

# USC Viterbi School of Engineering

## Systems Architecting & Engineering Program

### **SAE 560:**

### **Economic Considerations for Systems Engineering**

**Fall 2024—Mondays—6:40-9:20 PM**

**Location: Olin Hall of Engineering (OHE) 114 on campus  
and Virtual (DEN Webcasted Class)**

**Instructor: Mr. Kenneth L. Cureton**

**Office: Virtual – By Appointment**

**Office Hours: Virtual – By Appointment**

**Contact Info: cureton@usc.edu**

**Instructor: Dr. Edwin Ordoukhanian**

**Office: Virtual – By Appointment**

**Office Hours: Virtual – By Appointment**

**Contact Info: ordoukha@usc.edu**

### **Course Description**

The design and development of engineering systems is generally strongly influenced by economic considerations. This class provides system architects and engineers with tools for understanding such economic considerations, including fundamental quantitative analysis of cash flow, life-cost estimating for systems and software engineering, and affordability considerations.

### **Learning Objectives**

- To provide students with an understanding of the time value of money and interest rate concepts.
- To enhance the student's ability to evaluate series of cash flows in determining investment decisions.
- To provide the ability to create and understand parametric cost models.
- To understand practical aspects of justifying projects in an organization, especially in terms of affordability and cash flow.
- To identify and use heuristics related to cost aspects of systems architecting and engineering.
- To improve the students' ability to generate a professional-level research paper regarding economic analysis of a chosen topic, suitable for presentation at a systems engineering conference or publication in a professional journal.

## SAE 560: *Economic Considerations for Systems Engineering*

**Prerequisite(s):** None; however, SAE 549 *Systems Architecting* is recommended

**Co-Requisite (s):** None

**Concurrent Enrollment:** None

**Recommended Preparation:** None

### Course Notes

This class is available to on-campus students in a classroom, and to all students in real-time Distance Learning format via the USC Distance Education Network (DEN). All in-class course materials (lectures and lecture notes) are also available on-line via the USC Distance Education Network (DEN) for student access. All student work (homework, exams, and papers) is submitted and graded via the DEN.

### Technological Proficiency and Hardware/Software Required

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 instructors.

### Required Readings and Supplementary Materials

The following textbook is REQUIRED:

- *Contemporary Engineering Economics*, 6th Edition, Park, C.S., Pearson Higher Education, Inc., © 2016. Hardback (ISBN-13: 978-0134105598 / ISBN-10: 0134105591), Paperback (ISBN-10: 1292109092 / ISBN-13: 978-1292109091), or eTextbook (ISBN-13: 978-0134105598 / ISBN-10: 0134105591)

**Note: DO NOT obtain the International Version!**

This text is available in hardback format via the USC Bookstore, or in all formats via on-line sources such as Amazon ([www.amazon.com](http://www.amazon.com)) or AbeBooks ([www.abebooks.com](http://www.abebooks.com)).

The following materials are suggested for reference:

- Eberhardt Rechtin (1991). *Systems architecting: Creating and building complex systems*. Englewood Cliffs, NJ: Prentice Hall. ISBN: 0-13-880345-5.  
This text is out of print but is available in the USC Bookstore as the "Course Reader" for SAE 549.
- Mark Maier & Eberhardt Rechtin (2009). *The Art of Systems Architecting* (3rd ed.). Boca Raton, FL: CRC Press ISBN: 978-1-4200-7913-5
- Kate L. Turabian (April 2018). *A Manual for Writers of Research Papers, Theses, and Dissertations, Ninth Edition* by The University of Chicago Press, Hardback ISBN: 9780226494425, Paperback ISBN: 9780226430577

## SAE 560: *Economic Considerations for Systems Engineering*

### Grading Breakdown

Assignment	Points	% of Grade
Final Project / Research Paper	160	40.0%
Presentation of Paper	40	10.0%
Midterm Exam	160	40.0%
Homework #1	10	2.5%
Homework #2	10	2.5%
Homework #3	10	2.5%
Homework #4	10	2.5%
<b>TOTAL</b>	<b>400</b>	<b>100.0%</b>

### Assignment Submission Policy

Submit assignments on-line to the DEN system, according to the published course schedule (see below). All assignments (including late submissions) are due no later than the scheduled Final Exam date—no submissions will be accepted beyond that date.

### FINAL PROJECT / RESEARCH PAPER

GOAL: Your paper must be purposeful—it should have an academically acceptable goal, something more than just demonstrating that you can accomplish research and write a cogent Research Paper that summarizes that research, as those are necessary but not sufficient goals for academic purposes.

