PRAIRIE VIEW A&M UNIVERSITY
DEPARTMENT OF ELECTRICAL ENGINEERING
ELEG 4223 – Photonic and Electronic Materials and Devices
Spring 2016

Study and, in general, the pursuit of truth and beauty is a sphere of activity in which we are permitted to remain children all our lives.
-Albert Einstein

To not know is bad; to not want to know is worse.
-African Proverb

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Office hours: MTW 9 am – 12 pm, F 9 am -10 am or by appointment. You are always welcome to stop by my offices if I am in. Call or e-mail ahead to see if I am here.

Recommended Text: Hand outs and class notes. The text from ELEG 3033 ("Physical Principles…") will be an excellent reference: *Solid State Electronic Devices,* 6th Edition by Streetman and Banerjee, Prentice Hall, 5th and 4th edition will also be useful. These texts are not required.

Prerequisites: ELEG 3033, Physical Principles of Solid State Devices (C or better).

BRIEF DESCRIPTION OF THE COURSE

A survey approach will be taken for the class. We will be focusing on the interactions of photons (light) with semiconductors and the electrons in these semiconductors to understand the optical properties of solids and devices made from them. The quantum nature of solids will be introduced to better understand the fundamental interactions of photons with matter, and the properties of various photonic and electronic materials and devices made from these materials. Semiconductor concepts introduced in ELEG 3033 will be extensively used, such as carrier type and concentration and band theory. Applications of photonics in communication, displays, and renewable energy and "green" lighting are topic for discussion. We will also introduce topics related to nano-electronics and nano-photonics, including a discussion of

graphene and carbon nanotubes, their properties and their applications. As time permits topics on the dielectric, magnetic and superconducting properties of materials will be discussed.

TENTATIVE OUTLINE OF THE TOPICS & SCHEDULE

Dates for all exams will be announced at least one week before the exam.

Basic Concepts:

Review of semiconductor concepts: intrinsic and extrinsic materials, carrier concentrations, energy bands, basics of the p-n junction.
Classical concepts: Types of solids, electrons in electric and magnetic fields, the electromagnetic spectrum, laws of reflection and refraction.
Quantum concepts: photons, electrons as a wave, Schrodinger's Equation, energy levels, quantum nature of atoms and molecules, solids, electron tunneling.
Weeks 1-5

Optical Properties of Semiconductors:

Elemental and compound semiconductors, direct and indirect energy gaps, electron-hole pairs, inter-band transitions and deep-level transitions, energy gap and wavelength, dielectric properties of solids. Weeks 6-9

Midterm

Photonic devices:

Photo-detectors, Solar cells, light emitting diodes, laser operating principals, semiconductor laser structure and properties, fiber optics. Weeks 10 -12.

Photonic Applications and Systems:

Opto-electronic communications systems.
Display systems.
Renewable energy and "green" lighting. Weeks 13 & 14.

Nano-technology:

Optical, electronic and other properties of graphene and carbon nanotubes and applications. optical interactions with nano-scale solids. Applications of nano-technology. Week 15

(As time permits)
Magnetic Properties of Materials and Superconductivity: Electron spin, ferromagnetism, qualitative discussion of superconductivity.

Measurement Techniques: (Selected and as time permits) four point probe, Hall effect, microscopies, photon and electron spectroscopies.

Final

Student Outcome: A student that completes this class with a passing grade should have a basic understanding of the optical properties of semiconductors, optoelectronic devices, photonic applications, and nano-technology as related to nano-electronics and nano-photonics.

FINAL GRADE

Your final grade will be determined upon these four factors with equal weight:

1. Midterm (100 points)
2. Final (100 points)
3. Writing assignment (100 points)
4. Projects – Quizzes (100 points; the total may vary but not more than 100 pts.)
5. Class attendance & timeliness. (100 points)

Total points for the course: up to 500 points.

Homework will be given on a regular basis. The homework will emphasize concepts and calculations I expect you to know for the exams. Homework will be collected and checked but will NOT count toward the final grade. The exams will reflect the homework, but also include materials from class lectures and handouts. **I cannot stress enough the importance of doing and understanding your homework.** As the course progresses I will provide homework solutions and problem review sessions. Studying the solutions and attending review sessions are probably NOT enough to insure good performance on exams. I will be available during office hours to help you with your work. I encourage you to take advantage of this. Homework will be reviewed in class with student participation for extra-credit.

Exams: The midterm and final will be given during the midterm and final periods. The materials covered on the exams will include the homeworks, handouts, class notes, and assigned readings. The midterm will cover those materials covered up to a specific point in the class which will be announced in class. The final will be comprehensive, but will emphasize material covered after the midterm. If you are a graduating senior, please advise me of this.

