A SYSTEMS APPROACH TO GLOBAL ENGINEERING

CVEN 4837/CVEN 5837 (3 credit hours)

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Instructor
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Prerequisites  Senior or graduate level

Web:  http://www.colorado.edu/mcedc/education/edc-courses/cven-45837-systems-approach-global-engineering

Course Description

The purpose of this course is to introduce engineering students to the global context in which engineers are asked to operate in the 21st century. The course also aims at introducing students to system dynamics tools and other decision-making tools (network analysis, agent based modeling, etc.) necessary to analyze the uncertainty and complexity inherent in global projects. At the end of this course, students should be able to:

- Have the ability to identify the multiple dimensions of engineering projects in a developed or developing country context;
- Be aware of the role non-technical issues may play in their technical decision-making;
- Appreciate the multi-cultural, social, and economic dimensions of practicing engineering;
- Understand the global interconnectedness of issues at different scales from the local to the global and why a systems approach can complement a more traditional linear approach;
- Formulate problems and their solutions in a more systemic and integrated way;
- Be able to approach a wide range of simple, complicated, and complex problems often characterized by different levels of uncertainty; and
- Be familiar with a range of decision making tools.

These seven goals will be met through a combination of lectures, seminars, and projects. Students will be exposed to a variety of projects in the developed and developing world. In each project, students will be shown how technical and non-technical issues have helped shaped the project outcome.

Throughout this course, students will be presented the importance of depth and breadth in their education and the need for balance between specialization (depth) and a broader understanding of the inter- and intra-disciplinary nature of engineering and society.

This course serves as the last course in the Undergraduate Certificate in Global Engineering at CU Boulder. It is offered as a technical elective at the senior and graduate level.
Expected Learning Outcomes

By the end of the course, students should have attained competency in the following areas:¹

- participatory decision making between many parties (ABET 3d)
- creation and administration of a community needs assessment (ABET 3c,e,h)
- creating and analyzing multiple design alternatives (ABET 3c,e)
- determining appropriate technology choices based on the existing knowledge within a partner community (ABET 3c,e,f,h)
- determining metrics for a project design (ABET 3c)
- determining metrics for project success vs. failure (ABET 3c,e,h)
- understanding of general construction and safety practices within the partner community (ABET 3k)
- objective monitoring and evaluation of a built system (ABET 3b,e)
- creation of long-term communication strategies between in-country partners, partner communities, and project teams (ABET 3d)

Class Hours and Location: Tu and Th from 8:00-9:15 am.; ECCE 1B41

Office Hours: Wednesday and Friday from 9-11 am (or by appointment)

Course Readings:

Students are responsible for all the required readings. These readings aim to set the context for the class, allow students to engage lecturers, to generate questions for discussions, and to deepen students’ knowledge of topics. A mandatory reading list will be provided for each class period. Textbooks used in class:


The web and the literature are rich in articles, videos, and web sites that cover the topics mentioned below. Students will be asked to read three to four articles (or book chapters) before each class, work and learn with their peers, and present their findings in class.

Course Content (30 lectures)

1. Course Overview and Introduction. Introduction to Systems Thinking (1 lecture)
2. A Systems View of the World (2 lectures)
   - Looking at the world as a system of systems
   - Systems science and complexity science
   - System thinking
   - Methods of decision making
   - Simple, complicated, and complex systems
3. Introduction to System Dynamics (4 lectures)
   - Components of system dynamics
   - System dynamics modeling
   - Stella Professional software
   - Concepts and models of development
   - Development challenges in the developed and developing world
   - The Millennium and Sustainable Development Goals
   - Integrating a systems approach to the MDGs and SDGs
   - Models of Global Change: IF Future trend “what if” models
   - Scenario planning models at different scales
5. The Water-Energy-Land-Food Nexus (3 lectures)
   - The Water of Ayole case study
   - Analyzing the components of a case study
   - Modeling a case study
   - Modeling population dynamics
   - System archetypes
7. Systems Approach to Management of Development Projects (9 lectures)
   - Stages of project management
   - Role of non-technical issues in all stages of project management
   - The non-technical dimensions of engineering innovation. Who benefits?
   - Right projects, done right, and for the right reasons. Who decides and participates?
   - Collecting and analyzing data for systems modeling
   - Defining issues and their dynamic hypotheses
   - Social network analysis and GIS
   - Methods of decision making, importance of perspective (Zoom)
   - Capacity, vulnerability, and risk analysis
   - Developing an implementation plan
   - Failure and the engineering mindset
   - The ethical dimensions of failure
   - Deciding when faced with uncertainty and complexity
   - Biases and cross-cultural communication
8. Sustainability and Sustainable Development (2 lectures)
   - Definitions
   - Integrating sustainability in engineering projects
9. Systems Approach to Community Resilience and Security (1 lecture)
   - Importance of context and scale
   - Capacity and vulnerability
- Critical infrastructure
- Response to hazards, adverse events, and human migrations

10. Group Decision Making Dynamics (1 lecture)
   - The different dimensions of leadership
   - Teamwork
   - Dealing with conflict (internal and external)

11. Case studies (2 lectures)

Assignments and Grades

Student grades will be determined based on in-class participation (20%), homework assignments, and possible quizzes (40%), and multiple projects (40%).

Taking the Class at the Graduate Level

Students interested in taking the course at the graduate level will be given additional reading assignments. They will be asked to work on more extensive term projects and serve as mentors to the undergraduate students.

Team Work

All homework assignments and projects will be done in teams of undergraduates and graduates.
Accommodations for Disability
If you qualify for accommodations because of a disability, please submit to your professor a letter from Disability Services in a timely manner (for exam accommodations provide your letter at least one week prior to the exam) so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities. Contact Disability Services at 303-492-8671 or by email at dsinfo@colorado.edu. If you have a temporary medical condition or injury, see Temporary Injuries guidelines under the Quick Links at the Disability Services website and discuss needs with professor.

Religious Holidays
Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, (insert your procedures here). See the campus policy regarding religious observances for full details. For more information on the religious holidays most commonly observed by CU Boulder students consult the online interfaith calendar.

Classroom Behavior
Students and faculty each have responsibility for maintaining an appropriate learning environment. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, color, culture, religion, creed, politics, veteran's status, sexual orientation, gender, gender identity and gender expression, age, disability, and nationalities. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. See the policies on classroom behavior and the student code.

Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation
The University of Colorado Boulder (CU Boulder) is committed to maintaining a positive learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct, discrimination, harassment or related retaliation against or by any employee or student. CU's Sexual Misconduct Policy prohibits sexual assault, sexual exploitation, sexual harassment, intimate partner abuse (dating or domestic violence), stalking or related retaliation. CU Boulder's Discrimination and Harassment Policy prohibits discrimination, harassment or related retaliation based on race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. Individuals who believe they have been subject to misconduct under either policy should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127. Information about the OIEC, the above referenced policies, and the campus resources available to assist individuals regarding sexual misconduct, discrimination, harassment or related retaliation can be found at the OIEC website.

Honor Code
All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the academic integrity policy of the institution. Violations of the policy may include: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access, clicker fraud, resubmission, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code Council (honor@colorado.edu; 303-735-2273). Students who are found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code Council as well as academic sanctions from the faculty member. Additional information regarding the academic integrity policy can be found at http://honorcode.colorado.edu.