

**ECE592-110 Circ Des, Tape-Out, & Test I “Tapeout”
(Spring 2025) - 3 credits
MoWe 4:30 to 5:45
1229 Engineering Building 2**

Instructor(s):

Dr. W. Shepherd Pitts (wspitts2@ncsu.edu)

TA(s):

TBD

Preferred Method of Communication:

Office hours, Email (private questions), Moodle forum (class questions)

Private questions are about accommodations, situations, etc that are not appropriate for a forum. E.g.:
“I have a question about my grades.”

Class questions are about course related content and instructional aid that might be needed. E.g.:
“I don’t understand the following problem in the homework.”

Response time ~48 hours

Technology Requirements:

Hardware:

NC State’s Online and Distance Education provides [technology requirements and recommendations](#) for computer hardware. On campus EOS/Unity labs are seen as the primary mode of infrastructure.

Software:

Access to the suite of ASIC (commercial and open source) design tools will be provided by the University.

Ecosystem:

It is expected that many will be able to run these tools via the campus VPN using a combination of campus + student hardware. The course is designed for the on campus EOS/Unity linux labs as the primary mode of use and remote use of the tools depending on internet speed and latencies might hinder students expecting to use those as the primary mode of operation. Those are outside of the control of the instructors and students should plan for the primary mode of use.

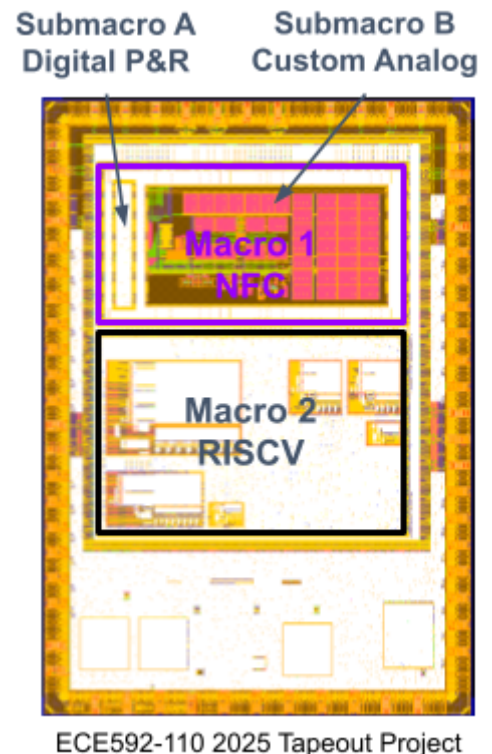
For issues with the University provided hardware/software please contact: ecehelp@ncsu.edu

Netiquette:

Students should be aware that their behavior impacts other people, even online. I hope we will all strive to develop a positive and supportive environment and be courteous to fellow students and your instructor. Due to the nature of the online environment, there are some things to remember when taking an online course and engaging with others.

Tips for Success:

- Do: Follow the same standards of behavior that you subscribe to offline. Keep in mind that all online communication is documented, and therefore permanent.



- Don't: Flame others in discussion forums. Flaming is the act of responding in a highly critical, sarcastic, or ridiculing manner – especially if done on a personal level. Remember that these discussions are meant for constructive exchanges and learning!
- Do: Ensure you are responding to forums by the due date to leave time for peers to comment on your response.
- Don't: Go for long periods of time without communicating with your instructors or classmates. It is important to stay a part of the online community!
- Do: Remember to read over your posts before selecting "Submit."
- Don't: Use slang, poor grammar, and other informal language in discussion forums or email messages to instructors or classmates.

Objective: Design a semi-custom ASIC that teaches the full cycle of design (specification, design, layout, measurement, verification). There will be “canned” parameterized project examples to execute and customize: Digital, Power, Analog, and RF that are integrated into a mixed signal ASIC.

Overview:

Background: Application-Specific Integrated Circuit (ASIC) design refers to the process of creating custom integrated circuits tailored to perform specific functions for a particular application. Unlike general-purpose integrated circuits, such as Field-Programmable Gate Arrays (FPGAs) and microcontrollers, ASICs are designed with a single purpose in mind, which enables them to deliver superior performance, power efficiency, and cost-effectiveness for their intended tasks. The course will focus on designing and fabricating Digital, Power, Analog, and RF ASICs. These circuits will be integrated onto an MPW and taped-out using eFabless Skywater 130nm. The following semester, the designs will return from the foundry and be tested. The intention is to use mostly commercial tools.

General Prerequisites:

Assumed to have taken ECE211, ECE212, ECE302, ECE310[1] or equivalent.

ECE546[2] or equivalent would be very helpful but it is not considered a hard prerequisite for this semester.

