

ECE 570 – OPTOELECTRONIC SEMICONDUCTOR MATERIALS AND DEVICES

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Class Meeting Day(s): MW
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Course Credits: 3
Class Time: 11:00 am – 12:15 pm
Term / Semester: Fall 2016

Class Website:

<http://www.unm.edu/~dfeezell/ECE570/>

I will post the syllabus, homework assignments and solutions, lecture slides, and other course materials. The website requires you to login using your UNM NetID. A detailed course schedule is also available on the course website. This schedule includes the material to be covered, recommended sections of the book for reading, exam dates, and approximate HW assignment dates and due dates. Please note that the lecture schedule is approximate.

Topics Covered:

Introduction to Semiconductor Materials (Ch. 1, 1 lecture) – common semiconductor materials and crystal structures, semiconductor growth techniques including MBE and MOCVD, lattice matching.

Basic Quantum Mechanics (Ch. 3, 3 lectures) – Schrodinger equation, bra-ket (Dirac) notation, operators, wavefunctions and basis representation, Hamiltonian, orthonormality, kronecker delta, probability density, infinite and finite barrier square potential wells, time-dependent perturbation theory, Fermi's golden rule.

Basic Semiconductor Electronics (Ch. 2, 5 lectures) – continuity equations, Poisson's equation, drift/diffusion, electron/hole concentrations, Fermi-Dirac distribution, density of states, generation/recombination (SRH, radiative, Auger), ABC model, stimulated recombination, optical pumping, pn junctions and heterojunctions.

Optical Waveguides (Ch. 7, 2 lectures) – dielectric slab waveguide, graphical solution, cut-off condition, effective index, confinement factor, effective index method, lossy and gain media.

Optical Processes in Semiconductors (Ch. 9, 4 lectures) – Fermi's golden rule, optical absorption coefficient, spontaneous and stimulated emission, Einstein's coefficients, absorption/gain spectra, absorption and gain in bulk and quantum wells, optical matrix element, joint density of states, momentum matrix element.

Fundamentals of Semiconductor Lasers (Ch. 10, 4 lectures) – threshold condition, transparency condition, light output power, differential efficiency, rate equations, LEDs and spontaneous emission, amplified spontaneous emission, gain-guided and index-guided lasers, quantum-well lasers, gain spectra, strained quantum-well lasers.

Advanced Semiconductor Lasers (Ch. 11, 3 lectures) – distributed feedback (DFB) lasers or vertical-cavity surface-emitting lasers (VCSELs) or GaN-based lasers.

Direct Modulation of Semiconductor Lasers (Ch. 12, 2 lectures) – modulation of semiconductor lasers, rate equations, small-signal response, linewidth enhancement factor, RIN.

Photodetectors and Solar Cells (Ch.15, 6 lectures) – photoconductors, noise in photodiodes, pn photodiodes, pin photodiodes, avalanche photodiodes, solar cells.

Required Text:

“Physics of Photonic Devices,” Shun Lien Chuang, John Wiley & Sons, 2nd edition (2009), ISBN-10: 0470293195; ISBN: 978-0470293195

**We will only have time to cover portions of the text in this one-semester course. The text is fairly comprehensive and will serve as a good reference in your future independent research activities. The text is also fairly advanced, so I suggest utilizing the reference texts below for additional perspective on difficult topics.*

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

“Diode Lasers and Photonic Integrated Circuits,” L. Coldren, S. Corzine, and Milan Masanovic, John Wiley & Sons Inc., 2nd edition (2012), ISBN: 0470484128.

“Photonic Devices, Part 2” Jia-Ming Liu, Cambridge University Press, (2005); ISBN 978-0-521-13578-8

Prerequisites:

ECE 471 or ECE 572 (required), undergraduate optoelectronics (strongly recommended), undergraduate electromagnetics (recommended)

Grading:

Homework (there will be approximately 9 homework assignments)	30%
Midterm Exam (Wednesday 10/26, 11:00am-1:00pm)	35%
Final Exam (Wednesday 12/14, 10:00am-12:00pm or TBD)	35%

Homework policy: Late homework assignments will typically not be accepted as I will post the solutions to the assignments right after you turn them in. Homework is due at the *beginning* of the class period on the due date. 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.”