NΨ Capstone Design Syllabus

Course Overview

> Engineering design integrates mathematics, natural sciences, engineering sciences, and complementary studies in order to develop elements, systems, and processes to meet specific needs. It is a creative, iterative, and open-ended process, subject to constraints which may be governed by standards or legislation to varying degrees depending upon the discipline. These constraints may also relate to economic, health, safety, environmental, societal or other interdisciplinary factors.
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> The engineering curriculum must culminate in a significant design experience … based on the knowledge and skills acquired in earlier work and it preferably gives students an involvement in team work and project management. (*Canadian Engineering Accreditation Board Accreditation Criteria and Procedures 2010*, Canadian Council of Professional Engineers, sections 3.3.3.3 and 3.3.4.4.)

The Engineering Science Capstone Design course provides students in different Majors, specifically Biomedical, Electrical and Computer, Nanoengineering, and Physics, with an opportunity to integrate and apply the technical knowledge gained during their undergraduate education to the solution of a given real-world engineering design challenge. Students work in small groups[1], and have significant latitude to explore and define the given challenge. There are no technical lectures or tutorials in Capstone Design; students are expected to have sufficient technical background that they can successfully address the design challenge with some minimal additional self-study.

The design challenge for the 20119 session of Engineering Science Capstone Design is:

> Design, or redesign, an experiment for, or from, the Engineering Science undergraduate curriculum

Each Capstone Design team will (re)design, prototype, and test a working laboratory experiment. Teams are expected to develop both the experiment itself, including all supporting apparatus and equipment, documentation, learning objectives, etc., and a full set of engineering documentation that substantiates their design. **The designs produced in Capstone Design must be developed into functioning products suitable for immediate deployment in the classroom or laboratory.** In addition to their team activities, each Capstone Design student is individually expected to provide evidence of reflective activities completed during the course.

Course Instructors

Jun Nogami (WB140)
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Co-instructor: TBA

Given the highly varying nature of upper year student schedules, in lieu of scheduled office hours students who desire additional contact time must make individual appointments with the Course Instructors. During

[1] Students may choose the composition of their teams to suit their interests and skills. While we recommend that teams have members from multiple Majors, this recommendation will not be mandated.

the term the Course Instructors may announce one or more scheduled times and locations where individuals or groups of students may obtain additional contact.

Graduate Attributes

Having completed ESC471 Engineering Science Capstone Design all student are expected to have demonstrated that they possess the abilities and understandings linked to the following CEAB graduate attributes[2]:

3.1.3 Investigation
3.1.4 Design
3.1.5 Engineering tools
3.1.6 Teamwork
3.1.7 Communication skills
3.1.8 Professionalism
3.1.10 Ethics and equity
3.1.11 Economics and project management
3.1.12 Lifelong Learning

Prerequisites

There are no formal prerequisites for Capstone Design beyond having completed the Engineering Science Foundation curriculum and one year of an Engineering Science Major. As part of their Foundation studies, all students in Capstone Design are expected to have engaged in the design of structures[3], circuits[4], software programs[5], socio-technical systems[6], and other forms of engineering. They are also expected to be familiar with engineering design as a distinct topic of study[7]. Informal prerequisites include having completed laboratory experiments as part of a course, and the use of analytic and simulation tools such as Matlab and Labview.

Capstone Design builds on the Praxis Approach to Engineering Design Education introduced in the Engineering Science Foundation Curriculum. Accordingly students are expected to be aware of this approach and to use it as the basis of their Capstone Design activities. Key features of this approach include:

- Having students **make and defend design decisions**;
- Encouraging students to **explore and question** the activities and assignments they are asked to undertake;
- Exposing students to multiple conceptions of "engineering" and "design" and having **students develop their own, individualized conception of "engineering design"** that guides their practice;
- Expecting students to **undertake their own investigations** and to **explore alternate perspectives and approaches** to the materials they are presented; and,
- Having the **students responsible for integrating theory and practice**, supported by the instructional team.

The Praxis Approach to Engineering Design Education has as core theoretical underpinnings the Perry Model of Intellectual and Ethical Development and the Kolb Learning Cycle. Students are encouraged to explore these models to better understand the philosophy of the Capstone Design course.

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[2] Further information on the CEAB Graduate Attributes can be found at: http://www.engineerscanada.ca/e/files/Accreditation_Criteria_Procedures_2010.pdf

[3] In CIV102 and possibly in ESC101.

[4] In AER201 and possibly in ECE159 and ECE253.

[5] In either CSC192 or in the combination of CSC180 and CSC190, and possibly in AER201.

[6] In ESC102 and possibly in ESC201.

[7] From ESC101, ESC102, AER201, and possible ESC201.

Resources

Capstone Design makes use of a number of electronic resources:

Blackboard: available through `http://portal.utoronto.ca`

There is no textbook for Capstone Design; any required readings will be made available electronically as the course progresses. Links to these readings will be made available on the Blackboard site.