For this class, your purpose should include two additional goals that are above and beyond conducting research and writing Masters-level Research Papers:

- Your first goal is to demonstrate that you understand and can properly apply the concepts presented in the class through the accomplishment of structured economic analyses of an Engineering or Scientific technical topic.
- Your second goal is to inform the reader and “teach” your instructors regarding both the economic and technical details of your chosen topic.

Failure to achieve any of the above will impact your paper’s grade!

TOPIC: Describe an engineering or scientific program and analyze it in terms of the course concepts. Most of your analysis should be quantitative, supplemented by discussions using the economic consideration factors presented in this course.

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Subject to my approval, you get to choose the topic:

- It can be something that interests you, or something with which you have been personally involved. But be careful if using a program from a current employer—make sure that you have authorization to write on that topic!
- It can be an engineering program or a scientific program. Personal or social programs are discouraged unless they have significant engineering or scientific components.
- It can be ongoing, or it can be past history. New or future programs are discouraged unless they have substantial progress to-date or comparable experience with past systems.

**APPROVAL:** You must submit a one-page abstract regarding your proposed topic for approval. Please submit on-line via DEN Assignments no later than **October 14, 2024, Midnight Pacific Time.**

**FORMAT:** Microsoft WORD (.DOC or .DOCX) or Adobe Acrobat (.PDF) format for abstracts and research papers.

The class website provides guidelines on how to write a research paper, with suggestions for format, organization, structure, and content of good research papers.

**LENGTH:** Experience to date shows that the average is somewhere around 12-15 pages, single-spaced, in 10 or 12-point type. Papers are NOT graded by their weight! Take as long as it takes to present a well-organized analysis in terms of the course concepts. N.B. very few papers of size less than 10 pages have been worthy of a good grade in this class.

**SOURCES:** You must properly reference all sources. We use the turnitin.com service to look for matches with existing books, magazine and newspaper articles, journals, prior student papers, and all Internet sources. Published works (such as books, scholarly articles, and journal publications) are preferred. If you obtain information via interviews, then a list of sources and contacts is essential, listing what sources you used and anyone you interviewed. Be sure to provide the URLs of any Internet sources used in your research. If you directly quote text from a source, you must properly designate quoted material “in quotation marks” or in italics and give a citation for each quotation via a footnote or a numbered reference or in-text (author-date) notation. The amount of quoted text relative to the total text in your paper should be kept to a minimum—if excessive; this will detract from your paper’s grade.

**WARNING:** Failure to properly designate copy-and-pasted text will be considered as a violation of academic integrity (see University Policy Statements at the end of this syllabus). This includes quotations from your prior papers (e.g., from SAE 549 or other classes)! You can build on your own work from other classes, and from other author’s works, as long as you properly cite those references. You must not directly copy text from those sources—even *your own*—unless properly marked and cited as a quotation.

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Instead, you must add value by citing then restating such work in your own words plus your own enhancements, such that the combination has enhanced relevance to this class. You can directly copy graphics, tables, or figures if you give a citation for each copied item. Although there is no limitation on the relative number of copied items, your own artwork—however crude yet clearly legible and illustrative—is always acceptable.

**LIMITS:** We cannot accept a request to limit access to your abstract or research papers. Although we do not plan to disseminate your work without your permission, we cannot guarantee that other people (including non-US citizens) will not view or handle your submitted materials. Thus, you must not use classified, proprietary or company limited-distribution materials in your coursework. If your employer requires review and approval for your submitted materials (e.g., Public Affairs Office or Export Compliance Review) then you must obtain such approval within the deadlines listed in this syllabus. As the approval practices in many companies may be time consuming, the best practice is not to use company material at all.

**DELIVERY:** Please submit on-line via DEN Assignments no later than the scheduled final exam date (**December 16, 2024, Midnight Pacific Time**).

**GRADING:** Your research paper will be graded on the letter scale: A, A-, B+, B, B-, etc. Collaboration or plagiarism in the term paper is forbidden. Violators will receive an automatic grade of zero for the final paper.

N.B. very few papers are worthy of an “A” grade in this class unless they are of suitable quality for presentation at a Systems Engineering conference or inclusion in a Systems Engineering journal or other publication. Also, if English grammar, spelling and syntax are not your strong points, then we strongly suggest that you obtain help in editing your text. Your grade depends on the clarity of presentation.

We must turn in the class grades shortly after the end of the Semester (after Final Exams Week), so we'll inform you via e-mail regarding your research paper grade (as well as your overall grade) no later than two weeks after the paper is due.

### **HOMEWORK**

Each of the four homework assignments will consist of economic analyses that require students to apply that week's learning to answer the assigned homework questions. The homework will be assigned at the end of Lectures #1, #2, #3, and #4 and will be due before start of class the following lecture (typically the next week or week after a holiday). Answers to all homework assignments will be posted on-line for student review in preparation for the Midterm Exam.

