Electronics
Physics 3420
Spring 2026

In Person Lecture, Tu/Th 9:30-10:50
Lab Section Thursday **or** Friday 13:00-15:50 (see **Lab-Canvas** page for Details)
Recitation Tu/Th 11:00 – 11:50

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Pronouns: He, him, his
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Office Hours: Wednesday 9:30-11:30 or by appointment

Welcome! As members of the UNT community, we have all made a commitment to be part of an institution that respects and values the identities of students and employees with whom we interact. UNT does not tolerate identity-based discrimination, harassment, and retaliation. Everyone should feel comfortable being their authentic selves in our class. If you have any questions or concerns, do not hesitate to contact me.

Course Description: Electronics is the domain of electrical engineering; however, many physics graduates pursuit careers in this field. Engineering, **applied physics and specifically semiconductor technology are the biggest growth markets in the US, with predicted semiconductor job growth of up to 33% in the next 5 years**, compared to about 2-10% in astronomy.[1] To illustrate this: The field of Astronomy has about 150 job openings annually (based on AAS) nationwide, Texas Instruments had 280 openings alone.[2] The average starting salary for astronomers is $50k, while applied physics is $75-90k.[3] Furthermore, there are way more graduate (Ph.D. positions) in applied physics. This course will allow you to understand and communicate in the field of applied physics and engineering and hopefully opens the avenue to careers and research in these markets of the future. Apart from the huge commercial interest, electronics is a vivid research field, recognized with multiple noble prizes starting in 1909 and continuing to the most recent Nobel prize in physics 2026.

This class strives to provide the core knowledge underlying novel electronics without diving too deep into the engineering or quantum mechanics aspects. We will present the basics of circuit theory in combination with hands-on lab experiments. The combination of these two aspects shall enable you to understand and build circuits on an advanced level. This effort will be complemented by using state-of-the-art circuit design and simulation software (SPICE). We will not only focus on circuits but also gain a detailed understanding of the physics that governs a circuit element's current-voltage response, including Diodes, Field Effect Transistors (FET), and Solar Cells. The underlying semiconductor physics combines solid-state physics, statistical (quantum) mechanics, electrodynamics, and quantum mechanics. Keep in mind, this is actually the research Einstein got his Nobel Prize for! Or in other words: **this will be one of the hardest classes that you had the privilege to take.**

Format: This is an in-person class, with a lab section, and a recitation.
You can contact me via email at jens.neu@unt.edu or by sending a message in Canvas. In most cases, you can expect to receive a response within one workday. You are also always welcome to come by my office during office hours or at other times. You are expected to check your UNT email and Canvas messages at least once a workday.

[1] Based on US-Bureau of Labor Statistics
[2] ChatGPT search of TI job postings and AAS information
[3] ChatGPT search AIP and AAS data and US-Bureau of Labor Statistics

PHYS-3420 contributes to the following core course learning objectives:

- **Critical Thinking:** Creative thinking, analysis, evaluation, and synthesis of information
- **Communication:** Development, interpretation, and expression of ideas through written, oral, and graphical means
- **Quantitative Skills:** Manipulate and analyze data to reach meaningful, informed conclusions
- **Teamwork:** Consider different points of view and work effectively with others to support a shared purpose or goal

Course Pre-requisites: Physics 2: PHYS 1420/PHYS 1440, or PHYS 2220/PHYS 2240, or PHYS 1520/1540 MATH 1710 with a C or higher or MATH 1820 (may be taken concurrently)

Use of Artificial Intelligence: Artificial Intelligence that can produce content is now widely available to produce text, images, and other media. We encourage the use of such AI resources to inform yourself about the field, to understand the contributions that AI can make, and to help your learning. However, keep the following three principles in mind: (1) An AI cannot pass this course; (2) AI contributions must be attributed and edited for accuracy; (3) The use of AI resources must be open and documented.

1. **To pass this course:** AI generated submissions cannot achieve a passing grade. This is necessary to ensure you are competent to surpass generative AI in the future – whether in academia, research, the workplace, or other domains of society. In particular, **AI cannot be used during exams, quizzes, and labs.**
2. **Attribution:** You are taking full responsibility for AI-generated materials as if you had produced them yourself: ideas must be attributed, and facts must be true.
3. **Documentation:** The use of AI needs to be properly attributed.

