**ECE 4314/5314: Solid State Devices (Fall 2021: Aug. 23 - Dec. 8)**

**Lecture Time:** Thursday 14:00 pm – 16:50 pm                **Room:** Online

**Instructor Information**
- **Instructor:** Prof. Ravi Joshi
- **Offices:** EE building #108
- **Office hours:** 11:00 am – 1:45 pm (M-F), or by appointment
- **E-mail:** ravi.joshi@ttu.edu // **Telephone number:** (806)-834-7979

**Description**
This course introduces the physical principles of semiconductor devices and their practical implementation in electronic circuits. Topics include metal-semiconductor junctions, p-n junctions, bipolar junction transistors, field-effect transistors, integrated circuits, and light emitting diodes. The emphasis will be on the physical principles and the devices, not how the devices are used in circuits. The detailed operation of the p-n junction diode will be emphasized.

**Textbook**

**Suggested Supplemental Texts**

**Topics Covered**

*Semiconductor material and physics (Chap. 1-4):* Crystal lattice structure; Si and III-V semiconductors bulk and epi wafer growth; Energy band structure; Carrier transport; Excess carriers in semiconductor //

*Semiconductor junctions and diodes (Chap. 5)* p-n junction at equilibrium; Bias and steady state; Breakdown; Transient conditions; Metal-semiconductor junctions //

*Field Effect Transistors (Chap. 6)* JFET and MESFET; MOSFET basics; CMOS //

*Bipolar Junction Transistors (Chap. 7)* BJT basics; BJT analysis; Switching //

*Optoelectronic Devices (Chap. 8)* Light emitters; Laser diode; Photodetectors; Photovoltaics.

**Expected Learning Outcomes**
Upon completion of this course, the students will be able to:

1. **Understand the fundamentals of semiconductor physics on which electronic devices are based.** The importance of electrons and holes in semiconductor transport, and the operating principles of some common solid state devices.
2. **Know the operating characteristics and device applications.**
3. **Use knowledge of numerical techniques to obtain device response.**
### Learning Outcome | Assessment Method
---|---
Describe the fundamental semiconductor properties. | Quizzes, home works, and comprehensive final examination
Describe the principle and analyze the operation of p-n diodes. | Quizzes, home works, and comprehensive final examination
Describe the principle and analyze the operation of BJTs. | Quizzes, home works, and comprehensive final examination
Describe the principle and analyze the operation of FETs. | Quizzes, home works, and comprehensive final examination
Describe the fundamentals of optoelectronic devices. | Quizzes, home works, and comprehensive final examination

**Course Grading Details:**
Exams (two): 20 points \( \times 2 = 40 \) points // October 7 and November 18 (open-notes, closed-book).
Quizzes (two): 10 points \( \times 2 = 20 \) points // September 16 and October 21 (open-notes, closed-book).
One term paper: 10 points. Due last week of semester.
(Term paper topics could be related to graduate research. List of possible topics will be given).
(For undergraduate students: **No Term Paper** / for graduate students the overall score will be scaled down by factor of 100/110)
Assigned homeworks = 20 points
Finals (Comprehensive) = 20 points
Total course grade 100 pts // Relative grading system; Clustered groups receive same grades.
Homeworks are due on the assigned date, and no delays will be granted unless documented reasons in extenuating circumstances are provided. Instructor will judge the validity of the reasons at his discretion.

**Methods of Assessment of Learning Outcomes**
Quizzes, tests (exams), and final comprehensive exam. All tests, quizzes and final will have an open-notes, closed-book format. Cells phones have to be SHUT-OFF during Tests, Quizzes, Finals, and Term Papers!

**Important Note**
There will be no make-ups for quizzes and/or tests without prior permission from the instructor for legitimate reasons which will be judged by the instructor at his discretion. If a student has a scheduling conflict with any of the exams, he or she will give notice at which time other arrangements could be made. If a student misses an exam or quiz due to unforeseen and extenuating circumstances, the student’s performance percentage will be substituted for the missed examination or quiz. However, in such cases, it is the student’s responsibility to provide documented reasons.
Only hand-written notes and material uploaded on Blackboard for this Fall 2021 class are allowed in class for tests, quizzes and finals – no textbooks or other copied materials will be permitted. Cell phones should be turned off at all times during classes and exams, otherwise students may be asked to leave.

**Academic integrity**
Students caught submitting the work of others or cheating on a test, or quiz, or the final will receive an automatic ZERO score for ALL parties involved. Repeat offenders could receive an “F” grade for the entire course. For a complete description of academic integrity see Texas Tech Operating Policy 34.12.
Standard Texas Tech Policies That Apply to the Course:
1. Any student who, because of a disability, may require special arrangements in order to meet the course requirements should contact the instructor as soon as possible to make any necessary arrangements. Students should present appropriate verification from Student Disability Services during the instructor’s office hours. Please note instructors are not allowed to provide classroom accommodations to a student until appropriate verification from Student Disability Services has been provided. For additional information, you may contact the Student Disability Services office at 335 West Hall or 806-742-2405.

2. Any student absent for a religious holiday should make that intention known prior to the absence and shall make up missed exams in accordance with Texas Tech Operating Policy 34.19.

