496mcd2018

Master Course Description for EE-496 (ABET sheet)

Title: Engineering Entrepreneurial Systems and Design

Credits: 2

UW Course Catalog Description

Coordinator: Payman Arabshahi, Associate Professor, Electrical and Computer Engineering

Goals: To learn fundamentals of systems engineering, feasibility studies, project management and design, budgeting, risk and liability, and intellectual property and patents. To apply these topics to Entrepreneurial capstone projects starting late in the quarter, and carry them through to EE-497/498 (Engineering Entrepreneurial Capstone I, II), and thus to lay the foundation for these two courses in winter and spring.

Learning Objectives: At the end of this course, students will be able to:

1. *Understand and manage* the development of complex technical and organizational systems.
2. *Apply* fundamentals of systems engineering, quantitative techniques, and analysis to the design of hardware/software systems.
3. *Recognize* the connections between applied engineering and practical management.
4. *Analyze* business problems better to formulate strategy, tactics, plans and policies.
5. *Engage* in creative problem solving.
6. *Improve* on abilities to lead and manage.
7. *Engage* with relevant ethical principles and apply core concepts to industry projects.
8. *Complete* preliminary phases of an applied R&D project.
9. *Understand* the fundamentals of intellectual property and patents.
10. *Contribute* to industry innovation, research, and entrepreneurship.

Textbooks: Class notes, technical papers, industry reports, web resources, plus

1. *System Engineering Fundamentals*, Defense Acquisition University Press, 2001. ISBN #: 978-1537703466.
2. C. Shamieh, *Systems Engineering For Dummies,® IBM Limited Edition*, Wiley, 2011, ISBN #: 978-1118100011. Download Link.

Reference Texts:

1. H.F. Hoffman, *The Engineering Capstone Course: Fundamentals for Students and Instructors*, Springer,
2. ISBN #: 978-3319058962.

3. D.H. Meadows and D. Wright, *Thinking in Systems: A Primer*, Chelsea Green Publishing, 2008. ISBN #: 978-1603580557.
4. D.D. Walden, G.J. Roedler, K.J. Forsberg, R.D. Hamelin, and T.M. Shortell, *INCOSE Systems Engineering Handbook: A Guide for System Life Cycle Processes and Activities*, Wiley, 2015. ISBN #: 978-1118999400.
5. D.J. Hatley, P. Hruschka, I.A. Pirbhai, *Process for System Architecture and Requirements Engineering*, Dorset House, 2000. ISBN #: 978-0932633415.
6. C.S. Wasson, *System Engineering Analysis, Design, and Development: Concepts, Principles, and Practices*, Wiley, 2015. ISBN #: 978-1118442265.
7. J.R. Schermerhorn Jr. and D.G. Bachrach, *Exploring Management, 6th Ed.*, Wiley, 2017. ISBN #: 978-1119403388.
8. S.H. Voldman, *From Invention to Patent: A Scientist and Engineer's Guide*, Wiley, 2018. ISBN #: 978-1119125259.
9. J.P. Kennedy, W.H. Watkins, and E.N. Ball, *How to Invent and Protect Your Invention: A Guide to Patents for Scientists and Engineers*, Wiley, 2012. ISBN #: 978-1118369371.

Prerequisites by Topic:

1. Junior or Senior standing

Topics:

Systems Engineering 1. Stakeholder analysis 2. Requirements definition 3. System architecture and concept generation 4. Concept selection and tradespace exploration 5. Design definition and multidisciplinary optimization 6. Systems integration and interface management 7. Verification and validation 8. Commissioning and operations 9. Lifecycle management

Entrepreneurship 1. Idea pitches, team formation, lean canvas 2. Idea validation, lean experiments 3. IP and patents, licensing

General 1. Teamwork, Scrum, project management, scheduling tools and techniques 2. Written and oral presentations 3. Budgets, procurement, balance sheets

Course Structure: The class meets for one 80-minute lecture a week covering the topics above and reinforcing them with homeworks, and proof-of-concept system analysis and synthesis projects.

