ENGRG 3400: Cornell Custom Silicon Systems Project Team
Course Syllabus

College of Engineering
Cornell University

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1. Course Information

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2. Description

Silicon CMOS chips are at the heart of every modern computing device from the smallest Internet-of-Things (IoT) device to the largest supercomputer. Unfortunately, undergraduate students currently do not have any opportunity to actually go through the process of fully specifying, designing, implementing, testing, fabricating, and evaluating a computer chip. Undergraduates leave Cornell thinking that fabricating computer chips is only possible at huge companies like Intel, AMD, NVIDIA, and Apple. Until recently, there was no realistic hands-on way for students to experience the complete computer chip design process. At the same time, exposing students to the beauty of computer chip design has never been more important, since the slowing of CMOS technology scaling means computer system designers must increasingly rely on specialized computer chips for continued improvements in performance and/or energy efficiency.

How can students (from freshmen to seniors) gain hands-on computer chip design experience? The answer lies in the recent explosion in open-source chip design tools, open-source chip implementations, open-source process design kits, and low-cost computer chip fabrication services. Just as open-source software has democratized software design, open-source hardware is poised to democratized hardware design.

The Cornell Custom Silicon Systems (C2S2) Project Team is a new project team funded through the Shen Fund for Social Impact. The team is leveraging this emerging open-source hardware ecosystem to enable undergraduate students to specify, design, implement, test, fabricate, and evaluate custom computer chips. The final outcome will be a custom computer chip integrated on a custom circuit board with a complete software stack targeting an important application domain. This ambitious student-led team is likely unique across US universities, and will hopefully inspire a new generation of computer system designers.

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3. Objectives

C2S2 is meant to be a microcosm of semiconductor and silicon development in industry. Students will not only develop practical technical skills (e.g., low-level programming, digital and analog design, verification, physical design flows, chip testing), but will collaborate with other students on the team and communicate their work. Such engagement will prepare students for careers in semiconductor development, as well as engineering teams in general. By the end of each semester, students should be able to:

- **plan** personal goals for the semester (including technical, soft-skills, and career exploration goals), and **evaluate** their degree of achievements over time;

- **apply** technical skills towards creating concrete deliverables that further C2S2's goals (such as designs, software, resources, etc.);

- **collaborate** with other team members to create multi-faceted deliverables that integrate their work with others;

- **communicate** their work to others at varying technical levels, including peers, course advisor(s), members of the ECE community, and the general public;

- **write** documentation on their work, including how to use and test their deliverables, such that others could interpret and re-use their existing work;

- *(Leads)* **devise** the team and subteam's high-level goals, including planning how progress will be made across the course of the semester;

- *(Leads)* **manage** members of their subteam, ensuring that adequate progress is made towards the subteam's high-level goals.

4. Prerequisites

C2S2 is targeted towards undergraduates with an interest in semiconductor design. No formal prerequisites are required at a team level, although students may need to utilize in-house training materials to become familiar with necessary tools, depending on the subteam.

5. Format and Procedures

C2S2 includes a combination of self evaluations, peer evaluations, blog posts, design reviews, final demonstrations, and final presentations.

- **Semester Learning Goals –** At the beginning of the semester (within the first two weeks), students will formulate **three** substantial goals for the semester. These include a technical goal, soft-skills goal, and career readiness goal. Students should express each goal as a substantial paragraph, and conclude each with a concrete approach to how they will achieve their goal.

- **Blog Post –** Once per semester, members are expected to complete a blog post with one of their peers. The post should be a unified discussion of a topic related to C2S2 and/or semiconductor design (not necessarily their primary project on the team). Blog posts should be targeted towards members of the ECE community; including technical details and takeaways, but at a level approchable by others. A good blog post will have takeaways for a wide variety of audiences.

- **Bi-Weekly Check-Ins –** Every two weeks, members are expected to complete a bi-weekly check-in, a short assignment tracking their progress and short-term goals. Completing these will allow leads to track the progress of their team/subteam members, but additionally will prompt members to reflect and plan on short-term intervals.