Civility in the Classroom
Students are expected to assist in maintaining a classroom environment that is conducive to learning. Inappropriate behavior in the classroom that leads to the distraction of others shall not be tolerated under any circumstances.

Illness Based Absence Policy
If at any time during this semester you feel ill, in the interest of your own health and safety as well as the health and safety of your instructors and classmates, you are encouraged not to attend face-to-face class meetings or events. Please review the steps outlined below that you should follow to ensure your absence for illness will be excused. These steps also apply to not participating in synchronous online class meetings if you feel too ill to do so and missing specified assignment due dates in asynchronous online classes because of illness.

1) If you are ill and think the symptoms might be COVID-19-related:
   a. Call Student Health Services at 806.743.2848 or your health care provider.
   b. Self-report as soon as possible using the Office of the Dean of Students website. This website has specific directions about how to upload documentation from a medical provider and what will happen if your illness renders you unable to participate in classes for more than one week.
   c. If your illness is determined to be COVID-19-related, all remaining documentation and communication will be handled through the Office of the Dean of Students, including notification of your instructors of the period of time you may be absent from and may return to classes.
   d. If your illness is determined not to be COVID-19-related, please follow steps 2 below.

2) If you are ill and can attribute your symptoms to something other than COVID-19:
   a. If your illness renders you unable to attend face-to-face classes, participate in synchronous online classes, or miss specified assignment due dates in asynchronous online classes, you are encouraged to visit with either Student Health Services at 806.743.2848 or your health care provider. Note that Student Health Services and your own and other health care providers may arrange virtual visits.
   b. During the health provider visit, request a “return to school” note.
   c. E-mail the instructor a picture of that note.
   d. Return to class by the next class period after the date indicated on your note. Following the steps outlined above helps to keep your instructors informed about your absences and ensures your absence or missing an assignment due date because of illness will be marked excused. You will still be responsible to complete within a week of returning to class any assignments, quizzes, or exams you miss because of illness.
Facial Covering may ensure a safer and healthier outcome. Current research on the COVID-19 virus suggests that there is a significant reduction in the potential for transmission of the virus from person to person by wearing a mask/facial covering that covers the nose and mouth areas. Observing safe distancing practices within the classroom by spacing out and wearing a mask/facial covering will greatly improve our odds of having an overall safe and healthy experience.

*If Texas Tech University campus operations or mandates are required to change because of health concerns related to the COVID-19 pandemic, students will be advised accordingly.*

**Important Dates:**
- Exam I and II: October 7 and November 18
- Quiz I and II: September 16 and October 21
- Last Day to Drop a Course Without Penalty: September 8
- Last Day to Withdraw With Penalty: September 20
- Mid-semester grades due: October 25
- Period of No Exams: November 22 – December 1
- Thanksgiving Break: November 24 – November 28
- Last Day of Class: December 1
- Term paper presentation: December 1
- Finals: December 6 (13:30 pm – 16:00 pm)

**Attendance Policy:**
In-class attendance will not be taken; nor will it count towards the course grade. However, each student is responsible for all material covered in class and any announcements made in class.
There are 14 lectures in EE 4314/5314. The following describes the topics and corresponding text sections.

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<thead>
<tr>
<th>Date</th>
<th>Description</th>
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<tbody>
<tr>
<td>8/26</td>
<td>L1: Course syllabus / Semiconductors, Lattices, Growth, Atoms and electrons</td>
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<tr>
<td>9/02</td>
<td>L2: Energy bands and carriers in semiconductors</td>
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<tr>
<td>09/08</td>
<td>Last day to withdraw without penalty</td>
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<tr>
<td>9/09</td>
<td>L3: Excess carriers in semiconductors</td>
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<td>9/16</td>
<td>L4: Quiz #1 (10 points); pn junctions, Analysis for equilibrium conditions</td>
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<td>9/21</td>
<td>Last day to withdraw</td>
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<tr>
<td>9/23</td>
<td>L5: pn junctions (contd.), Forward- &amp; reverse-biased conditions</td>
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<td>9/30</td>
<td>L6: Deviations from simple theory, Different pn junction diodes</td>
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<td>10/07</td>
<td>L7: Exam #1 (20 pts), Bipolar junction transistors</td>
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<td>10/14</td>
<td>L8: Bipolar junction transistors (contd.)</td>
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<td>10/21</td>
<td>L9: Quiz #2 (10 points); Switching in bipolar junction transistors</td>
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<td>10/28</td>
<td>L10: Frequency response of bipolar junction transistors</td>
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<td>11/04</td>
<td>L11: Junction Field Effect transistors (JFET), MESFETs</td>
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<td>L12: pnpn devices, Thyristors</td>
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<td>11/18</td>
<td>L13: Exam #2 (20 points); Elements of Microwave and Optical devices</td>
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<td>12/01</td>
<td>L14: Term Paper Presentations, Last Day Of Class</td>
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<tr>
<td>12/06</td>
<td>FINALS (13:30 pm – 16:00 pm) 20 Points</td>
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*Note: Topics and/or dates may be changed during the semester at the instructor’s discretion because of scheduling issues, developments in the discipline, or other contingencies.*