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FORMAT: Microsoft WORD (.DOC or .DOCX) or Adobe Acrobat (.PDF) format. If a question requires computation via a spreadsheet program or scientific/business calculator, then the specific computational methodology must be included in the document. Specific details will be provided in the first class lecture.

DELIVERY: Please submit on-line via DEN Assignments no later than the designated due date—BEFORE class. All late homework is due no later than the scheduled Final Exam date—all missing assignments will receive a score of zero.

GRADING: Each homework submission will be graded on a scale of zero-to-10, based on both accuracy of answers and computational methodology. We'll grade and comment on your homework as soon as possible after the appropriate due date. Late submissions will receive a maximum of half-credit after the due date/time.

Collaboration on the homework assignments is forbidden. Violators will receive an automatic score of zero for that assignment.

### **STUDENT PRESENTATIONS**

Each student must accomplish an individual presentation of their Research Paper findings. These presentations will be pre-recorded by each student and will be posted on the DEN. Questions by the class Instructors and students will be presented and answered for each presentation on DEN discussion boards rather than on-line.

GRADING: Your presentation is scored on a scale of 0-to-40, based on the quality of your recorded presentation. If you do not generate and post a presentation, you will receive a grade of zero for this assignment.

DELIVERY: Please submit on-line via DEN Assignments no later than the final class lecture #13 (**December 2, 2024, Midnight Pacific Time**).

### **MIDTERM EXAM**

The Midterm Exam will cover lecture topics associated the four homework sets and Lectures 1 through 8. The exam will be an individual effort, take-home exam with open book and notes. The exam will be downloadable from the DEN starting **on Monday October 21<sup>st</sup> 2024** at 9:20 PM Pacific Time. Responses must be submitted to the DEN before the following class session, i.e., Monday **October 28<sup>th</sup> 2024** at 6:40 PM Pacific Time.

FORMAT: Microsoft WORD (.DOC or .DOCX) or Adobe Acrobat (.PDF) format. If a question requires computation via a spreadsheet program or scientific/business

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calculator, then the specific computational methodology must be included in the document. Specific details will be provided with the Midterm Exam questions.

DELIVERY: Please submit on-line via DEN Assignments BEFORE the designated due date and time. If you make multiple submissions, only the last submission will be considered.

GRADING: The Midterm will be graded on a scale of zero-to-140. We'll grade and comment on Midterm Exams as soon as possible after the appropriate due date. All late or missing submissions will receive a score of zero. Collaboration on the Midterm is forbidden. Violators will receive an automatic score of zero.

### **FINAL GRADE**

GRADING: Your class grade is computed as follows:

First, your project/research paper letter grade is converted into a numerical score according to USC Grading Standards: 4.0 for A, 3.7 for A-, 3.3 for B+, 3.0 for B, 2.7 for B-, 2.3 for C+, 2.0 for C, 1.7 for C-, 1.5 for D+, 1.0 for D, 0.7 for D-, 0.0 for F. This score is then multiplied by forty to achieve a point range of 160-to-0.

Your midterm score is added to the above (0 to 160 points total). The total of all homework scores is added to the above. Note that the score for any one of the four homework assignments may range from 0 to 10 points. The score for your presentation of your research paper is added to the above (0 to 40 points total).

The grand total of points is divided by 100 (to scale your total to a range of four-to-zero):  
CLASS SCORE = (PROJECT/PAPER + MIDTERM + HOMEWORK + PRESENTATION) / 100

This class score is converted into a letter grade for the class:

A	4.0 to above 3.7
A-	3.7 to above 3.3
B+	3.3 to above 3.0
B	3.0 to above 2.7
B-	2.7 to above 2.3
C+	2.3 to above 2.0
C	2.0 to above 1.7
C-	1.7 to above 1.5
D+	1.5 to above 1.0
D	1.0 to above 0.7
D-	0.7 to above 0.5
F	0.5 or below.

This letter grade is reported to USC as your class grade.