- **Mid-Semester Peer Feedback –** Approximately halfway throughout the semester, members will be expected to provide mid-semester feedback for their peers. They will be asked to provide quantitative feedback on criteria such as contributions, collaboration, inclusion, and punctuality, as well as qualitative feedback on their interactions in general. Such feedback is critical for knowing how members are perceived, and for helping to identify strengths and weaknesses from an external perspective. In order to successfully complete the assignment, members are expected to provide feedback for **five** other members.

- **Design Review –** Approximately halfway throughout the semester, C2S2 will hold a design review. Subteams will organize a formative presentation explaining the work they've done so far, and their path forward for the remainder of the semester, as well as challenges faced and lessons learned. Team advisor(s) and other team members will be present to ask questions and provide feedback. Leads are expected to be present for all subteams; while other members are only required to be present for their subteam, they are strongly encouraged to remain for other subteams to provide feedback, understand what others are doing on the team, and provide support for their peers.

- **Final Demonstration –** At the end of the semester, members will form groups to create and present a final demonstration, or demo. A successful demo will include a strong motivation, technical content, and an interactive, "live" component. Members are encouraged to bring together their work with others and combine them into one unified demonstration. Groups should be 2–3 members; groups of 1 or 4 are allowed only with advisor approval.

- **Final Presentation –** At the end of the semester, the team will hold a final presentation. This will be a polished, professional summary of the team's activities over the semester. Members will work with their subteam to create a summative presentation. This includes determining which aspects to present; not all members need to present, but it should be evident what each member on the subteam did (possibly including a slide giving credit to each member). C2S2 will use an official final exam time slot for the final presentation. The time slot will be scheduled by the University; as such, all members are expected to attent. If a student has a conflict with a final exam for a different course, they should let an advisor know at least two weeks in advance.

- **End-of-Semester Reflection –** At the end of the semester, members will reflect on the three goals they set out at the beginning of the semester. Reflections should include concrete analysis of whether they achieved their goals, as well as how their goals can continue and assist them beyond C2S2.

- **End-of-Semester Peer Feedback –** At the end of the semester, members will be expected to complete end-of-semester feedback for their peers. They will be asked to provide quantitative feedback on criteria such as contributions, collaboration, inclusion, punctuality, and improvement from previous feedback, as well as qualitative feedback on their interactions in general. Such feedback is critical for knowing how members are perceived, and for helping to identify strengths and weaknesses from an external perspective. In order to successfully complete the assignment, members are expected to provide feedback for **five** other members.

6. Assignment and Exam Schedule

C2S2's schedule can vary; exact dates can be found on Canvas, with deliverables always being posted at least two weeks in advance. However, the following is a rough outline of the assignment cadence:

Assignment	Occurrence
Semester Learning Goals	First Two Weeks
Bi-Weekly Check-Ins	Bi-weekly
Blog Post	Variable
Design Review	Mid-Semester
Mid-Semester Peer Feedback	Mid-Semester
Final Demonstration	End Of Semester
Final Presentation	End Of Semester
End-of-Semester Reflection	End Of Semester
End-of-Semester Peer Feedback	End Of Semester

7. Grading Scheme

Each part or criteria of every assignment is graded on a five-point scale. A score of 5.25 is an A+, 5 roughly corresponds to an A, 4 roughly corresponds to a B, 3 roughly corresponds to a C, 2 roughly corresponds to a D, and below a 2 roughly corresponds to D- or lower. A score of 5.0 usually indicates that the submitted work demonstrates no misunderstanding (there may be small mistakes, but these mistakes do not indicate a misunderstanding) or there may be a very small misunderstanding that is vastly outweighed by the demonstrated understanding. A score of 4.0 usually indicates that the submitted work demonstrates more understanding than misunderstanding. A score of 3.0 usually indicates that the submitted work demonstrates more misunderstanding than understanding. A score of 2.0 usually indicates that the submitted work is significantly lacking in some way. A score of 1.0 usually indicates that the submitted work demonstrates minimal effort. A score of 5.25 is reserved for when the submitted work is perfect with absolutely no mistakes or is exceptional in some other way.

