Course Outline for CECS 406: Information and Communication Technology (ICT) for Sustainability (3 Units)

I. General Information

A. Course Number: CECS 430

B. Course Title: "ICT for Sustainability (ICT4S)"

C. Units: 3

D. Co-Requisites: ENGR 350 (Computers, Ethics and Society) or Consent of Instructor

E. Responsible Faculty: Dr. Birgit Penzenstadler, Department of Computer Engineering and Computer Science;

F. Standard course outline prepared by Birgit Penzenstadler, March 3rd, 2016

II. Catalog Description

This course aims to equip students with the foundational knowledge on sustainability and its relation to information and communication technology (ICT). It gives insights into the most important concepts for understanding, analyzing, and assessing the sustainability of a given context. We will go through a list of application domains that are highly relevant for sustainability, including but not limited to climate change, sustainable food production, smart systems, and gamification. Furthermore, we will learn about and experiment with systems thinking approaches and learn how to develop feasible future scenarios.

Lecture: 1 hour twice per week.
Lab (activity): 2 hours twice per week.
Grading: Individual and team assignments, midterm and final exam. Letter grade only (A-F).

III. Student Learning Outcomes

After completing the course students will be able to:

- Critically reflect upon the different dimensions of sustainability in a given context, specifically in any context that involves software-intensive systems or information and communication technology.
- Define sustainability in a specific context with regard to the dimensions of what to sustain, for whom, for how long, and at what cost. They will be good at defining system scopes.
- Understand causes of and dependencies between sustainability problems by seeing the bigger picture, by being able to expand a system's scope to include further impact factors.
- Judge the quality of ICT solutions because they understand the wider impact these solutions may have on their operational environment and business as well as societal context.
- Translate sustainability concepts for their community and become visionaries and thought leaders that inspire actions. They can design sustainable ICT solutions for their communities.

- Analyze the availability or scarcity of resources and judge their consequences for ICT development and its wider context in business, society, and for the environment.
- Have a habit of making food choices that are good for their body and the environment, and they understand how ICT systems can support growing, supplying, and distributing sustainably produced food, and how to engage people in making informed choices supported by ICT.
- Have cultivated a habit of making lifestyle choices for more sustainability for themselves and their environment and therefore serve as role models for their communities and network, and they can design ICT systems that support behavior changes for a sustainable lifestyle in their communities.

IV. Curriculum Justification

This course is the essential stepping-stone for understanding the concept of sustainability and how it relates to the application domains computer scientists work in. It equips students with the necessary concepts, methods, and tools to analyze the sustainability of a proposed solution and assess its long-term effects. As engineers we are responsible for the long-term effects and impacts of the systems we develop, therefore it is crucial that our students develop an understanding of how these systems impact the environment and our society locally and globally.

V. Outline of Subject Matter

This course exposes students to
In detail, the course covers the following topics (*1 per week*):

1. Introduction to sustainability (definitions, history, aspects)
2. Information and communication technology in relation to sustainability
3. The five dimensions of sustainability
4. The three orders of effect and rebound effects
5. Peak oil and climate change
6. Sustainable food production and permaculture
7. Smart X – green product and service development
8. Behavior change: Gamification of sustainability
9. Sustainable development concepts
10. Sustainable development process
11. Introduction to systems thinking
12. System dynamics
13. Leverage points
14. Sustainability assessment (metrics and procedures)
15. Possible future scenarios for ICT supporting sustainability

VI. Modes of Instruction

The class consists of traditional lectures from faculty and of discussion sessions with activities that the students perform individually and in teams.

VII. Textbook

Currently, there is no adequate textbook for this course. The book by Hilty and Aebischer below is a research book with compiled essays and is written accordingly, not as a textbook for courses, but it may well serve to prepare the lectures as it covers most of the topics in the outline of the subject matter. For inspiration for activities, the book by Booth Sweeney gives much inspiration. More detailed resources on individual topics are listed in the bibliography.

- Hilty, Lorenz M., and Bernard Aebischer. ICT Innovations for Sustainability. Springer International, 2015.
- Booth Sweeney, L., Meadows, D. The systems thinking playbook: Exercises to Stretch and Build Learning and Systems Thinking Capabilities. Chelsea Green Publishing; 2010.