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### Course Schedule: A Weekly Breakdown

	Topics/Activities	Readings	Deliverable/ Due Dates
Lecture 1 Aug 26	Syllabus, Introduction to the Course: Time value of money <i>Homework #1 assigned</i>	PARK chapters 1-2 for background, emphasis on chapters 3 & 4 up through 4.1.3, 4.2-4.6 for info.	None
Sep 2	Labor Day Holiday (no class meeting)	None	None
Lecture 2 Sep 9	Present and Annual Worth Analysis <i>Homework #2 assigned</i>	PARK chapters 5-6	<i>Personal Introduction, Homework #1 due before class</i>
Lecture 3 Sep 16	Rate of Return Analysis <i>Homework #3 assigned</i>	PARK chapter 7 Posted readings	<i>Homework #2 due before class</i>
Lecture 4 Sep 23	Decision Evaluation Theory and Analytical Methods <i>Homework #4 assigned</i>	Posted readings	<i>Homework #3 due before class</i>
Lecture 5 Sep 30	Intro to Cost Estimation and Parametric Models	Posted readings	<i>Homework #4 due before class</i>
Lecture 6 Oct 7	Software Cost Estimation	Posted readings	None
Lecture 7 Oct 14	Systems Engineering Cost Estimation & Simulation in Cost Analysis	Posted readings	<i>Abstract for Research Paper</i>
Lecture 8 Oct 21	Cost Risk Identification and Analysis	Posted readings	None
<i>Oct 21-28</i>	<i>Midterm Exam</i>	None	None
Lecture 9 Oct 28	Case Study: System Cost Evaluation of Civilian V-22 Alternatives	Posted readings	<i>Take-home Exam due by Oct 28 before start of class</i>
Lecture 10 Nov 4	Cost as an Independent Variable (CAIV)	Posted readings	None
Lecture 11 Nov 11	Concurrent Engineering Methods and Costing Practices	Posted readings	None
Lecture 12 Nov 18	Special Topic (TBD)	Posted readings	None
Nov 25	Thanksgiving Holiday (no class meeting)	None	None
Lecture 13 Dec 2	Special Topic (TBD)	Posted readings	<i>Student Presentation Due</i>
Dec 9	Study Day (no class meeting)	None	None
FINAL Dec 16	None—no lecture	None	<i>Research Paper Due All Late Homework Due</i>

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## 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](http://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, [policy.usc.edu/scientific-misconduct](http://policy.usc.edu/scientific-misconduct).

### Support Systems:

*Counseling and Mental Health - (213) 740-9355 – 24/7 on call*  
[studenthealth.usc.edu/counseling](http://studenthealth.usc.edu/counseling)

Free and confidential mental health treatment for students, including short-term psychotherapy, group counseling, stress fitness workshops, and crisis intervention.

*National Suicide Prevention Lifeline - 1 (800) 273-8255 – 24/7 on call*  
[suicidepreventionlifeline.org](http://suicidepreventionlifeline.org)

Free and confidential emotional support to people in suicidal crisis or emotional distress 24 hours a day, 7 days a week.

*Relationship and Sexual Violence Prevention Services (RSVP) - (213) 740-9355(WELL), press “0” after hours – 24/7 on call*  
[studenthealth.usc.edu/sexual-assault](http://studenthealth.usc.edu/sexual-assault)

Free and confidential therapy services, workshops, and training for situations related to gender-based harm.

*Office of Equity and Diversity (OED) - (213) 740-5086 | Title IX – (213) 821-8298*  
[equity.usc.edu](http://equity.usc.edu), [titleix.usc.edu](http://titleix.usc.edu)

Information about how to get help or help someone affected by harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants.

*Reporting Incidents of Bias or Harassment - (213) 740-5086 or (213) 821-8298*  
[usc-advocate.symplcity.com/care\\_report](http://usc-advocate.symplcity.com/care_report)

Avenue to report incidents of bias, hate crimes, and microaggressions to the Office of Equity and Diversity | Title IX for appropriate investigation, supportive measures, and response.

*The Office of Disability Services and Programs - (213) 740-0776*  
[dsp.usc.edu](http://dsp.usc.edu)

Support and accommodations for students with disabilities. Services include assistance in providing readers/notetakers/interpreters, special accommodations for test taking needs, assistance with architectural barriers, assistive technology, and support for individual needs.

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*USC Campus Support and Intervention - (213) 821-4710*

[campussupport.usc.edu](http://campussupport.usc.edu)

Assists students and families in resolving complex personal, financial, and academic issues adversely affecting their success as a student.

*Diversity at USC - (213) 740-2101*

[diversity.usc.edu](http://diversity.usc.edu)

Information on events, programs and training, the Provost's Diversity and Inclusion Council, Diversity Liaisons for each academic school, chronology, participation, and various resources for students.

*USC Emergency - UPC: (213) 740-4321, HSC: (323) 442-1000 – 24/7 on call*

[dps.usc.edu](http://dps.usc.edu), [emergency.usc.edu](http://emergency.usc.edu)

Emergency assistance and avenue to report a crime. Latest updates regarding safety, including ways in which instruction will be continued if an officially declared emergency makes travel to campus infeasible.

*USC Department of Public Safety - UPC: (213) 740-6000, HSC: (323) 442-120 – 24/7 on call*

[dps.usc.edu](http://dps.usc.edu)

Non-emergency assistance or information.