Course Approval Form

Action Requested: (definitions available at website above)
- Create NEW
- Modify (check all that apply below)
- Inactivate

Course Level:
- Undergraduate
- Graduate

College/School: VSE
Department: SEOR
Submitted by: CH Chen
Ext: 3-3572
Email: cchen9

Subject Code: SYST
Number: 514
Effective Term: Fall
Year 2017

Title: Systems Thinking
Banner: Current
New

Credits: Fixed → 3
Variable → to
Repeat Status: Not Repeatable (NR) →
Lec + Lab/Rct → or
Repeatable within term (RT) →

Grade Mode:
- Regular (A, B, C, etc.)
- Satisfactory/No Credit
- Special (A, B, C, etc. +IP)

Schedule Type:
- Lecture (LEC)
- Lab (LAB)
- Recitation (RCT)
- Seminar (SEM)
- Studio (STU)

Prerequisite(s): SYST 505

Restrictions Enforced by System: Major, College, Degree, Program, etc. Include Code(s).

Equivalencies:
- YES, course is 100% equivalent to
- YES, course renumbered to or replaces

Catalog Copy for NEW Courses Only (Consult University Catalog for models)

Description (No more than 60 words, use verb phrases and present tense)
This course enables students to understand and use systems thinking concepts, tools and techniques that can apply across all system types, especially those which exhibit a fusion of technology and human activities. Additionally, the course extends the understanding of systems beyond technology, to systems with significant human activity components, such as organizations and enterprises.

Notes (List additional information for the course)

Indicate number of contact hours:
When Offered: (check all that apply)
- Fall
- Summer
- Spring

Hours of Lecture or Seminar per week: 
Hours of Lab or Studio: 

Approval Signatures

CH Chen 12/10/2016
Department Approval Date

2/7/17
College/School Approval Date

If this course includes subject matter currently dealt with by any other units, the originating department must circulate this proposal for review by those units and obtain the necessary signatures prior to submission. Failure to do so will delay action on this proposal.

For Graduate Courses Only

Graduate Council Member

Provost’s Office

Graduate Council Approval Date
Abstract:
A fundamental competency required of systems engineers is a mastery of systems thinking – looking at the “big picture”, and understanding and managing emergent behavior, unintended consequences, and non-linear behavior in systems and problems of all scales. This course explores systems thinking and its application to modern systems and problems, emphasizing mental models and the simultaneity of perspectives, the role of paradox, and the centrality of soft issues in resolving complexity. We explore tools and concepts such as systems dynamics, systems archetypes, leverage points, and soft systems methods, especially as they relate to understanding the development and behaviors of complex enterprise systems and systems of systems. To assist in our understanding, we will look at case studies of systems thinking application where it was properly considered and managed and failures where it was not.

This class is aimed at decision-makers, analysts, and engineers at all levels in an organization.

Course Objectives:
The main objective of this course is to enable students to develop the ability to understand and use systems thinking concepts, tools and techniques that can apply across all system types, especially those which exhibit a fusion of technology and human activities. Additionally, the course will help extend the understanding of systems beyond technology, to systems with significant human activity components, such as organizations and enterprises.

After taking this course the student will be able to:

• Discuss the fundamental concepts of systems thinking, e.g. system boundary, relationships, openness, feedback and closed loop thinking, emergence, and unintended consequences.
• Understand the various types of systems, including their common characteristics as well as how they differ.
• Formulate a robust articulation of the problem, including an outline of the behavior of concern, and how the problem relates to the system.
• Investigate the consequences arising from the amalgamation of simultaneously tenable viewpoints, or stakeholder perspectives, and the harmonization of these using a soft systems methodology.
• Use system dynamics and causal loop diagrams to explore interactions of system elements and their counter-intuitive effects at the system level including feedback, non-linear behaviors and paradoxes.
• Explore systems of systems (SoS) via discussion of ‘conventional’ uses of that term contrasted with fundamental notions of autonomy, belonging and connectivity within a framework for SoS conception, development and maintenance.
• Discuss the relevance and impact of wicked problems and complexity (and their underpinning science) in the context of socio-technological systems with the aim of producing sensible heuristics for coping with both.
• Synthesize concepts, principles, and tools into a framework for practical application to today’s problems of national significance, with the goal of identifying leverage points for system behavior change.
• Relate systems thinking to the systems engineering project lifecycle, illustrating the value of systems thinking concepts to the systems engineering discipline.
Course Methodology:
The course will employ lectures and supplemental readings as part of instruction and learning. Class exercises will be used to reinforce and expand concepts and ideas. Students will also execute simulations to explore system concepts.

Grading System:
- Individual class participation (discussions, class exercises) 10%
- Homework Assignments 10%
- Group project/presentation 15%
- Group Final Report 65%

Required Software:
- Vensim PLE– System dynamics simulation software (Ventana Software – Free Educational Version Available)
- Netlogo – Multi-agent modeling environment (Free Open Source)

Required Textbooks:
Final text selection pending, but may include one or more of the following:
- The Fifth Discipline: The Art & Practice of The Learning Organization, Peter M. Senge
- Thinking in Systems, Donella Meadows

Additional Reading Materials:

Course Outline:

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<tr>
<th>Topics</th>
<th>Subject</th>
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<tbody>
<tr>
<td>1</td>
<td><strong>Systems Thinking Introduction</strong> – Provide overview of systems thinking concepts along with several motivational examples, relating</td>
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| 2 | **System Types** – Discuss the various system types, both technological and social, concentrating on their important characteristics and how those impact system behavior.  
**Perspectives** – Discuss the reality of multiple perspectives inherent in stakeholder communities; introduce the viewpoints system thinkers must employ; and explore the concept of mental models. |
| 3 | **Problem Definition** – Provide overview of problem definition methodologies, especially those integral to and benefiting from systems thinking. Through example, discussion, and exercises, work to improve problem definition skills. |
| 4 | **Soft Systems Methodology** – Extend the discussion of the human element in systems, introducing the work of Checkland and other thought leaders in soft systems. Explore the concepts of rich pictures and root definitions of pertinent systems. |
| 5 | **System Dynamics** – Discuss the origins and applications of system dynamics, along with the associated tools and methods. Discussion will include causal loop diagrams and their practical application. Examples and exercises will be used to help reinforce the concepts and to illustrate the power and usefulness of the system dynamics approach. |
| 6 | **System Archetypes** – Continue discussion of system dynamics through the exploration of system archetypes. Explore the utility of system archetypes and their value in understanding the underlying structure of the systems.  
**Leverage Points** – Discuss the various types of leverage points, their relative impact, and how they are identified in a system. Leverage points become the point of intervention for system improvement. |
| 7 | **System of Systems** – Explore system of systems, relevant frameworks, and how they relate to the discipline of systems thinking. Concentrate on application of these frameworks to further system understanding and behavior change. |
| 8 | **Paradox, Wicked Problems, and Complexity** – Discuss advanced concepts in systems thinking and introduce both wicked problems and complexity. In all cases, these concepts will be developed to further understanding and improvement of real-world systems. |
| 9 | **Operationalizing Systems Thinking** – Bring concepts, principles, and tools together to introduce a framework suitable for assessment and improvement of systems and problems at all scales. Review the application of systems thinking to the system engineering lifecycle. |
| 10 | **Group Presentations** – Each group presents an overview of their group project displaying application of systems thinking concepts and discussing possible improvements to chosen system of interest.  
**Team project final report due** |