Writing assignment: This exercise will give students experience in researching information on a topic and summarizing this research in a concise and accurate technical memo. The topic will be assigned and it will be something on which the student is unlikely to have any prior knowledge. Details of this assignment will be forthcoming later in the semester.

Projects and Quizzes: I am hoping to have one or two projects for the class that will involve in-class activities. One involves working with a lab kit on light and photonic devices. Another will be a "field trip" to the 3-D virtual reality lab in Wilson Building for an exercise in nano-scale science. Other activities may be developed as the course progresses. There may be several short quizzes as well.

Class attendance: Since the course has no specific text and meets once a week, attendance in class is essential. Attendance will be taken at every class and counts for the same amount as an exam. You must be present for the entire class to get credit for that class. Absences, lateness and early departure will be excused only according to those accepted excuses by the university and must be documented.

Final Grade

Your final grade will be determined by your percentage of the total points possible (up to 500 points) from the exams, writing assignment, and attendance compared to your classmates. It is possible that exceptional performance on the final will help borderline grades. The **maximum** grading schedule will be: 90-100%=A, 80-89%=B, 70-79%=C, 60-69%=D, below 59%=F. This means that if everyone in the class scores above 90%, everyone will get A's.

******A minimum score of 60% will be required to pass the course.*******

Extra Credit: Opportunities for extra credit points **may** be offered during the semester. The assignments will be designed to encourage you to acquire a better understanding of engineering and scientific concepts and foster "life-long" learning. Stay tuned…

Other notes:

No "I" will be given for this course unless the conditions specified by the university are satisfied.

Note: If you have any needs that fall under the Americans with Disabilities Act, please inform me so that appropriate actions can be taken.

Please see the current university undergraduate catalog for a summary of all university academic policies (A catalog is available on the university's web site). This course will be conducted in accordance with these policies. Per university policy, attached are pages from the undergraduate catalog regarding student academic appeals process. **Please also see below.**

Finally, if you have any questions or concerns about the class, I will be happy to discuss them with you.

HAVE A GOOD SEMESTER!

University Rules and Procedures

Disability statement (See Student Handbook):
Students with disabilities, including learning disabilities, who wish to request accommodations in class should register with the Services for Students with Disabilities (SSD) early in the semester so that appropriate arrangements may be made. In accordance with federal laws, a student requesting special accommodations must provide documentation of their disability to the SSD coordinator.

Academic misconduct (See Student Handbook):
You are expected to practice academic honesty in every aspect of this course and all other courses. Make sure you are familiar with your Student Handbook, especially the section on academic misconduct. Students who engage in academic misconduct are subject to university disciplinary procedures.

Forms of academic dishonesty:

1. Cheating: deception in which a student misrepresents that he/she has mastered information on an academic exercise that he/she has not mastered; giving or receiving aid unauthorized by the instructor on assignments or examinations.

2. Academic misconduct: tampering with grades or taking part in obtaining or distributing any part of a scheduled test.

3. Fabrication: use of invented information or falsified research.

4. Plagiarism: unacknowledged quotation and/or paraphrase of someone else's words, ideas, or data as one's own in work submitted for credit. Failure to identify information or essays from the Internet and submitting them as one's own work also constitutes plagiarism.

Nonacademic misconduct (See Student Handbook)
The university respects the rights of instructors to teach and students to learn. Maintenance of these rights requires campus conditions that do not impede their exercise. Campus behavior that interferes with either (1) the instructor's ability to conduct the class, (2) the inability of other students to profit from the instructional program, or (3) campus behavior that interferes with the rights of others will not be tolerated. An individual engaging in such disruptive behavior may be subject to disciplinary action. Such incidents will be adjudicated by the Dean of Students under nonacademic procedures.

Sexual misconduct (See Student Handbook):
Sexual harassment of students and employers at Prairie View A&M University is unacceptable and will not be tolerated. Any member of the university community violating this policy will be subject to disciplinary action.

Attendance Policy:
Prairie View A&M University requires regular class attendance. Excessive absences will result in lowered grades.

Excessive absenteeism, whether excused or unexcused, may result in a student's course grade being reduced or

in assignment of a grade of "F". Absences are accumulated beginning with the first day of class.

Student Academic Appeals Process
Authority and responsibility for assigning grades to students rests with the faculty. However, in those instances where students believe that miscommunication, errors, or unfairness of any kind may have adversely affected the instructor's assessment of their academic performance, the student has a right to appeal by the procedure listed in the Undergraduate Catalog and by doing so within thirty days of receiving the grade or experiencing any other problematic academic event that prompted the complaint.