VIII. Instructional Policies Requirements

Instructors may specify their own policies with regard to plagiarism, withdrawal, absences, etc., as long as the policies are consistent with the University policies published in the CSULB Catalog. It is expected that every course will follow University policies on Attendance (PS 01-01), Course Syllabi (PS 04-05), Final Course Grades, Grading Procedures, and Final Assessments (PS 05-07), and Withdrawals (PS 02-02 rev).

IX. Distance Learning/Hybrid Courses

This course can either be taught in a traditional format where students attend in-class lectures and carry out assignments individually and in teams, or it can be carried out as hybrid course with one face-to-face meeting per week for a lecture and team activities and one remote reading assignment plus an individual research activity/assignment and an online discussion of the results.

X. Bibliography

This is a highly selective bibliography to provide instructors with a primary set of resource materials. To ensure brevity, important works may be missing from this list. The list is intended to show the range of materials available to our students. Many of the listed articles are research articles and need to be discussed with the students in order to make sure they grasp all concepts.

Sustainability

- Heinberg, Richard, and Daniel Lerch. "What Is Sustainability?." The Post Carbon Reader (2010): 11-19.
- Ehrenfeld, John R. "The roots of sustainability." MIT Sloan Management Review 46.2 (2005): 23-25.
- Tainter, Joseph A. "Social complexity and sustainability." ecological complexity 3.2 (2006): 91-103.

ICT and Sustainability

- Hilty, Lorenz M., and Bernard Aebischer. "Ict for sustainability: An emerging research field." ICT Innovations for Sustainability. Springer International Publishing, 2015. 3-36.
- Ferrario, Maria Angela, et al. "Software engineering for 'social good': integrating action research, participatory design, and agile development." Companion Proceedings of the 36th International Conference on Software Engineering. ACM, 2014.

Application areas

- Foley, Jonathan A., et al. "Solutions for a cultivated planet." Nature 478.7369 (2011): 337-342.
- Deterding, Sebastian, et al. "Gamification. using game-design elements in non-gaming contexts." CHI'11 Extended Abstracts on Human Factors in Computing Systems. ACM, 2011.
- Anthony M. Townsend. "Smart cities: Big data, civic hackers, and the quest for a new utopia." W. W. Norton & Company. 2013
- Dohler, M., Vilajosana, I., Vilajosana, X., & LLosa, J. "Smart cities: An action plan." In Barcelona Smart Cities Congress. (2011, December).

Systems thinking

- Meadows DH. Thinking in systems: A primer. Chelsea Green Publishing; 2008.
- Weinberg GM. An Introduction to General Systems Theory. Dorset House; 2001.
- Booth Sweeney, L., Meadows, D. The systems thinking playbook: Exercises to Stretch and Build Learning and Systems Thinking Capabilities. Chelsea Green Publishing; 2010.
- Meadows, Donella. Leverage Points: Places to Intervene in a System

Assessment

- Tibor, Tom, and Ira Feldman. "ISO 14000: a guide to the new environmental management standards." (1996).
- Pojasek, Robert B. "ISO 26000 guidance on social responsibility. "Environmental Quality Management 20.3 (2011): 85-93.
- Bell, Simon, and Stephen Morse. Sustainability indicators: measuring the immeasurable?. Earthscan, 2008.

XI. Student-Level Assessment

The exact set of course assignments will vary depending on the instructor. University policy requires that no single evaluation of student achievement may count for more than one-third of final grade. Appropriate assessment tools include quizzes, exams, written homework, computer-programming assignments and oral presentations.

Sample assignments:

- Write your own definition of sustainability (teamwork)
- Analyze the five dimensions of sustainability for a case study
- Play through a number of scenarios with cultural factors and establish sustainability policies
- Analyze leverage points for an example system

XII. Course-Level Assessment

The exact set of course assignments will vary depending on the instructor. University policy requires that no single evaluation of student achievement may count for more than one-third of final grade. Appropriate assessment tools may include quizzes, exams, written homework, computer-programming assignments and oral presentations. The suggestion is:

1. Several individual and team assignments (to practice and demonstrate the skills from the course objectives above).
2. A midterm and a final examination in form of a written test or an essay.

XIII. Consistency of this Standard Course Outline across Sections

The course coordinator will review this SCO and offer advice and/or materials to each faculty member new to teaching the course. All future syllabi will conform to the SCO. The course coordinator may offer or require regular review of instructors' course materials as well as anonymous samples of student work.