Be aware that during exams and labs no AI can be used! AI can be a useful tool for you to better understand the concepts or to automate repetitive tasks, but **learning electronics remains your responsibility**.

Course Goals:
By the end of this course, students will be able to:

- Read and understand circuit diagrams
- Design Circuits for specific applications
- Learn the "language" of electrical engineering needed for academic and industrial careers
- Understand the basic physics that governs semiconductor electronics
- Understand the concepts of semiconductor physics
- Understand how dopants govern the properties of semiconductors
- Understand the core concepts of integrated circuits and the building blocks forming them
- Communicate with Microprocessors

Textbook:
Main Text: *Introductory Semiconductor Device Physics,* by G. Parker, Taylor & Francis *ISBN 0-7503-1021-9*

Additional text for the first 3 weeks: Physics 2 textbook from your past semesters.

Further reading if you are interested in an in-depth discussion: *Physics of Semiconductor Devices*, by S.M. Sze, Y. Li, and K.K. NG, Wiley, ISBN: 978-1-119-42911-1

Technical Skill Requirements

- The course includes a laboratory component that includes handling small parts: Do not swallow them.
- Manipulation skills are needed, please discuss with me or the laboratory TA if visual recognition or handling of small parts is challenging to you.
- Canvass and emails

Attendance and Participation: You are adults and can make your own choices: If you think that you can learn the subject matter without attending class, fine with me. However, there will be unannounced, in class quizzes for extra credit. **Attendance for the lab section is mandatory.**

Exams: There will be two exams given during class in the lecture classroom at the dates indicated on the schedule at the end of the syllabus. **This date might change depending on our progress** and I will update these dates at least one week before the exam. I will also send out a canvas announcement with the new date. The comprehensive final exam is on Thursday, May 8th from 7:30-9:30 in the Physics building.

Exam questions can involve mathematical calculations, multiple choice, and conceptual explanations and will be based on material from lecture, labs, and homework assignments.

- There will be no makeup exams. If you miss an exam for a suitably serious reason, the average of your other exam scores will substitute for the missed grade.
- Questions pertaining to the grading of exams must be directed to the instructor in writing within one week of receiving your graded exam.

Homework: All homework will be posted online using Canvas and submitted via Canvas.

Late Homework: There are no points for late homework; If you are likely to miss a deadline (sickness, personal emergencies), you can request an extension up to 12 hours before the due date. The homework will be posted before Thursday 23:59. Submission closes Tuesday's 9:29.

Physics Instructional Center (PIC): The PIC is a peer mentor program that can help you better understand the material.

Learning from Mistakes: Learning necessarily involves making mistakes. If you never make mistakes then you are not being sufficiently challenged. The goal is to make most of your mistakes on the homework and during in-class practice so that you can ask questions and review your notes/textbook to learn from those mistakes before you get to the exam. When you make a mistake on an exam, your goal is still to understand what you did wrong and to learn from that mistake. I will therefore provide answer keys of the exam questions, after the exam of course 😊.

Course Grades: Course grades will be calculated as follows:

Exam 1	10
Exam 2	10
Final Exam	20
Homework/Recitation	20
Labs	40
Quizzes	5 Extra Credit

A = 90 to 100 B = 80 to 89 C = 70 to 79 D = 60 to 69 F = below 60

Lab Class/Recitation: To enhance our learning success we will have hands-on experience in building circuits and analyzing their responses. This lab class is partially new designed and some of the experiments will not work. Which is an excellent preparation for future research work in which you should anticipate that things don't work the way you intended them to. The recitation is guided by a TA and will give you an additional opportunity to learn electronics. The core of the recitation will be a peer driven discussion, so please come prepared.

Course Outline:
The course is divided into **6 Modules** plus if time permits one very advanced additional module. See module overview on canvass.

Hints to being a successful student (Strongly suggested!):

1. Prepare for the Class. The slides (in draft form) will be online before the class. Look over them.
   a. The same applies to the lab classes which also has pre-lecture assignments.
2. Pay attention to the deadlines!
3. Invest the time that is needed for you to succeed. For a 4-hour class (as this is) you should expect another 8-12 hours of work on your own! Meaning, with class (3 hours), recitation (2 hours) and lab (3.5 hours) the total time is about **20 hours a week!**
4. No question is a dumb question! Ask! If you do not ask, I assume that you understood everything and will see in the exams whether this assumption was correct.

