THE UNIVERSITY OF BRITISH COLUMBIA

FACULTY OF APPLIED SCIENCE (Engineering)

ELEC 391: Electrical Engineering Design Studio II **Updated**: Jan, 2024

Contact Information:

Leo Stocco
Kaiser 3026
leos@ece.ubc.ca
(604) 822-0166

1. Calendar Entry

ELEC 391: Engineering Design Studio II (6) [2-6-2*]

Introduction to project management. Problem definition. Design principles and practices. Implementation techniques including circuit design, software design, solid modelling, PCBs, assembling, and packaging. Testing and evaluation. Effective presentations.

Pre-requisite: One of {CPEN 291, ELEC 291, ELEC 292} and two of {ELEC 301, ELEC 341, ELEC 311, ELEC 342}.
Co-requisite: None.

2. Course Structure

The 13-week term comprises 5 instruction weeks, 7 tutorial weeks, and 1 final evaluation week. There is no final exam.

All lectures are held in person. Recordings may be provided to supplement lectures. Tutorials may be in person or online. During the evaluation week there are no classroom hours. During the 5 instruction weeks, all 4 classroom hours are devoted to technical instruction. During the 7 tutorial weeks, 2 classroom hours are devoted to student-led tutorials.

Students register for 6 lab hours per week but are provided 24/7 access to the lab and may attend at any time. During scheduled lab hours, TAs and technical support staff are available for consultation and to supply physical resources. Technical support is not provided outside of scheduled lab hours.

Evaluations take place during scheduled lecture and lab hours. When student teams are made up of students registered in different lab sections, those students may have their final demonstration scheduled outside of their registered lab hours. Those students are expected to resolve any time conflicts so they can attend their final demonstration.

3. Course Motivation

This course satisfies the 3rd year design studio requirement of a BASc in Electrical Engineering.

The project provides an opportunity to exercise skills obtained in the following 3rd year courses.

- ELEC 341 – System & Control
- ELEC 301 – Electronic Circuits
- ELEC 342 – Electro-Mechanical Energy Conversion and Transmission
- ELEC 311 – Electromagnetic Fields and Waves

Pre-requisite knowledge is applied toward the design of an electro-mechanical control system. The

design is documented in a technical design report. Lectures and tutorials provide the necessary design and prototyping background to design and implement the design project, which is demonstrated live.

4. Course Learning Outcomes

By the end of the course the students should be able to:

A. Formalize an Engineering Design Project in terms of Requirements, Constraints and Goals (RCGs).
- Derive product and component specifications based on project requirements and constraints. (GA 4.3)
- Identify and mitigate risks that impact the project design process. (GA 11.3)

B. Apply Scientific Theory and Engineering Design Principles to optimally satisfy the RCGs.
- Evaluate system / sub-system design alternatives to identify the best solution based on the project requirements. (GA 4.4)
- Implement the product design using best practices. (GA 4.5)
- Compare experimental measurements with theory / simulation tools to justify design decisions. (GA 3.4)
- Evaluate a curated list of course references to address personal knowledge gaps. (GA 12.3)

C. Evaluate demonstrated level of success in satisfying the RCGs.
- Collect product data using state of the art tools to assess performance specifications. (GA 5.1)
- Verify their product design based on the project requirements including tolerances or confidence levels. (GA 2.4)

D. Effectively deliver results using written and verbal communication techniques.
- Document the project design in sufficient detail to allow an undergraduate engineer to reproduce the results. (GA 7.2)
- Justify the most significant design decisions through an oral presentation. (GA 7.3)

E. Work effectively in a team environment.
- Create and follow a team plan that meets the course project milestones. (GA 6.3)
- Impartially assess individual and peer contributions to the project tasks. (GA 6.2)
- Formulate a team charter that promotes equitable contribution of all team members. (GA 10.3)

F. Identify and mitigate safety hazards to both product developers and end-users.
- Identify hazards associated with prototyping equipment and implement appropriate risk mitigation steps. (GA 8.2)
- Identify how the design impacts health, safety and productivity in the context which it is deployed. (GA 9.1)

5. Course Content

<u>Section I – Project Description & RCGs (4 Lecture Hours)</u>

- Mini-Project Specifications
- Team Project Specifications
- Team Formation & Peer Review Policy
- Introduction to Requirements, Constraints & Goals

<u>Section II – Design Tools (8 Lecture Hours)</u>

- WinCupl – Designing Digital PLDs
- MultiSim & UltiBoard – Designing Analog Circuits & PCBs
- SolidWorks – Designing & Modelling Mechanical Parts & Assemblies

Section III – Engineering Design & Prototyping (8 Lecture Hours)

- Mechanisms
  - Fasteners & Rigid Connections
  - Joints & Sliding Surfaces
  - 3D Printing
- Sensors & Actuators
  - Encoders
  - Decoders & Programmable Logic Devices (PLDs)
  - Current & Voltage Drivers
  - DC, Servo & Stepper Motors
- Gears & Robotics
  - Gear Configurations
  - Gear-Motors
  - Simulation Models
  - Direct & Inverse Kinematics
  - Path Planning
- Engineering Design Reports
  - RCGs
  - Detailed Design
  - Verification

6. Course Activities

The course has 3 activities, each allocated approximately 4 weeks to complete.