Preliminary Project Prerequisites [3]:

Digital: ECE464/564 (core requirement), ECE720/745/748 (Helpful)

RF: ECE511/ECE712 (Some Exposure to Verilog)

Power: ECE511(helpful), ECE534 and/or ECE734 (Some Exposure to Verilog)

Analog: ECE511 (Some Exposure to Verilog)

[1] Note: Ideally ECE310 would be helpful

[2] There will be a significant amount of layout, more so for the RF/Power/Analog/Full Custom Digital track.

[3] Note: the project prerequisites are subject to change as the course and projects develop before the start of the semester.

Expectations:

Fabrication, flow, and tapeout is going to require interfacing with HDL design blocks and a significant amount of scripts for both Digital and Non-Digital. There are wrappers, interface specifications, etc. We are not just getting a bare silicon die back. It is placed into an SoC wrapper.

Digital: There will be a significant amount of HDL (i.e. verilog/system verilog).

Power/Analog/RF: will have a limited amount depending on the project needs. It is expected that the students have had basic exposure to verilog, systemVerilog, python, scripting, etc.

Course Details:

Design a semi-custom ASIC that teaches the full cycle of design (specification, design, layout, measurement, verification). There will be “canned” parameterized project examples to execute and customize: Digital, Power, Analog, and RF that are integrated into a mixed signal ASIC.

The projects will implement the entire design cycle:

Semester 1: Understanding specifications and requirements, architecture and high-level design, RTL design/design Verification, Analog/Digital/RF/Mixed signal design and optimization, physical design and Layout, develop functional test plans, develop “bring up” documentation, and finally signoff and “tapeout”.

Third Party Fabrication: Wafer fabrication, packaging and assembly.

Semester 2: Execute “bring up” documentation, execute functional testing plans, validation and performance testing, and propose modifications/improvements.

Semester 1: Tapeout (Fab) Design examples, implementation, and foundry submission (April 21, 2025)

Structure:

This course is in-person and synchronous. It will be managed and administered via the course Moodle website. Course Lectures and other presentation materials will be posted on the Moodle site. Learning activities include watching videos, quizzes, narrated PowerPoint presentations, in-class workshops and discussions, discussion forums, and team projects.

Course topics and Objectives:

1. Be able to demonstrate the skills required to bring a chip to fabrication-ready status.
2. Be able to define functional test plans and bring up documentation.
3. Build a prototype to match provided specifications.
4. Use lab equipment to validate the prototype.
5. Fabricate the chip (when funds available)
6. Design/Verification/Test.
7. Understand Functional Test Plans.
8. Understand Bringup Documentation.

Course Requirements:

Assignments and Grading:

Bonus Points (TBD%):

There will be a number of bonus points for achieving milestones early “Early Submissions.” Additional opportunities throughout the course will be evaluated on an ongoing basis.

Homework 1 (15%):

Individually Graded – The homework is designed to get the student quickly up to speed with the design tools. It is not expected that the student will fully understand ALL parts of the flow through execution of the homework 1 when it is submitted. It is however expected that the student will use the homework to continually revisit throughout the semester to compare and improve the course projects.

Quizzes (5%):

A number of quizzes will be provided during the semester to aid learning retention. If there are none needed in the semester, then these points will be absorbed into another area(s) of the course to balance out an equity of time commitment.

Project 1 (20%):

Individually Graded – The project is designed to get the student quickly up to speed with implementing their own design using the design tools. It is not expected that the student will fully understand ALL parts of the flow through execution of this assignment when it is submitted. It is however expected that the student will

garner a larger understanding of the design flow when compared to the homework. This will allow the design knowledge to be transferred to the next projects.

Project 2 (40%):

Group Grading + Individual Performance Grade (Instructor + Peer)

Status Reviews (10%):

The team will present the project's status in terms of the project plan, issues, risks, achievements, action items, and more after the design review.

Teamwork, Professionalism, Project Organization, Communications, and Active Project Participation (10%): Individual and Team score: How well a team works together, how well they communicate (with each other and instructors), and how well an individual works & contributes to a team as well as professionalism displayed with the instructor, sponsors as well as team members. This grade may be split into two grades:

- 5 points: Midterm teamwork grade: - published after the midterm survey
- 5 points: Final teamwork grade: - published after the final survey

The points are based on observations throughout the semester. These observations may be made through meeting interactions, peer team assessment surveys, sponsor feedback, and instructor observation.

Team acknowledgment of receiving feedback given by an instructor is also a part of this grade. Teams need to acknowledge on their project website that they received and understood the feedback given to them on their website to ensure communications are taking place.

Keeping well-organized project website & meeting notes - instructors will evaluate as part of this grade that teams clearly organize and maintain their project website, including keeping good quality meeting notes covering team meeting interactions & team meeting interactions with their sponsors. The project team must submit an "Design For Test Document" at the end of the semester.