Students are required to develop functional, and optionally non-functional, prototypes of their Capstone designs. To support these efforts, students will be reimbursed for their purchases and will have access to machine shop services. **To receive reimbursement or gain access to machine shop services, students must obtain prior approval from both the course instructors and from a designated authority.**

Students may also choose to engage in activities that have associated costs, for example having posters printed on large format paper or producing bound, colour copy reports, Students in Capstone Design are expected to spend an amount similar to the cost of a textbook over the course of the term without expectation of compensation.

As much as possible, assessment will be structured so that the grade and the level of expenditure will not be correlated, allowing students to choose their own level of expenditure. Students should consult with the Course Instructors should they feel that the costs of the course are becoming excessive.

Activities and Workload

Design Studios ("Practical"; 5 scheduled hours per week)

Studios are designed as weekly opportunities for group work and consultation with the Course Instructors. Portions of certain Studios will be used for structured activities including discussions with subject matter experts, presentations by guest speakers, demonstrations, and class discussions. **We do not anticipate using the full 5 scheduled hours and will accommodate students with scheduling conflicts.**

Workload

The nominal expectation is that students spend one hour outside of class for every one hour of classroom time. On a weekly basis this translates to five hours per student per week. Note that is a nominal, average expectation; in any particular week, and for any particular student, the actual amount of time spent on the course may differ from this expectation.

Course Feedback

Over the course of the term, students may be requested to provide feedback on the course. This feedback may be solicited by the Division of Engineering Science or the Course Instructors. Any such feedback will be used to improve the course, during both this and future sessions. While students are not required to respond to the requests for feedback, they are encouraged to do so as their feedback can significantly improve both their course experience and that of future students. Should feedback be requested, student anonymity will be preserved unless the student explicitly chooses to share their identity with the Course Instructors.

Preliminary Timeline

Note that with the exception of the due dates for assignments, this timeline is subject to change. See the "Composition of Final Grades" section for specific due dates and time.

Date	Session	Studio Activities
2012-09-10	1	Course Introduction / Team Formation / Problem Assignment / Field Trip
2012-09-17	2	ESC471 20119 Post-Mortem / Proposal Formation
2012-09-24	3	Critique of Project Proposals with Course Instructors
2012-10-01	4	Team Dynamics and Performance, meetings with Course Instructors
2012-10-8	*No scheduled ESC471 activities (Thanksgiving)*	
2012-10-15	5	Pre-critique of Preliminary Designs with the Course Instructors
2012-10-22	6	Critique of Preliminary Designs
2012-10-29	7	Scheduled meetings with the Course Instructors
2012-11-05	8	Pre-critique of Final Designs with the Course Instructors
2012-11-12	9	Critique of Final Designs / Final Grade Category Allocation
2012-11-19	10	Scheduled meetings with the Course Instructors
2012-11-26	11	Course Evaluations
2011-12-03	12	Scheduled meetings with the Course Instructors

Grading Policies

Composition of Final Grades

The deliverables associated with a design activity can be broken down into three categories: product, process, and reflection. To provide students with the flexibility to pursue their own learning goals, in Capstone Design each student team is able to select what percentage of their overall grade is allocated to each of those categories. The allocation must sum to 100% while meeting the following restrictions:

Category	Definition	Min.	Max.
Product	Final deliverables and accompanying descriptions. Examples include experimental apparatus, laboratory protocols, technical specifications, WHMIS sheets, schematics, etc. Product deliverables focus on answering the question “What is the design?”	35%	55%
Process	Process deliverables frame, explain, and justify the product. Examples include problem definitions, stakeholder needs assessments, multi-criteria decision making, proposed future changes, etc. Process deliverables focus on answering the question “Why is this a credible engineering design?”	35%	55%
Reflection	Reflection deliverables demonstrate individual changes in knowledge, practice, or attitude. They may also be used to plan future activities. Reflection deliverables focus on answering the question “What did you, as an engineering designer, obtain from this design experience?”	10%	15%

Assignments with a weight of “Formative” are submitted to elicit feedback from the Course Instructors and possibly from peer teams. Assignments with a weight of “Varies” will have an exact percent weighting assigned by each team in consultation with the Course Instructors.

