Course Name: MODELING AND ANALYSIS OF COMPLEX SYSTEMS (COMPLEX SYSTEM DESIGN)
Course Number: ME 516
Course Credits: 4 hours, includes 4 hours/week lectures
Prerequisites: None. Graduate Standing.

Instructor:
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Course Description:
Introduction to challenges and considerations when designing complex systems. Fundamentals of systems engineering and methods used in practice. Models and tools used to enable the use of models for trade studies during the design of complex systems. Model based design environments and methodologies. Introduction to decision support tools in design.

Learning Outcomes:
By the completion of this course, students will be able to:
- Identify major challenges in complex system design
- Utilize models during complex system design
- Utilize system engineering tools during complex system design
- Analyze and design a subsystem in a concurrent and collaborative design session using design tools, models, and methodologies presented in class
- Formulate a research need and conduct research based on identified challenges
- Present findings in a professionally written report and an oral presentation

Textbook:
No textbook is assigned. Reading assignments will be handed out for selected topics either from published articles or books. Suggested books for reading include:
- The art of systems architecting. M.W. Maier and E. Rechtin
- Space mission analysis and design. J. R. Wertz and W. J. Larson
- Introduction to systems engineering. A.P. Sage and J. E. Armstrong

Grading:
Homework & In-class discussions 30%
Concurrent Design Project 30%
Research Project 40% (Research proposal, literature findings, interim report and presentation, final report and presentation)

Homework Assignments:
- 2 page summary and discussion on the invited seminar topics and relationship to research project after each seminar
- 2-page summary and discussion of reading assignments (from textbooks or research papers)

Requirements for Concurrent Design Project:
- Team-X setup: Teaming (Systems, structures, aerodynamics, cost modeling)
- Introduction to Models
- Method: Trade space exploration using ATSV as a background optimizer
- Software training
- Design of system using subteams (subsystem chairs)
- Design of systems using optimizer tool (teams)
- Discussion of observations and results of mock design session
• Report and presentation of design session results, before & after comparison

Requirements for Research Project:
• Problem formulation
• Research Proposal report
• Literature search
• Development of approach
• Interim progress report
• Implementation
• Discussion of how approach would improve system design process
• Final report and powerpoint presentations

Possible Research Topics:
• Function based methods for conceptual design
• Trade space exploration: Visualization
• Model based design
• Cost benefit analysis
• Decision Capture

Special Needs:
Students with documented disabilities who may need accommodations, who have any emergency medical information the instructor should know of, or who need special arrangements in the event of evacuation, should make an appointment with the instructor as early as possible, no later then the first week of the term. Accommodations are collaborative efforts between students, faculty and Disability Access Services (DAS). Students with accommodations approved through DAS are responsible for contacting the faculty member in charge of the course prior to or during the first week of the term to discuss accommodations. Students who believe they are eligible for accommodations but who have not yet obtained approval through DAS should contact DAS immediately at 737-4098.

Academic Integrity:
Academic dishonesty is prohibited and considered a violation of the OSU Student Conduct Regulations. It includes cheating, the intentional use of unauthorized materials, information, or study aids; fabrication, assisting in dishonesty or tampering (intentionally or knowingly helping or attempting to help another commit an act of dishonesty or tampering with evaluation instruments and documents); and plagiarism, intentionally or knowingly representing the words or ideas of another person's as ones' own. If you have a question regarding academic integrity, please talk to the instructor or refer to the OSU student conduct homepage at http://osu.orst.edu/admin/stucon/index.htm.

Topics and Approximate Schedule:
Wk 1: Introduction to Complex Engineered Systems
  1. Complex Engineered Systems
     Reading assignment: Complex systems
     Preliminary literature search on research topic

Wk 2: Introduction to Complex System Design
  3. Design and Architecting of Complex Engineered Systems
  4. Introduction to potential solutions and active research areas
     Research Project Assignment
     In-class assignment: discussion of reading assignments/preparation for design session

Wk 3: Systems Engineering Fundamentals
  5. Complex Systems Design: Systems Engineering View
  6. System Engineering tools and research methods
Research proposals report due (brief presentations/discussion by each student.)
Reading assignment: Spacecraft systems engineering

Wk 4: Systems Engineering Methods and Tools
7. Spacecraft Systems Engineering
8. In-class systems engineering activity
HW assignment: summary of seminar
Reading assignment: Model based design and collaborative design environments

Wk 5: Model based design: Environments and Tools
9. Models and Issues in System Level Design and Trade Studies
10. Model Based Design Environments
   a. Team X/PDC/JPL Details
   b. Other Examples: NASA Goddard; Langley; Northrop, Boeing, Lockheed Martin; Automotive industry (General Motors)
HW assignment: Summary of seminar and reading assignments on ATSV/visualization
Reading assignment: Safety and accident modeling in complex systems

Wk 6: Model Based Design
11. Methods and tools
12. Model-based design session: Run I
   a. Visualization for Automated trade space analysis
   b. Interactive critique
HW assignment: Summary of design session (How would you improve this process?)
Reading assignment: System engineering

Wk 7: Decision Making in Design
13. Decision making under uncertainty
14. Design Session: Run 2
   a. Revisiting the design problem using decision support tools
   b. Interactive critique
HW assignment: Discussion of the before and after use of tools and results
Reading assignment: reliability and risk based design

Wk 8: Safety Considerations in Complex System Design
15. Safety and accident modeling for Complex System Design
   a. Safety engineering
   b. Accident modeling
HW assignment: Summary of seminar and reading assignment
Interim Research report and presentations due: literature findings & progress
Reading assignment: Integrated systems health management

Wk 9: Prognostics and Health Management Considerations in Complex System Design
16. Integrated systems health management
   a. History & Goal; functions and requirements
   b. ISHM primary solutions/successful examples in practice
HW assignment: Summary of seminar and reading assignment
In-class presentations: design projects
Final Design project reports

Wk 10: Summary and Research Presentations
17. Course summary
18. Final reports and in-class research project presentations
Final Research project presentations
Final Research Project reports due