Instructors may adjust individual students' grades (including assignments previously graded) based on assessment surveys," team feedback, sponsor feedback, or instructor observations that reflect poor or exceptional contributions to the team, project, or other deliverables.

Points Deductions: Points may be removed for a number of reasons, including: unexcused class absences -1 point each (see "Attendance and Participation" section below for definition), late form/survey submissions -1 point each, and other items described on the class schedule or in class.

TEXTBOOK: NO textbook is required for this course. Be prepared to read a lot of manuals, wiki guides, and project specifications.

WEBSITE: <https://moodle-courses2425.wolfware.ncsu.edu/course/view.php?id=8578&bp=s>

This course will be managed and administered via the course Moodle website. Course Lectures and other presentation materials will be posted on the Moodle site.

POLICIES AND PROCEDURES:

Grading Scale:

Letter Grade	Lower limit	Upper Range
A+	98	100
A	94	97.999
A-	91	93.999

B+	88	90.999
B	85	87.999
B-	82	84.999
C+	79	81.999
C	76	78.999
C-	73	75.999
D+	70	72.999
D	67	69.999
D-	64	66.999
F	<64	<64

Note on Individual Evaluations:

The instructors may adjust individual student's grades based on exceptional or poor contribution to the project and class deliverables. Adjustments to the individual grades will be based on the level of individual performance on the project and other deliverables.

Late assignments/deliverables:

Late deliverables will be accepted, with 10% of the said deliverable points taken off for every day it is submitted late. Deliverables submitted later than one week past the original due date will NOT be accepted unless with prior approval.

Attendance and Participation:

Your final grade is affected based on attendance as there are both individual and team status reviews. You are expected to materially contribute to those. It is expected that as you are a graduate student the following need not be strictly enforced but should it become a problem the following will apply: *"Each student can have up to one unexcused absence for regular class lectures and zero unexcused absences for guest lecturers in the entire semester. Attendance will typically be documented via a sign-up sheet, entry quiz, class quiz, and/or attendance forms. Note, an EXCUSED absence means that you have notified the INSTRUCTORS PRIOR to your absence about unavoidable scheduling or you have a DOCUMENTED MEDICAL or OTHER PERSONAL emergency, and you notify instructors within 48 hours where possible."* Workplace etiquette is expected. For example, you wouldn't not show up to work without informing your boss/colleagues that you would be missing the meeting.

NC State's Attendance Policy: <https://policies.ncsu.edu/regulation/reg-02-20-03-attendance-regulations/> and the Withdrawl Process: <https://studentservices.ncsu.edu/your-classes/withdrawal/process/>

Video Call Tools:

Use of AI tools to record, transcribe, or otherwise are not permitted for video calls (Zoom) associated with this course. All reviews and meetings conducted over video call must have all participants with their cameras on for the duration of the call to ensure the identity of the student by the instructors.

Copyright:

All material provided and created during this course is copyright-protected. No material associated with this class may be published without the express written permissions of the instructors and associated sponsors.

Material Reuse from other institutions:

There is a large amount of material in this course that may be used from other institutions. Permission where appropriate has been obtained. If you find something in the instructional content please let the instructors know so that we can assign appropriate credit (this will always have been an oversight).

Notes:

- It is expected that if you are required to attend a conference/event as part of your student/research obligations, discuss with the instructor BEFORE the conference. As the schedule for a tapeout can be very time dependent, you may need to complete the coursework early depending on the week.
- It is expected that if you have a medical/illness/death in your family. These events sometimes arise unfortunately during the semester and can't be predicted. When these events occur, please make sure that you INFORM the professor as soon as possible so that accommodation can be provided. You will be expected to follow up with appropriate supporting documentation. If you do NOT inform the professor, then the professor does NOT know you are dealing with the situation and cannot accommodate unless it is known.
- An INCOMPLETE will be given if lab equipment is not returned
- INDIVIDUAL grades may be adjusted based on TA or instructor observations/feedback (even retroactively)

Students with Disabilities:

Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with the [Disability Resource Office](#) at Holmes Hall, Suite 304, Campus Box 7509, 919-515-7653 . For more information on NC State's policy on working with students with disabilities, please see the [Academic Accommodations for Students with Disabilities Regulation \(REG02.20.01\)](#)

Trans-Inclusive Statement:

In an effort to affirm and respect the identities of transgender students in the classroom and beyond, the course will use the name provided in the Student Information System for grading purposes, this is the preferred name you provide the university and not your legal name. You are welcome to change your preferred name in MyPack Portal. If you wish to go by a name other than the preferred name provided, please contact us, and we will accommodate you where possible.

Academic Integrity:

Students are required to comply with the university policy on academic integrity found in the [Code of Student Conduct](#). Therefore, students are required to uphold the university pledge of honor and exercise honesty in completing any assignment.

