SAE 542 Advanced Topics in Systems Engineering

Units: 3.0

Fall 2019 — Thursdays, 6:40 - 9:20 PM

Location: Olin Hall of Engineering, Room 114 (OHE-114)
Course URL - https://courses.uscden.net/d2l/login

Instructor: Dr. Phan Phan
Virtual Office: Discussion Board - https://courses.uscden.net/d2l/login
Office Hours: Virtually on demand and by appointment
Contact Info: PPhan@Usc.Edu

Guest Speaker: Mr. Kenneth Cureton
Office: RRB 227 Astro Conference Room
Office Hours: Wednesdays, 4:00 – 5:00 PM
Contact Info: Cureton@Usc.Edu

IT Help: DEN@Viterbi Technical Support Center.
Hours of Service:
M-TH: 8:00AM-10:00PM (PST),
F: 8:00am - 6:00pm (PST),
Saturday - Sunday: Closed.
Contact Info: dentsc@usc.edu or 213-740-9356.

Course Description

Probability theory in systems engineering: test design and performance, reliability and maintainability, quantitative decision models. Constraint theory to manage and de-conflict complex requirements. Complexity theory.

Learning Objectives

Upon successful completion of this course, a student should be able to demonstrate analytical skills in applying quantitative methodologies in critical consideration and performance of various systems engineering activities. Course topics are organized into the following modules:

a. Probability Theory and applications in system testing and performance evaluation, test design, assessment of test accuracy and fidelity.
b. Quantitative decision models and applications in risk management.
c. Constraint Theory as an enabling tools set to manage system requirements and modeling of complex systems.
d. Complexity Theory with applications to software-intensive and complex systems.

Prerequisites: SAE-541.

Co-Requisite: None.

Concurrent Enrollment: None.

Recommended Preparation: Calculus, linear algebra and multivariate probability.

Course Notes

- The course is delivered to students in a Distance Education Network (DEN) section via WebEx and is also available to on campus students for in-person attendance.
- Video of course lectures are delivered synchronously to students in the DEN section and archived on DEN's Desire2Learn (D2L) Web Portal for later viewing on demand by all students.
- Copies of lecture slides and other class information are posted on D2L Web Portal.
- Discussion Board is also available on D2L Web Portal to facilitate students' exchange of technical inquiries on course content.
- Administrative questions or requests of personal nature are to be addressed privately via one-on-one e-mail.

Technological Proficiency and Hardware/Software Required

Students must have access to (and be proficient in the use of) a web browser in order to access course materials, view lectures, submit assignments, and interact with the Instructor. For hardware/software required to access the course online:
https://viterbigrad.usc.edu/technical-support/technical-requirements/

For additional information specific to DEN's D2L course management system and the various learning tools offered by D2L:
https://viterbigrad.usc.edu/technical-support/course-management-system/

Required Readings and Supplementary Materials

- To be acquired by students (available at https://www.uscbookstore.com/textbooks):
  - Friedman, George J. & Phan Phan (2017). *Constraint Theory, Multidimensional Mathematical Model Management*, 2nd edition. New York, NY: Springer.
  - Blanchard, Benjamin S. & Wolter J. Fabrycky. *Systems Engineering and Analysis*. Upper Saddle River, NJ: Prentice-Hall. (Either 4th edition in 2006 or 5th edition in 2010 will suffice.)
- To be downloaded from D2L Web Portal by students:
  - Moffat, James. *Complexity Theory and Network Centric Warfare,* The DoD Command & Control Research Program (CCRP) publication (September 2003) ISBN 1-893723-11-9.

Description and Assessment of Assignments

- Readings and homework problems are assigned and graded weekly. Homework solutions will be subsequently posted on D2L and walked through in class to enable students' knowledge check.
- Course grade will be based on homeworks and two exams, which will consist of multiple questions to assess students' knowledge about the advanced systems engineering topics presented in class.
- Each exam will cover the lectures, homeworks and assigned readings prior to the exam. The exams are not cumulative.
- These will be open-book, take-home exams over a four-day period. The exams can be downloaded, completed and submitted to D2L Web Portal.
  - Students are not allowed to collaborate on the exams.
  - Students are not allowed to copy-and-paste from the readings, publications, any other Internet sources, or the course materials.
  - All exam answers must be an individual student's own work in his/her own words.
  - A student's exams will be checked via anti-plagiarism tools (e.g. turnitin.com) and the system will catch violators of these warnings!
  - The default punishment for unauthorized collaboration, cheating, and plagiarism on the exam is a grade of F for the course.
- Since most students complete this course via DEN, they are not graded explicitly on class participation. Nevertheless, class participation via WebEx and/or Discussion Board on D2L is highly encouraged as it can be a factor in determining the final course grade for borderline cases.