Tentative Course Calender/Syllabus
PHYS 3420
Spring 2026

Date	Module/Lab	Topics
Tu Jan 13	Module 1	Introduction; Conservation laws; Perfect electrical conductor
Th Jan 15	Module 1	Electrical Field/Potential, Kirchhoff, Inductance, Capacitance
Th/Fr 15/16	Lab: 1	Orientation and Introduction to experiments
Tu Jan 20	Module 1	Impedance, Complex Currents/Voltages
Th Jan 22	Module 2	Time response and frequency response, SPICE
Th/Fr 22/23	Lab: 2	Kirchoff's Law in action
Tu Jan 27	Module 3	From Orbitals to Bands
Th Jan 29	Module 3	Band Diagrams, Electrons, Holes
Th/Fr 29/30	Lab: 3	RC Filter

Tu Feb 3	Module 3	Fermi Level
Th Feb 5	Module 3	Dopants, n and p conductivity
Th/Fr 5/6	Lab: 4	LC Resonator
Tu Feb 10	Module 4	n-p junctions
Th Feb 12	Module 4	pn-junctions
Th/Fr 12/13	Lab: 5	Micro Processors Control of Stepper Motor
Tu Feb 17	Module 4	pn-junctions
Th Feb 19	EXAM 1	Exam (Module 1,2,3, some of 4)
Th/Fr 19/20	Lab: 6	PID
Tu Feb 24	Module 4	Schottky contacts/barrier and pin diodes
Th Feb 25	Module 4	Buffer
Th/Fr 25/26	Lab: 7	Diodes
Tu Mar 3	Module 4	Bipolar Devices
Th Mar 5	Module 4	Field Effects
Th/Fr 5/6	Lab: 8	Solar Cells and Photodiodes
Tu Mar 10	Spring Break	Spring Break
Th Mar 12	Spring Break	Spring Break
Th/Fr 12/13	Spring Break	Spring Break
Tu Mar 17	Module 4	Amplifier
Th Mar 19	Module 4	Amplifier
Th/Fr 19/20	Lab: 9	BJT
Tu Mar 24	Module 5	Opto-electronics
Th Mar 26	Module 5	Opto-electronics
Th/Fr 26/27	Lab: 10	MOSFET
Tu Mar 31	Module 6	Data Communication/Baud Rate/Handshake
Th Apr 2	Module 6	Synchronization

Th/Fr 2/3	Lab: 11	OpAmp
Tu Apr 7	Module 6	A-D-Converter
Th Apr 9	EXAM 2	Module 4,5,6
Th/Fr 9/10	Lab: 12	AM Radio
Tu Apr 14	Module ?	Noise
Th Apr 16	Module ?	Noise
Th/Fr 16/17	Lab: 13	**Schedule Make Up Session for lab if needed!**
Tu Apr 21	Module X	Lock-In Amplification
Th Apr 23	Module X	Advanced Circuit Theory and Simulation
Th/Fr 23/24	Lab: Make Up	Make Up if Snow, or canceled if no university closure
Tu Apr 28	Module X	Continuity Equations: Model Charge Flow under non-equilibrium conditions.
Th Apr 30	Module X	Continuity Equations: Model Charge Flow under non-linear conditions.
Th/Fr 30/31	No Labs	Reading Day

UNT Policies

Dropping the Course: The last day you can drop this course without W is January 24th, 2026, and with W is April 10th 2026. See UNT's Registrar page for more information on dropping a course. (https://registrar.unt.edu/dropping-classes)

Course Evaluation: The Student Perceptions of Teaching (SPOT) is a requirement for all organized classes at UNT. This short survey will be made available to you on-line at the end of the semester and will provide you with an opportunity to provide feedback to your course instructor. SPOT is considered to be an important part of your participation in this class. You will receive an email from "UNT SPOT Course Evaluations" from no-reply@iasystem.org with the survey link. You will have separate SPOT evaluations for lecture, recitation, and lab. During fall and spring semesters SPOT surveys are open to students to complete two weeks prior to final exams.