Please refer to the [Academic Integrity](#) web page for a detailed explanation of the University's policies on academic integrity and some of the common understandings related to those policies.

The "Tapeout" course includes self-directed learning and seeking of information that may come from various sources. It is acceptable to pull information, such as but not limited to, designs or code from external sources if:

- 1) The source is referenced in your documentation
- 2) It is consistent with all copyright laws
- 3) It is consistent with the license agreement associated with the material used
- 4) The sponsor is aware of the material source and agrees with the use
- 5) The source is not a result of a quid pro quo agreement that has not been disclosed. (E.g. you may not pay somebody to write code for you and not disclose it)

For use in courses where student information may be accessible to persons beyond the instructor and students in the course:

This course may involve electronic sharing or posting of personally identifiable student work or other information with persons not taking or administering the course. Students will be asked to sign a consent form allowing disclosure of their personally identifiable work. No student is required to sign the consent form as a condition of

taking the course. If a student does not want to sign the consent form, he or she has the right to ask the instructor for an alternative, private means of completing the coursework.

Students are responsible for reviewing the NC State University PRR's which pertains to their course rights and responsibilities:

- > [Equal Opportunity and Non-Discrimination Policy Statement](#) and [additional references](#)
- > [Code of Student Conduct](#)
- > [Grades and Grade Point Average](#)
- > [Credit-Only Courses](#)
- > [Audits](#)

For homework and projects, while collaboration is encouraged, sharing of design data is expressly not permitted. In particular sharing of any electronic files, or schematics is forbidden.

Recorded Lecture Notice:

Please be advised this course is being recorded for current and potential future educational purposes. By your continued participation in this recorded course, you are providing your permission to be recorded.

Food and Drink:

Consumption of food and drink are NOT allowed in the lab or in the lecture room. If you require food or drink, please step outside the building or to any designated/approved areas.

Personal Responsibility: (from [Fall semester COVID-19 readiness | Protect the Pack | NC State University \(ncsu.edu\)](#))

“As we enter the semester, it’s important we continue to take steps to help protect ourselves and the community while remaining respectful of others and their choices.

- *Familiarize yourself with the university’s [Protect the Pack](#) website, which includes important information about the university’s ongoing COVID-19 response.*
- *Face coverings are not required on campus, but are encouraged.*
- *When preparing to return to campus, include COVID-19 precautions in your planning. Discuss isolation and quarantine procedures with your roommates and family if applicable.”*

Basic Needs Security:

Any student who faces challenges securing their food or housing or has other severe adverse experiences and believes this may affect their performance in the course is encouraged to notify the professor if you are comfortable in doing so. Alternatively, you can contact the Division of Academic and Student Affairs to learn more about the Pack Essentials program <https://dasa.ncsu.edu/pack-essentials/>

WolfPack Wellness Resources:

As a student, you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating, and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student’s ability to participate in daily activities. NC State University offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via The Counseling Center:

<https://counseling.dasa.ncsu.edu/>

<https://counseling.dasa.ncsu.edu/workshops-and-events/suicide-prevention/resources/>

National Suicide Hotline: 1.800.273.TALK (8255) (24 hours/7 days a week)

Hopeline: 919.231.4525 or 1.877.235.4525 (24/7 confidential local hotline)

Lastly, please be aware of the WolfPack Wellness Resources (<https://wellness.ncsu.edu/resources/>) that are available to you, your TA/graders, and students. I point out at the bottom of that link the excellent Mental Health First Aid (MHFA) and QPR Training programs that are available to anyone.

COURSE EVALUATIONS:

ClassEval is the end-of-semester survey for students to evaluate instruction of all university classes. The current survey is administered online and includes 12 closed-ended questions and 3 open-ended questions. Deans, department heads, and instructors may add a limited number of their own questions to these 15 common-core questions.

Each semester students' responses are compiled into a ClassEval report for every instructor and class. Instructors use the evaluations to improve instruction and include them in their promotion and tenure dossiers, while department heads use them in annual reviews. The reports are included in instructors' personnel files and are considered confidential.

Online class evaluations will be available for students to complete during the last two weeks of the semester for full semester courses and the last week of shorter sessions. Students will receive an email directing them to a website to complete class evaluations. These become unavailable at 8am on the first day of finals.

- Contact ClassEval Help Desk: classeval@ncsu.edu
- [ClassEval website](#)

[More information about ClassEval](#)

Syllabus Modification Statement:

Our syllabus represents a flexible agreement. It outlines the topics we will cover and the order we will cover them in. Dates for assignments represent the earliest possible time they would be due. The pace of the class depends on student mastery and interests. Thus minor changes in the syllabus can occur if we need to slow down or speed up the pace of instruction. Additionally, if there are interruptions to tools, third party vendors, or other unforeseen issues the syllabus may be modified. All modifications will be announced in class and via email.