Grading Breakdown

- Homework Assignments - 10%
- Mid-term Exam - 45%
- Final Exam - 45%

Grading Scale

Course grades are determined by the distribution of percentage point totals for the class. "Natural groupings" will be used to assign letter grades. The highest scoring group will receive A, the second highest group will receive A-, the third highest group will receive B+, and so on. A gap must exist to create a grade boundary.

Assignment Rubrics

As assessed and graded in the mid-term and final exams, a student's answers must demonstrate that he/she:

1) understands the question;
2) understands the appropriate advanced systems engineering concepts covered in the class;
3) can apply those concepts to answer the question.

For questions that require computation, a student's answer must include both the result and the necessary steps to derive that result.

- A student must demonstrate (1) through (3) above.
- The computational steps used to obtain an answer are just as important as a correct answer!
- Partial credit will be awarded for demonstrated work and knowledge of key concepts presented in class.

Assignment Submission Policy

- All homeworks and exams are administered online via DEN's D2L Web Portal with respective due date and time specified in Course Schedule below.
- Homeworks and exams submitted past due, based on time stamp by D2L, will not be accepted.
- Each homework and exam must be submitted in a complete MS Word document with machine-readable text (also in any embedded diagrams, computations, tables, etc.).
  - Do not submit hand-written material and diagrams.
  - Do not submit documents in other formats, such as PDF, PowerPoint, Excel, etc.
  - However, formulas may be embedded via Equation Editor or MS Excel table or MS PowerPoint objects, etc. in the MS Word document.
  - Do not "embed as static picture" of diagrams, formulas, computations, tables, etc.
  - Do not submit partial answers across multiple documents

Grading Timeline

Grading and feedback will be typically provided in about a week after submission.

Additional Policies

- If a student has any questions regarding the exams (either before or during the exam period):
  - DO NOT call or e-mail questions!
  - The student must use the appropriate Exam Discussion Board on D2L to ask exam-related questions.
  - A student's questions and all answers will be visible to all students.
  - All students are responsible to periodically visit the discussion board.

Course Schedule: A Weekly Breakdown

The exact course schedule is subject to change. Dates of readings may change to align with other schedule adjustments. Changes will be announced. Since this is a 3-unit course, each student is expected to spend an average of six (6) hours outside of class per week, over a 15-week Fall or Spring semester (or equivalently a 10-week Summer term), on homework, readings, writing and other academic activities, per University's policy.