1. Mini-Project (Work done individually)
2. System Design (Work done in partners)
3. System Integration (Work done in teams of 4)

Mini-Project

Students individually develop 2 elementary systems:

1. Mechanical System (Mechanism & System ID)
2. Electrical System (Digital & Analog Circuits)

All software tools must be mastered but minimal design work is required to complete the Mini-Project. Successful completion demonstrates the necessary background to participate in the Team Project.

The Mini-Project comprises a live presentation and a brief document containing screen-captures, which is graded Pass/Fail. The deadline is approximately 4 weeks into the course, and coincides with the add/drop deadline for all UBC courses. Any student that does not successfully complete the Mini-Project by the deadline will not be added to a group and will work individually on an extended Written Design Report if they decide to remain in the course.

After receiving a Passing grade on the Mini-Project, a student is added to the Team of their choice. Teams are made up of 4 students who work together to complete the Team Project.

Any student that does not complete their Mini-Project in time to be added to a Student Team is de-registered from the course.

System Design

Each Team divides into 2 pairs of students. Each pair is responsible for 1 Sub-System.

1. Mechanism & Controller
   i. Hardware Design & ID
   ii. Controller ID & Design

2. Electric Circuits
    i. Analog Circuit Design
    ii. Digital Circuit Design

A design document and proof-of-concept prototype is prepared for each Sub-System. The proof-of-concept is demonstrated in a video that is also submitted on Canvas.

Any student that does not complete their Mini-Project in time to be added to a Student Team must complete both Sub-System designs for 1 System. One Sub-System design will be due approximately 8 weeks into the course, and the second will be due at the end of the course.

System Integration
The entire Team works together to integrate all sub-systems into a working prototype. The prototype is demonstrated during live Final Demonstrations scheduled in the last week of the course.

System integration details and a formal test procedure to measure system performance is provided in a Power-Point presentation. A duty roster identifying individual contributions is also provided.

The quality of the prototype is evaluated during the Final Demonstration based on the following criteria.

- Completeness
- Implementation Quality & Reliability
- User Interface
- Development History
- Extra Features

7. Assessment Policies

- Attendance at all lectures and labs is optional.
- Attendance at demonstrations is mandatory and may only be excused with special permission granted in advance. All Team members must attend the Team demonstration.
- Demonstrations take place during scheduled hours.
- All graded documentation is submitted on Canvas.
- Passing the Mini-Project earns a grade that reduces over time.
- Students are added to a Team only after they have passed the Mini-Project.
- Students are allocated a fixed amount of time during live demonstrations. It is the responsibility of the student to use that time effectively.
- All grades earned during live demos are final, and ineligible for “Review of Assigned Standing” according to UBC policy.

8. Assessment

The following is the weighting of all assessed components:

- Mini-Project (2-Part) 10% (pass/fail - late penalties apply)
- Sub-Sys Report 40% (equal weighting – late penalties apply)
- Final Demonstration 50% (grade distributed based on contribution)

Mini-Project
The deadline is approximately 4 weeks into the course. Late penalties apply after.
Document of screen captures is submitted on Canvas and is graded Pass/Fail.
Demonstration is graded Pass/Fail.
The grade is applied to the individual.

System Design
The deadline is approximately 8 weeks into the course.
Document and video are submitted on Canvas and graded according to a posted rubric.
A system design report that receives a failing grade must be re-submitted. Late penalties apply.
Students who do not wish to be graded with equal weighting may submit individual work.

System Integration
The deadline is the final week of the course.
Slide Deck is submitted on Canvas. Slide deck and live demonstration are graded according to a subjective assessment of quality and completeness.
Individual duty roster is submitted on Canvas. Team grade is scaled to reflect individual contributions.

Any disagreement between team members regarding individual contributions is resolved by a meeting with the instructor where students show physical evidence of individual contributions.

9. Texts and Bibliography (including any required materials)

- Course notes and various resources are provided on Canvas. These include:
  - Software tutorials and examples
  - FAQs about software tools
  - Links to department resources such as component and service order forms

- There is no text for this course. It exercises technical content from pre-requisite courses.

