Course Outline

ENGR/ECE 532: Dynamics of Complex Engineering Systems

Instructor:

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Textbook:

- Sterman, J. (2000). Business Dynamics: Systems Thinking and Modeling for a Complex World (Text and CD-ROM). Irwin/McGraw Hill. ISBN 0-07-238915X.

Prerequisites:

ENGR/ECE501 concurrent registration

Instructional Methodology/Mode of Delivery:

Classroom instruction using mixed media to present content and examples. Discussion and other interactive teaching methods will be used whenever possible.

Grading:

- 5 Assignments: 40%
- 5 Quizzes: 20%
- Final Project: 30%
- Class Participation: 10%

Class Rhythm:

- Biweekly Quizzes, Reading and Modeling Assignments. The Quizzes ensure the students are in sync with the required reading and main takeaways from previous lecture materials and assignments.
- The reading volume is intentionally heavy so that the students learn ways of processing a huge amount of information quickly. Ability to process a lot of information and reach conclusions quickly is very helpful to engineering and management leaders in the industry.
- The assignments are intentionally vague, do not have a single correct answer, are ill-defined (i.e. not N equations and N unknowns) and certainly not an exact replica of an example covered in the text book or class material. The first two assignments are individual assignments. The other 3 assignments and the final project are done in groups.
- Class participation is very important. For on campus students the participation point will be calculated based on their attendance (You should be present for at least 14 sessions in order to get the full point). Distance students need to make a presentation in order to

earn these points. The details will be announced in class.

Grading Policy:

No exams. Due dates are ***strictly enforced*** because there are no alternative assignments and the answers are posted on the due dates.

Course Description:

System Dynamics deals with understanding the higher-level behavior and issues that emerge from interaction between components in complex socio-technical systems. Most of the problems that experienced engineers face in the real world are not purely technical and are usually dynamic. The following are a few examples of sorts of problems that were traditionally not tractable with classical approaches and therefore tended to be approached by ad-hoc, subjective or crystal ball techniques:

- Engineering Quality Initiatives or Policy Improvements that initially improve quality but eventually fade away to the levels that existed before the initiatives were implemented.
- New Product Development projects that take more than twice as long as expected.
- Technical Projects that remain 95% complete for a long time despite intensive resource utilization to complete the work.
- Engineering policy or process changes that yield the exact opposite result to what was intended.

System Dynamics is not new in a purely technical sense. However, applying this type of thinking to solve Complex Engineering Systems that fall into the full socio-technical spectrum is relatively new. This course emphasizes System Thinking, Dynamic Cause and Effect relationships and the higher-level emergent behavior that results from the interaction of many smaller effects that are individually well understood but more difficult to grasp at the higher level. Software tools are used in this class, but developing the intuition and skills to solve real world complex system type problems is the major take away for the students. This course will benefit engineers who want to gain an appreciation for the associated Socio-Technical problems that arise in the real world in developing complex engineering systems. Solving Socio-Technical problems is an important skill for engineers that work for organizations that develop complex engineering systems or engineers who plan to eventually move into a technical leadership position.

Student Learning Objectives:

Successful students in the class will be able to:

- Solve a spectrum of problems that arise in the real world when designing complex engineering systems with their associated Socio-Technical issues by applying System Dynamic principles and tools.
- Improve their "System Thinking" and learn how to model and extract important emergent dynamic behavior from interactions between sub-components of a complex engineering system.
- Learn how to use objective and practical skills grounded in engineering to deal with the typical hurdles that mature engineering system organizations are battling with today.