Also during this quarter companies present projects to class on the annual Capstone Pitch Day Event. Students interested in taking EE-497/498 in winter and spring rank order the projects, submit their resumes and transcripts, and complete a questionnaire on their technical skills and personal learning objectives for the ranked projects. Teams of 3-4 students are then assigned by faculty, matching project technical needs to student skillsets and project rankings. Companies are then informed of a team assignment, and invoiced for the project fee. All student team members sign a project agreement, covering confidentiality. Student teams will be multidisciplinary in nature. They may include members from the ECE Department, but with different areas of concentration, experience, strengths, or interests. They may also include members from other Departments in the

College of Engineering. Team assignment and all paperwork will be complete by the end of Fall quarter. Preliminary meetings occur between student teams and industry mentors. Work begins on a requirements document, to feed into formal project start in EE-497/498 in winter.

Computer Resources: Homeworks and projects can be done on any personal computer.

Laboratory Resources: None.

Grading: 1. Homeworks: 40% - Every other week. Homework will be graded/checked mainly for completion, and the amount of qualitative thought that goes into each answer. 2. Two projects: 60% - Based on a new design (synthesis) and existing design (analysis), which will be designed and constructed, or broken down and analyzed/reconstructed using the Systems Engineering Process.

ABET Student Outcome Coverage: This course addresses the following outcomes:

H = high relevance, M = medium relevance, L = low relevance to course.

(1) *An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics* **(M)** This courses focuses on fundamental principles of systems engineering, as applied to design of systems incorporating sensing, computing, communication, control, power, electronics, signal processing, machine learning, and other systems (these technical engineering topics are covered elsewhere and are not specifically addressed here). The high-level framework, and the specific systems engineering techniques focus on identifying, formulating, and solving complex open-ended engineering problems, which are typically subject to a variety of constraints, and present themselves as a series of interconnected engineering problems. These engineering problems are not explicitly stated, but must be identified by the design team before they can be solved.

(2) *An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors* (**M**) As part of the systems engineering process students are instructed in ways of developing requirements and specifications imposing realistic constraints on the operation of systems. Much of this is driven by considerations of cost, safety and reliability. Other considerations include size, weight, power consumption, alignment ease, component variation, manufacturability, user interface, and user experience. Students must choose among design alternatives on the basis of these considerations. Specific consideration of safety issues and engineering design standards is required.

(3) *An ability to communicate effectively with a range of audiences* (**H**) Best practices of good written and oral communications (progress and final reports, documentation, presentations, posters) are covered in class, and writing assignments given as homeworks and project reports. Emphasis in any such communication is placed upon clear descriptions of system design, build, and test steps, analysis of tradeoffs, results of verification and validation, illustrative block diagrams, industry acceptable

schematic diagrams, a formal bill of materials with full component (software or hardware) sourcing, and proper discussions and references to engineering design standards.

(4) *An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts* (**M**) These concepts are covered in subtopics of systems engineering above, such as stakeholder analysis, requirements definition, concept generation, and concept selection. The analysis and synthesis team projects have relevant components where students are asked to discuss ethical and professional responsibilities.

(5) *An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives* (**H**) Best practices of multi-disciplinary team work, task allocation, work breakdown structure, and Scrum are covered. Project assignments have students operate in teams of 3-4 to solve analysis and synthesis problems and prepare reports. The students organize themselves and divide up the work among them.

(6) *An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions* (**L**) Students are instructed in the role, methodologies, and timings of verification and validation (V&V) in the systems engineering process, as well as feedback from V&V activities back to the requirements, architecture, concept generation and selection, design, integration, and V&V stages. Students are also exposed to topics such as lean experiments and idea validation via data analysis and customer discovery. The analysis and synthesis team projects have a V&V component where students are asked to discuss and propose relevant V&V activities.

(7) *An ability to acquire and apply new knowledge as needed, using appropriate learning strategies* (**M**) The course material distributed does not contain all of the information necessary to solve the design problem. Students must consult reference sources and inform themselves concerning many aspects of the design problem. This helps students realize that they need to be able to learn material on their own, and gives them some of the necessary skills.

Prepared By: Payman Arabshahi

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