Due Date	Deliverable	Type	Weight	Submitter
2012-09-22	Proposal Draft Delivered electronically to the Course Instructors	Process	Formative	Team

Due Date	Deliverable	Type	Weight	Submitter
2012-09-28@1200	Proposal Delivered electronically to the Client and the Course Instructors	Process	5%	Team
2012-10-20	Preliminary Design Draft Delivered electronically to the Course Instructors	Product + Process	Formative	Team
2012-10-26@1200	Preliminary Design Delivered electronically to the Client and the Course Instructors and physically (as appropriate) to the Client.	Product + Process	Varies	Team
2012-11-19	Design Critique (group presentation)	Product	10%	Team
From 2012-12-6 to 2012-12-14	Walkthrough Scheduled by appointment with the Course Instructors and, schedules permitting, the Client	Product	Varies	Team
2012-12-21@1200	Final Design Delivered electronically to the Client and to the Course Instructors, and physically to the Client.	Product + Process	Varies	Team
2012-12-21@1200	Record of Reflection Delivered electronically to the Course Instructors	Reflection	Varies	Individual

Additional details will be released at a reasonable point in time prior to each deliverable's due date.

Team Grades

When working in teams, students are expected to divide workload in an equitable fashion. The nature of the division is up to the team members, and does not require that all members work the same hours or produce identical volumes of work. Team members are expected to follow practices of good teamwork and to comport themselves as professionals. **Students are also expected to report any difficulties with regards to teamwork to the Course Instructors as soon as possible during the term**; failure to report such difficulties may result in the instructional team being unable to address student concerns.

By default, members of a team receive an identical grade on team assignments. **Based on solicited, confidential feedback, the Course Instructors may adjust the grade distribution within a team.**

"Double-counting"

Students who are enrolled in both ESC471 Engineering Science Capstone and PHY427 Advanced Physics Laboratory may use the same experiment as the basis for, and may obtain academic credit in, both courses. Students who wish to base their ESC471 project on an experiment in a different course that they are taking concurrently must receive approval from the ESC471 Course Instructors. **Students who do not receive such approval will be assumed to have violated the University of Toronto Code of Behaviour on Academic Matters.**

Late Penalties

Due dates have been selected such that course workload is spread out over the term and that sufficient time is available to provide formative feedback prior to the submission of summative assignments. Assignments that are submitted late will be subject to a cumulative penalty, as outlined in the respective assignment descriptions. Note that this practice deviates from the more common industry practice of not accepting late deliverables.

Support and Accommodation

Students with diverse learning styles and needs are welcome in this course. Students who have a disability or health consideration that may require accommodations are both encouraged and welcome to approach the Course Instructors as soon as possible. **Should accommodations be necessary, by University of Toronto policy students are required to contact the Accessibility Services Office**.

Policies

Students in Capstone Design are expected to comport themselves professionally and to exercise common sense[8]. They are also expected to be familiar with, and act according to, the following University policies, guidelines, and interpretations:

- Code of Behaviour on Academic Matters
  http://www.governingcouncil.utoronto.ca/policies/behaveac.htm
- Code of Student Conduct
  http://www.governingcouncil.utoronto.ca/policies/studentc.htm
- Academic Integrity (Student Rights & Responsibilities Series)
  http://www.utoronto.ca/academicintegrity/Academic_integrity.pdf
- Petitions and Appeals
  http://www.apsc.utoronto.ca/Calendars/2011%2D2012/Academic-Regulations.html#Note105
- University of Toronto Inventions Policy
  http://www.governingcouncil.utoronto.ca/policies/invent.htm
- University of Toronto Policy on Official Correspondence with Students
  http://www.governingcouncil.utoronto.ca/policies/studentemail.htm

Instructional Materials and Copyright

Students are prohibited from recording or otherwise reproducing any copyrighted materials associated with ESC471 Capstone Design unless they obtain prior permission from the copyright holder. Unless otherwise indicated, tangible instructional materials (e.g. assignments, slides, handouts, etc.) developed by the Course Instructors are released under a Creative Commons license that permits the sharing of the materials, so long as attribution is made, no financial remuneration is asked, and any derivative works are similarly licensed. Tangible instructional materials developed by other parties are assumed to be copyright those parties unless otherwise indicated.

Intangible instructional materials, in particular spoken or presented content, is assumed to be copyright those providing the materials, including the Course Instructors.

Public Disclosure

Students agree that by taking this course all submitted deliverables may be used for teaching and learning purposes, in this or subsequent courses, or to support research into improving engineering education. Should such use take place, any content identifying the student will be removed. **Students who are concerned about the intellectual property ramifications of potential disclosure must notify the Course Instructors prior to the end of the 20129 academic session.**

[8] Students are encouraged to consult with the Course Instructors any time that they are uncertain as to whether an activity or decision would be unprofessional or would indicate a lack of common sense.

Turnitin

Students agree that by taking this course all required papers may be subject to submission for textual similarity review to Turnitin.com for the detection of plagiarism. All submitted papers will be included as source documents in the Turnitin.com reference database solely for the purpose of detecting plagiarism of such papers. The terms that apply to the University's use of the Turnitin.com service are described on the Turnitin.com web site. The intellectual property of all students submitting to Turnitin.com is protected by the licensing agreement between the University of Toronto and iParadigms. This agreement further ensures that student papers submitted to Turnitin.com will not be used for commercial purposes.