The final grade is calculated using a weighted average of all assignments. The weighting for the various assignments is shown below.

Semester Learning Goals	5%	
Blog Posts	15%	
Bi-Weekly Check-Ins	10%	(weighted equally)
Mid-Semester Peer Feedback	7.5%	
Design Review	15%	
Final Demonstration	15%	
Final Presentation	20%	
End-of-Semester Reflection	5%	
End-of-Semester Peer Feedback	7.5%	

Detailed rubrics for all assignments are made available in advance on Canvas.

C2S2 has additionally responsibilities for leadership positions. These often involve a significant amount of additional work, including attending leadership meetings, mentoring subteam members, organizing subteam meetings and work sessions, managing subteam tasks, and ensuring the sub-

team is accomplishing their goals. Because of this, members in leadership positions that stand out in their contributions and presence on the team are eligible to receive a +0.25 bonus, at the advisor's sole discretion.

8. Degree Requirements

C2S2 members are expected to enroll in ENGRG 3400 for 3 credits, graded. Enrolling for less than two credits or for pass/fail credit is only allowed with written advisor permission. It may be possible for C2S2 to contribute towards your degree requirements, but this depends on your specific major. Be sure to to talk with your department's student services coordinator. However, the Project Team staff have worked to make sure that most, if not all engineering departments accept Project Team credits to satisfy major requirements in some way. Some common examples are given below:

- **ECE –** Project Team credits can be used to satisfy the Advisor-Approved Elective requirement. Additionally, up to three credits can be applied towards the Outside Technical Elective requirement

- **CS –** Project Team credits can be used to satisfy either the Major-Approved Elective or Advisor-Approved Elective requirements, with a maximum of six credits applied across them.

- **AEP –** Nine credits of Project Team credits can be applied towards the Major-Approved Elective requirement, although they must be taken in your final four semesters. Any credits beyond this can be applied to your Advisor-Approved Electives.

Project Team credits are also applicable beyond engineering majors; most majors allow credits to be applied as some form of elective. For more information, consult with your particular major.

9. Policies

This section outlines various policies concerning attendance, late assignments, external tools, workspace expectations, accommodations for students with disabilities, and extenuating circumstances.

9.A Attendance Policy

Unlike other classes, C2S2 relies on the continuous engagement of its members for the progress and success of the team. Because of this, members are expected to remain active and available for communication with the rest of the subteam. This includes:

- Attending weekly All-Team meetings
- Attending weekly subteam meetings
- Being active on Slack regularly (responding within 24 hours)
- *(Leads)* Attending weekly leads meetings

Consistent engagement with the team is part of being on C2S2, and evaluated as part of the Bi-Weekly Check-Ins. If members have extenuating circumstances that cause them to be absent, they must communicate with the team lead or relevant subteam lead in advance if at all possible.

9.B Late Assignment Policy

Assignments should be submitted on Canvas (or with an external method specified by the Canvas assignment). Assignments must be submitted by 11:59 p.m. on the due date unless otherwise

specified. Late assignments will incur a -0.50 penalty for each day they are late, with a maximum deduction of -3.00.

C2S2's assignments are largely assessed based on their quality, not when they were submitted. Because of this, many deadlines are flexible **with communication!** If you need an extension, communicate with the team lead and/or team advisor(s) **in advance**; advance notice allows for more flexibility. No extensions are guaranteed, but the team leadership will do their best to be accommodating of a variety of situations. The exceptions to this rule are the Bi-Weekly Check-Ins; these evaluate progress in a time-sensitive manner, so no extensions will be granted.