Academic Integrity Standards and Consequences: According to UNT Policy 06.003, Student Academic Integrity, academic dishonesty occurs when students engage in behaviors including, but not limited to cheating, fabrication, facilitating academic dishonesty, forgery, plagiarism, and sabotage. A finding of academic dishonesty may result in a range of academic penalties or sanctions ranging from admonition to expulsion from the University.

ADA Accommodation Statement: UNT makes reasonable academic accommodation for students with disabilities. Students seeking accommodation must first register with the Office of Disability Accommodation (ODA) to verify their eligibility. If a disability is verified, the ODA will provide a student with an accommodation letter to be delivered to faculty to begin a private discussion regarding one's specific course needs. Students may request accommodations at any time; however, ODA notices of accommodation should be provided as early as possible in the semester to avoid any delay in implementation. Note that students must obtain a new letter of accommodation for every semester and must meet with each faculty member prior to implementation in each class. For additional information see the ODA website at disability.unt.edu.

Emergency Notification & Procedures: UNT uses a system called Eagle Alert to quickly notify students with critical information in the event of an emergency (i.e., severe weather, campus closing, and health and public safety emergencies like chemical spills, fires, or violence). In the event of a university closure, please refer to Canvas for contingency plans for covering course materials.

Sexual Assault Prevention: UNT is committed to providing a safe learning environment free of all forms of sexual misconduct, including sexual harassment sexual assault, domestic violence, dating violence, and stalking. Federal laws (Title IX and the Violence Against Women Act) and UNT policies prohibit discrimination on the basis of sex and therefore prohibit sexual misconduct. If you or someone you know is experiencing sexual harassment, relationship violence, stalking, and/or sexual assault, there are campus resources available to provide support and assistance. UNT's Survivor Advocates can assist a student who has been impacted by violence by filing protective orders, completing crime victim's compensation applications, contacting professors for absences related to an assault, working with housing to facilitate a room change where appropriate, and connecting students to other resources available both on and off campus. The Survivor Advocates can be reached at SurvivorAdvocate@unt.edu or by calling the Dean of Students Office at 940-565-2648. Additionally, alleged sexual misconduct can be non-confidentially reported to the Title IX Coordinator at oeo@unt.edu or at (940) 565 2759.

Important Notice for F-1 Students taking Distance Education Courses

Federal Regulation

To read detailed Immigration and Customs Enforcement regulations for F-1 students taking online courses, please go to the Electronic Code of Federal Regulations website (http://www.ecfr.gov/). The specific portion concerning distance education courses is located at Title 8 CFR 214.2 Paragraph (f)(6)(i)(G).

The paragraph reads:

(G) For F-1 students enrolled in classes for credit or classroom hours, no more than the equivalent of one class or three credits per session, term, semester, trimester, or quarter may be counted toward the full course of study requirement if the class is taken on-line or through distance education and does not require the student's physical attendance for classes, examination or other purposes integral to completion of the class. An on-line or distance education course is a course that is offered principally through the use of television, audio, or computer transmission including open broadcast, closed circuit, cable, microwave, or satellite, audio conferencing, or computer conferencing. If the F-1 student's course of study is in a language study program, no on-line or distance education classes may be considered to count toward a student's full course of study requirement.

University of North Texas Compliance

To comply with immigration regulations, an F-1 visa holder within the United States may need to engage in an on-campus experiential component for this course. This component (which must be approved in advance by the instructor) can include activities such as taking an on-campus exam, participating in an on-campus lecture or lab activity, or other on-campus experience integral to the completion of this course.

If such an on-campus activity is required, it is the student's responsibility to do the following:

(1) Submit a written request to the instructor for an on-campus experiential component within one week of the start of the course.

(2) Ensure that the activity on campus takes place and the instructor documents it in writing with a notice sent to the International Student and Scholar Services Office. ISSS has a form available that you may use for this purpose.

Because the decision may have serious immigration consequences, if an F-1 student is unsure about his or her need to participate in an on-campus experiential component for this course, s/he should contact the UNT International Student and Scholar Services Office (telephone 940-565-2195 or email internationaladvising@unt.edu) to get clarification before the one-week deadline.

Student Verification

UNT takes measures to protect the integrity of educational credentials awarded to students enrolled in distance education courses by verifying student identity, protecting student privacy, and notifying students of any special meeting times/locations or additional charges associated with student identity verification in distance education courses.

