not legally permitted to inquire. Students who may require assistance in emergency evacuations should contact the instructor as to the most appropriate procedures to follow. Contact [Accessibility Resource Center](#) at 277-3506 or arcsrvs@unm.edu for additional information. UNM is committed to providing courses that are inclusive and accessible for all participants. As your instructor, it is my objective to facilitate an accessible classroom setting, in which students have full access and opportunity. If you are experiencing physical or academic barriers, or concerns related to mental health, physical health and/or COVID-19, please consult with me after class, via email/phone or during office hours. You are also encouraged to contact [Accessibility Resource Center](#) at arcsrvs@unm.edu or by phone 277-3506.

Academic Integrity: The University of New Mexico believes that academic honesty is a foundation principle for personal and academic development. All University policies regarding academic honesty apply to this course. Academic dishonesty includes, but is not limited to, cheating or copying, plagiarism (claiming credit for the words or works of another from any type of source such as print, Internet or electronic database, or failing to cite the source), fabricating information or citations, facilitating acts of academic dishonesty by others, having unauthorized possession of examinations, submitting work of another person or work previously used without informing the instructor, or tampering with the academic work of other students. The University's full statement on academic honesty and the consequences for failure to comply is available in the college catalog and in the *Pathfinder*.

Title IX: Our classroom and our university should always be spaces of mutual respect, kindness, and support, without fear of discrimination, harassment, or violence. Should you ever need assistance or have concerns about incidents that violate this principle, please access the resources available to you on campus, especially the LoboRESPECT Advocacy Center and the support services listed on its website (<http://loborespect.unm.edu/>). Please note that, because UNM faculty, TAs, and GAs are considered "responsible employees" by the Department of Education, any disclosure of gender discrimination (including sexual harassment, sexual misconduct, and

sexual violence) made to a faculty member, TA, or GA must be reported by that faculty member, TA, or GA to the university's Title IX coordinator at the [Office of Compliance, Ethics, and Equal Opportunity](#). For more information on the campus policy regarding sexual misconduct, please see: <https://policy.unm.edu/university-policies/2000/2740.html>.

Cell Phones and Technology: As a matter of courtesy, please turn off cell phones, pagers, and other communication and entertainment devices prior to the beginning of class. Notify me in advance if you are monitoring an emergency, for which cell phone ringers should be switched to vibrate.

Library and Tutorial Services: UNM-Main campus provides many library services and some tutorial services for distance students. For library services, go to <http://www.unm.edu/libraries/> to link to a specific library or to contact a librarian. For tutorial services, go to <http://caps.unm.edu/online> to explore UNM's online services.

Weather Policy: In the event of severe weather conditions UNM may close. Please call 277-SNOW to check UNM's status during questionable weather conditions.

Copyright Policy and Law: *(University Counsel's Office - Subject to Change Without Notice)*

The unauthorized distribution of copyrighted material, including through peer-to-peer file sharing, may subject a student to criminal and civil penalties. The laws that govern copyright are not specific to any one technology. Students can violate the rights of a copyright holder using many different types of technology. Both uploading and downloading of files can pose a violation of the copyright law. Students should be cautious when obtaining any copyrighted material. As a rule of thumb, before a student receives anything for free, they should research whether that source provides material licensed by the copyright owner. A group called EDUCAUSE has a list of legal file sharing alternatives at <http://www.educause.edu/legalcontent>.

Individuals who violate copyright law by illegally uploading and downloading copyrighted files may be subject to civil penalties of between \$750 and \$150,000 per song. These penalties are established by federal law. In the past, pre-litigation settlements offered by copyright owners have been in the \$3,000 to \$4,000 and up range while juries in some jurisdictions have issued verdicts of hundreds of thousands and up. In addition, a court may, in its discretion, grant the copyright owner reasonable attorney fees. Although criminal prosecution of students for file sharing is extremely rare, federal law lays out criminal penalties for intentional copyright infringement which can include fines and jail time. In addition to potentially violating the law, unauthorized distribution or receipt of copyrighted material is a violation of University Business Policies and Procedures Manual 2500. That policy states that: "Users shall respect all copyrights including software copyrights...Use of University computing services in violation of applicable laws or University policy may result in sanctions, including withdrawal of use privilege; disciplinary action, up to and including, expulsion from the University or discharge from a position; and legal prosecution under applicable federal and/or state law."