

ECE 495/595 – LIGHT-EMITTING DIODES AND SOLID-STATE LIGHTING

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

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Course Credits: 3
Class Time: 12:30 pm – 1:45 pm
Term / Semester: Fall 2018

Class Website:

<https://learn.unm.edu>

I will post the syllabus, approximate course schedule, quizzes and solutions, lecture slides, and other course materials. The website requires you to login using your UNM NetID.

Topics Covered:

This course will cover the physics, materials, technology, and applications of light-emitting diodes (LEDs) and solid-state lighting. The course is intended for senior-level undergraduate students and graduate students and has a prerequisite of ECE 371 or 471 or 475 or equivalent. I will provide a comprehensive overview of LEDs, starting with historical developments, moving on to the materials and device physics, and finishing with state-of-the-art designs and performance levels. Throughout the course, literature reviews and applications will be interwoven. Typically, on Mondays we will discuss the literature review assignment from the previous week and take a short quiz on the material from the paper(s). On Wednesdays we will follow a more conventional lecture format where I will cover fundamentals. I will also introduce a short lab component in which students will characterize the performance of GaN-based LEDs. Topics covered include:

- History of LEDs
- Semiconductor materials for LEDs
- Radiative and non-radiative recombination (SRH, bimolecular, Auger)
- Electrical properties of LEDs (diode characteristics, carrier overflow, heterostructures)
- Optical properties of LEDs (emission spectrum, light extraction)
- Internal quantum efficiency (efficiency droop)
- Design of current flow and electrodes
- Packaging
- UV and Visible LEDs based on GaN/AlGaIn/InGaIn
- Photometric quantities, colorimetry, and white LEDs (phosphor converted and RGB)
- LED modulation characteristics and visible-light communication (VLC)
- Modern applications for high-efficiency LEDs
- Literature reviews of history, state-of-the-art designs, and important materials/device physics

Required Text:

“Light-Emitting Diodes,” E. Fred Schubert, Cambridge, 2nd edition (2006), ISBN-13: 978-0521865388, ISBN-10: 0521865387

We will also discuss various articles from past and present LED literature each week.

Reference Texts:

“Optoelectronics and Photonics: Principles and Practices,” S. O. Kasap, Pearson, 2nd edition (2013), ISBN-13: 978-0-13-215149-8.

“Fundamentals of Photonics,” B.E.A. Saleh and M.C Teich, Wiley, 2nd edition (2007), ISBN: 978-0-471-35832-9

Prerequisites:

ECE 371, 471, or 475. I prefer 471 or 475, but excellent students with only a 371 background may be admitted.

Grading:

Literature Reviews and Discussion (every Monday)	20%
Quizzes (every Monday, 15 minutes)	20%
Midterm Homework (Take Home Exam, dates TBD)	30%
Group Lab Project (LED characterization and report)	30%

Literature Reviews: Please read the paper(s) assigned on the previous Wednesday and be prepared to discuss the paper(s) in class on the following Monday. You should prepare a list of *at least three relevant* questions related to the paper that you would like to include in the discussion. These questions should be turned in at the beginning of class. I will select some of the questions for further discussion during the class period. Participation in the discussion is required and counts toward your grade.

Quizzes: Each Monday at the beginning of class, we will have a short (~15 minute) quiz related to the previous literature review assignment.

Homework policy: We will not have traditional homework assignments but a take-home midterm homework/exam will be assigned. 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.

Attendance Policy: Regular and punctual attendance is required. UNM Pathfinder policies apply, which in part means instructor drops based on non-attendance are possible. This policy applies regardless of the grading option you have chosen.

Accommodation Statement: Accessibility Services (Mesa Vista Hall 2021, 277-3506) provides academic support to students who have disabilities. If you think you need alternative accessible formats for undertaking and completing coursework, you should contact this service right away to assure your needs are met in a timely manner. If you need local assistance in contacting Accessibility Services, see the Bachelor and Graduate Programs office.

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*.

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.”