	Lecture Topics	Readings, homework & exams
Mtg #1 **29 Aug**	Course introduction and administration Review of set theory & probability theory Introduction to reliability and maintainability	HW set #1 and student biography assigned Read: Blanchard & Fabrycky (B&F) Appendix C.1 & Sections 13.1 thru 13.3
Mtg #2 **5 Sep**	Review HW set #1 answers Series, parallel & hybrid system architectures Imperfect testing and evaluation of test design	HW set #1 & students bio due @ 6:30PM, PDT HW set #2 assigned Read: B&F, Appendix C.2 & Chapter 6
Mtg #3 **12 Sep**	Review HW set #2 answers Discrete probability models Continuous probability models	HW set #2 due @ 6:30PM, PDT HW set #3 assigned Read: B&F, Sections 12.1 - 12.3
Mtg #4 **19 Sep**	Review HW set #3 answers Distribution models of failure rate & reliability Reliability of series & parallel systems Reliability assessment & life testing	HW set #3 due @ 6:30PM, PDT HW set #4 assigned Read: B&F, Sections 12.4 thru 12.6
Mtg #5 **26 Sep**	Review HW set #4 answers Interval Estimation of Reliability Decision-making models under risk & uncertainty	HW set #4 due @ 6:30PM, PDT HW set #5 assigned Read: B&F, Sections 7.1 thru 7.3 and 7.6
Mtg #6 **3 Oct**	Review HW set #5 answers Decisions with multiple objectives & trade off Intransitive Dice, Irrationality & Systems Engr	HW set #5 due @ 6:30PM, PDT HW set #6 assigned Read: B&F, Sections 7.4, 7.5 and 7.7
Mtg #7 **10 Oct**	Review HW set #6 answers Utility models and risk management Intransitive Dice, Irrationality & Utility Functions	HW set #6 due @ 6:30PM, PDT HW set #7 assigned Read: INCOSE Article by Dr. G. J. Friedman
No Mtg **17 Oct**	***Take-home mid-term exam covering lecture topics associated with homework sets 1 through 6***	***Open on Friday 18 Oct @ 6:00 AM, PDT*** ***Due on Monday 21 Oct @ 6:00 PM, PDT***
Mtg #8 **24 Oct**	Intro to graph theory and constraint theory Review solutions set to mid-term exam	Read: Constraint Theory (CT), Chapter 1 HW set #8 assigned
Mtg #9 **31 Oct**	Review HW sets #7 and #8 answers The Seven Bridges of Königsberg Constraint Theory: Motivations	HW sets #7 and #8 due @ 6:30PM, PDT HW set #9 assigned Read: CT, Chapters 2 & 3
Mtg #10 **7 Nov**	Review HW set #9 answers Constraint Theory: The 4-Fold Way Constraint Theory: General Results	HW set #9 due @ 6:30PM, PDT HW set #10 assigned Read: CT, Chapter 4
Mtg #11 **14 Nov**	Review HW set #10 answers Constraint Theory: Regular Relations Model Consistency & Computational Allowability	HW set #10 due @ 6:30PM, PDT HW set #11 assigned Read: CT, Chapter 5
Mtg #12 **21 Nov**	Analysis of Networked Systems (Guest Speaker – Professor Ken Cureton)	HW set #11 due @ 6:30PM, HW set #12 assigned Read: Complexity Theory, Chapters 1 and 2
No Mtg **28 Nov**	Thanksgiving Holiday	
Mtg #13 **5 Dec**	Review HW sets #11 and #12 answers Advances in Constraint Theory & Its Applications	HW sets #11 and #12 due @ 6:30PM, PDT Read: CT, Chapter 8
FINAL	***Take-Home Final Exam covering lecture topics associated with homework sets 7 through 12***	***Open on Friday 13 Dec @ 6:00 AM PST*** ***Due on Monday 16 Dec @ 6:00 PM PST***

Statement on Academic Conduct and Support Systems

Academic Conduct:

Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Part B, Section 11, "Behavior Violating University Standards" policy.usc.edu/scampus-part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, http://policy.usc.edu/scientific-misconduct.

Support Systems:

Student Counseling Services (SCS) – (213) 740-7711 – 24/7 on call
Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention. engemannshc.usc.edu/counseling

National Suicide Prevention Lifeline – 1 (800) 273-8255
Provides free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week. www.suicidepreventionlifeline.org

Relationship and Sexual Violence Prevention Services (RSVP) – (213) 740-4900 – 24/7 on call
Free and confidential therapy services, workshops, and training for situations related to gender-based harm. engemannshc.usc.edu/rsvp

Sexual Assault Resource Center
For more information about how to get help or help a survivor, rights, reporting options, and additional resources, visit the website: sarc.usc.edu

Office of Equity and Diversity (OED)/Title IX Compliance – (213) 740-5086
Works with faculty, staff, visitors, applicants, and students around issues of protected class. equity.usc.edu

Bias Assessment Response and Support
Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response. studentaffairs.usc.edu/bias-assessment-response-support

The Office of Disability Services and Programs
Provides certification for students with disabilities and helps arrange relevant accommodations. dsp.usc.edu

Student Support and Advocacy – (213) 821-4710
Assists students and families in resolving complex issues adversely affecting their success as a student EX: personal, financial, and academic. studentaffairs.usc.edu/ssa

Diversity at USC
Information on events, programs and training, the Diversity Task Force (including representatives for each school), chronology, participation, and various resources for students. diversity.usc.edu

USC Emergency Information
Provides safety and other updates, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible. emergency.usc.edu

USC Department of Public Safety – UPC: (213) 740-4321 – HSC: (323) 442-1000 – 24-hour emergency or to report a crime.
Provides overall safety to USC community. dps.usc.edu