- A budget is provided to each student group to purchase components, materials and services from the department. Any additional resources requirements are the responsibility of the students. No materials or components are explicitly prohibited, but use of Off-the-Shelf components that impact the design content of the project may have an associated impact on the grade.

10. UBC Academic Honest and Standards

The academic enterprise is founded on honesty, civility, and integrity. As members of this enterprise, all students are expected to know, understand, and follow the UBC codes of conduct regarding academic integrity. At the most basic level, this means submitting only original work done by you and acknowledging all sources of information or ideas and attributing them to others as required. This also means you should not cheat, copy, or mislead others about what is your work. Violations of academic integrity (i.e., misconduct) lead to the breakdown of the academic enterprise, and therefore serious consequences arise and harsh sanctions are imposed. For example, incidents of plagiarism or cheating may result in a mark of zero on an assignment or exam and more serious consequences may apply if the matter is referred to the President's Advisory Committee on Student Discipline. Careful records are kept in order to monitor and prevent recurrences.

For more information, see: http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,286,0,0

11. Non-Academic Misconduct

Whether you are a student, faculty member, or staff member, mistreatment towards anyone in our Engineering community is not acceptable. Mistreatment is disrespectful or unprofessional behavior that has a negative effect on you or your learning environment, or conduct that is contrary to the principles that support a respectful environment. This includes making demeaning, offensive, belittling, and disrespectful comments, using abusive language, engaging in bullying, harassment, and discrimination. If you have witnessed or been subject to mistreatment, there are people and support resources here to help. Find out how to get support or discuss an issue related to discrimination, bullying, harassment, or sexual misconduct through the non-academic misconduct link below:
https://academicservices.engineering.ubc.ca/degree-planning/non-academic-misconduct-discrimination-and-edi-i-support/

ECE students, faculty, and staff are also welcome to submit comments, suggestions, and requests around Equity, Diversity, Including and Indigeneity (EDII) in the ECE Department to our EDII Suggestion Box. Submissions can be anonymous, and are received directly by the ECE EDII.
Committee for review: https://ece.ubc.ca/engage-with-ece/edii-suggestion-box/

12. Health and Wellness

UBC provides resources to support student learning and to maintain healthy lifestyles, while recognizing that challenges and crises can arise for students. There are resources in ECE and at UBC where students can find can help and support, including wellness, equity, inclusion and indigineity, resources for survivors of sexual violence, and health. Some frequently used resources are as follows:

- ECE Wellness Hub: https://ece.ubc.ca/student-life/student-wellness/
- ECE has an EDI.I committee whose goals are to improve equity, diversity and inclusion in the ECE Department, and support the UBC Indigenous Strategic Plan. The committee welcomes feedback from all students, and can be contacted by emailing help@ece.ubc.ca.
- Central resource for supporting student success (medical and crisis support, Centre for Accessibility, and support for survivors of sexual violence): https://senate.ubc.ca/policies-resources-support-student-success/
- UBC Office of the Ombudsperson for Students: https://ombudsoffice.ubc.ca/how-we-can-help/

UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom. UBC provides appropriate

accommodation for students with disabilities and for religious, spiritual and cultural observances. UBC values academic honesty and students are expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions. Details of UBC's respectful environment policies, which all students, staff and faculty are expected to follow, can be found here: https://hr.ubc.ca/working-ubc/respectful-environment

13. Academic Concession

The University is committed to supporting students in their academic pursuits. Students may request academic concession in circumstances that may adversely affect their attendance or performance in a course or program. Students who intend to, or who as a result of circumstance must, request academic concession must notify their instructor, dean, or director as specified in the link below. https://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,329,0,0

Students seeking academic concession due to absence from the final exam for any reason must apply to Engineering Academic Services (EAS) within 72 hours of the missed exam. This is a standard practice for all final examinations at UBC. For more information, see:
https://academicservices.engineering.ubc.ca/exams-grades/academic-concession/

14. Land acknowledgment

This course is held on the UBC Point Grey (Vancouver) campus, which sits on the traditional, ancestral, unceded territory of the the Coast Salish Peoples, including xʷməθkʷəy̓əm (Musqueam) First Nation, Squamish, Tsleil-Waututh, Stz'uminus, and Stó:lō First Nations. UBC is implementing its Indigenous Strategic Plan, taking a leading role in the advancement of Indigenous peoples' human rights. To learn more about the Faculty of Applied Science's role in building upon the Indigenous Strategic Plan and committing to Truth and Reconciliation, please visit: https://apsc.ubc.ca/EDI.I