9.C External Tools Policy

C2S2 actively encourages its members to seek and use outside tools to aid in their projects. The key to this is **attribution**; when using external tools and resources, members should make their use clear. This includes attribution when used, as well as citation of all resources used. These citations do not need to be formal, but should be sufficient to provide attribution to the source.

This policy applies in particular to artificial intelligence and large-language models, such as ChatGPT and GPT4. Unlike other classes, use of these tools on C2S2 is allowed (and encouraged) *with the condition that their use is appropriately acknowledged and documented*. An example of this would be documenting the raw prompts and responses.

Lack of appropriate citation/documentation when using external resources and/or tools is considered to be an academic integrity violation. See `https://theuniversityfaculty.cornell.edu/academic-integrity` for more details. If you have any questions, please reach out to the team lead and/or the team advisor(s)

9.D Workspace Expectations

C2S2 is fortunate to have a dedicated workspace in the ELL. This space is shared across the team, so it is critical to keep it in a good state. This includes:

- **Keeping the space clear –** When not in use, the tables should be kept clear. If you are done with any supplies you are using, make sure to put them away (utilizing the shelves above or under the table, where appropriate). Sensitive equipment in particular (such as bird tags, FPGAs, chips, PCBs, etc.) should be given special care to be put away.

- **No food and drink –** Due to the presence of workstations and sensitive electronics, food and drink should be avoided at C2S2's tables. If you have food and/or drinks, please keep them on the communal tables in the center of the room.

- **Turn off equipment –** When leaving the space, double-check to make sure that all of the bench equipment is turned off, and that you have logged out of the workstations.

We have had issues in the past with other teams mis-using the space. If you see members of other teams using C2S2's space, especially with common space available and/or if they have food or drinks, politely ask them to move to a different space. If it becomes an issue, inform the team lead.

9.E Accommodations for Students with Disabilities

In compliance with the Cornell University policy and equal access laws, the team lead and team advisors are available to discuss appropriate accommodations that may be required for students with disabilities. Requests for academic accommodations are to be made during the first three weeks of the

semester, except for unusual circumstances, so arrangements can be made. Students are encouraged to register with Student Disability Services to verify their eligibility for appropriate accommodations.

9.F Extenuating Circumstances - "Life Happens"

In the course of the semester, students may encounter extenuating circumstances that prevent them from engaging to the fullest with the team, such as family or medical emergencies. If such cases arise, the affected member should contact the team lead and/or the team advisor(s). Flexibility to the above policies may be given in such cases.

10. Online and Computing Resources

We will be making use of a variety of online websites and computing resources.

- **Confluence –** We will be using Confluence to store all team documentation, including any tutorials/trainings and other resources. Members are expected to maintain quality documentation on their work throughout the semester.

- **Canvas Course Site –** We will be using Canvas to manage assignment scheduling and submission, as well as grade distribution. Assignment dates on Canvas will always be the most up-to-date. Canvas assignments will have rubrics attached for reference when completing the assignments.

- **GitHub –** GitHub is an online Git repository hosting service. We will be using a GitHub organization to track our code, including any designs and software developed. Repositories should include a "README" documenting the code and how to use it, or one that points to such documentation on Confluence. Members should make sure to commit and push their code regularly to keep the repository up-to-date. Note that we are not using the Cornell hosted version of GitHub as in some other courses; we are using `github.com`.

- **Google Drive –** The team maintains a shared Google Drive for storing non-code files. This includes any presentations, images, blog posts, and other files/resources.

- `c2s2-dev` **Server –** C2S2 uses a Red Hat Linux server as its reference development environment. You can access the `c2s2-dev` server remotely using PowerShell, Mac Terminal, VSCode, X2Go, MobaXterm, or Mac Terminal with X11. More information about accessing the server is available on Confluence.

- **Course Website –** `https://c2s2.engineering.cornell.edu` is the main public website for C2S2. It will include member information, applications, and any submitted blog posts.

- **Slack –** C2S2 maintains a paid Slack workspace for its members to communicate. This is the main source of communication for the team, and members should be responsive to messages.