See UNT Policy 07-002 Student Identity Verification, Privacy, and Notification and Distance Education Courses (https://policy.unt.edu/policy/07-002).

Use of Student Work

A student owns the copyright for all work (e.g. software, photographs, reports, presentations, and email postings) he or she creates within a class and the University is not entitled to use any student work without the student's permission unless all of the following

criteria are met:

- The work is used only once.
- The work is not used in its entirety.
- Use of the work does not affect any potential profits from the work.
- The student is not identified.
- The work is identified as student work.

If the use of the work does not meet all of the above criteria, then the University office or department using the work must obtain the student's written permission.

Download the UNT System Permission, Waiver and Release Form

Transmission and Recording of Student Images in Electronically-Delivered Courses

1. No permission is needed from a student for his or her image or voice to be transmitted live via videoconference or streaming media, but all students should be informed when courses are to be conducted using either method of delivery.

2. In the event an instructor records student presentations, he or she must obtain permission from the student using a signed release in order to use the recording for future classes in accordance with the Use of Student-Created Work guidelines above.

3. Instructors who video-record their class lectures with the intention of re-using some or all of recordings for future class offerings must notify students on the course syllabus if students' images may appear on video. Instructors are also advised to provide accommodation for students who do not wish to appear in class recordings.

Example: This course employs lecture capture technology to record class sessions. Students may occasionally appear on video. The lecture recordings will be available to you for study purposes and may also be reused in future course offerings.

No notification is needed if only audio and slide capture is used or if the video only records the instructor's image. However, the instructor is encouraged to let students know the recordings will be available to them for study purposes.

Academic Support & Student Services

Mental Health

UNT provides mental health resources to students to help ensure there are numerous outlets to turn to that wholeheartedly care for and are there for students in need, regardless of the nature of an issue or its severity. Listed below are several resources on campus that can support your academic success and mental well-being:

- Student Health and Wellness Center (https://studentaffairs.unt.edu/student-health-and-wellness-center)
- Counseling and Testing Services (https://studentaffairs.unt.edu/counseling-and-testing-services)
- UNT Care Team (https://studentaffairs.unt.edu/care)
- UNT Psychiatric Services (https://studentaffairs.unt.edu/student-health-and-wellness-center/services/psychiatry)
- Individual Counseling (https://studentaffairs.unt.edu/counseling-and-testing-services/services/individual-counseling)

Chosen Names

A chosen name is a name that a person goes by that may or may not match their legal name. If you have a chosen name that is different from your legal name and would like that to be used in class, please let the instructor know. Below is a list of resources for updating your chosen name at UNT.

- UNT Records
- UNT ID Card
- UNT Email Address
- Legal Name

*UNT euIDs cannot be changed at this time. The collaborating offices are working on a process to make this option accessible to UNT community members.

Pronouns

Pronouns (she/her, they/them, he/him, etc.) are a public way for people to address you, much like your name, and can be shared with a name when making an introduction, both virtually and in-person. Just as we ask and don't assume someone's name, we should also ask and not assume someone's pronouns.

You can add your pronouns to your Canvas account so that they follow your name when posting to discussion boards, submitting assignments, etc.

Below is a list of additional resources regarding pronouns and their usage:

- What are pronouns and why are they important?
- How do I use pronouns?
- How do I share my pronouns?
- How do I ask for another person's pronouns?
- How do I correct myself or others when the wrong pronoun is used?

Additional Student Support Services

- Registrar (https://registrar.unt.edu/registration)
- Financial Aid (https://financialaid.unt.edu/)
- Student Legal Services (https://studentaffairs.unt.edu/student-legal-services)
- Career Center (https://studentaffairs.unt.edu/career-center)
- Multicultural Center (https://edo.unt.edu/multicultural-center)
- Counseling and Testing Services (https://studentaffairs.unt.edu/counseling-and-testing-services)
- Pride Alliance (https://edo.unt.edu/pridealliance)
- UNT Food Pantry (https://deanofstudents.unt.edu/resources/food-pantry)

Academic Support Services

- Academic Resource Center (https://clear.unt.edu/canvas/student-resources)
- Academic Success Center (https://success.unt.edu/asc)
- UNT Libraries (https://library.unt.edu/)

- Writing Lab (http://writingcenter.unt.edu/)