

UNIVERSITY OF SOUTHERN CALIFORNIA
AME 408, Computer-Aided Design of Mechanical Systems
Spring 2023

Time and Location: T 6:30 PM to 9:10 PM SAL 127 (Section 1, 28758)
Th 6:30 PM to 9:10 PM SAL 127 (Section 1, 28759)

Instructor: Babak Boloury
bboloury@hotmail.com

Office Hours: Before and after class on TTh, by appointment only (email me for an appointment)

These are times I will be available to talk with you, answer your questions, direct you to additional resources, etc.

Web site: <https://blackboard.usc.edu/>

TA:

- For TA's name and office hours, please see blackboard.

Textbook: There is no official textbook for the course. Handouts will be distributed on Blackboard as necessary. An official textbook may be announced later.

Reference and Supplemental books:

SolidWorks:

<u>Title</u>	<u>Author</u>	<u>ISBN</u>
1. Beginner's Guide to SolidWorks 2021 - Level I	Reyes	978-1-63057-386-7
2. Beginner's Guide to SolidWorks 2021 Level II	Reyes	978-1-63057-389-8
3. SolidWorks 2021 Part 1 – Basic Tools	Tran	978-1-63057-415-4
4. SolidWorks 2021 Part 2 – Advanced Techniques	Tran	978-1-63057-425-3
5. Parametric Modeling with SolidWorks 2021*	Schilling & Shih	978-1-63057-404-8
6. SolidWorks 2021 Tutorial*	Plancharde	978-1-63057-409-3
7. Engineering Design with SolidWorks 2021*	Plancharde	978-1-63057-400-0
8. Assembly Modeling with SolidWorks 2012*	Plancharde	978-1-58503-708-7

SolidWorks Simulation:

<u>Title</u>	<u>Author</u>	<u>ISBN</u>
1. Engineering Analysis with SolidWorks Simulation 2021	Kurowski	978-1-63057-383-6
2. Introduction to FEA Using SolidWorks Simulation 2021	Shih	978-1-63057-387-4

All reference books are from SDC Publications (www.schroff.com)

Class Format:

- The class is a combination of lab and lecture. Usually for 1 hour and 15 minutes to 2 hours there will be a lecture, and the rest of the time is devoted to lab work.
- The class is generally conducted face-to-face and in person (this means we will all meet for the class together in the classroom). Online zoom lectures will *not* be available. Also, video recording of the lectures may be posted provided 3/4 or more of the students show up to the lectures. If less than 3/4 show up, the recording will *not* be available.
- If video recordings of the lectures are provided, please do not screen-capture and share the recordings outside of our class (it's creepy and the university claims the work is copyrighted!).
- Handouts, tutorials, exercises and notes are provided on Blackboard. These are copyrighted materials. Therefore, please do not distribute or post them anywhere outside of the class and do not share them with anyone else.
- If you need to miss a lecture session, you will be responsible for the material and the activities discussed during the lecture.
- I welcome interruptions during class sessions for questions or comments, and I encourage you to feel free to interrupt me if you have a question during lecture.
- I will do my best to make this course an excellent learning experience for you, well-organized, interesting, relevant, with meaningful assignments and the support you need to succeed. I will take suggestions for improving the learning environment seriously.
- If you don't understand why we're doing something, please ask!

Goals:

To develop student's understanding of the design of mechanical systems using advanced graphics techniques; design optimization, solids modeling and FEA methods. The course will develop the ability to effectively utilize commercial CAE software as a tool for better productivity in design. This semester SolidWorks and SolidWorks Simulation (CosmosWorks) packages will be used.

- *Everyone can, and should succeed* (meaning learn and demonstrate what you have learned) *in this course!* I am here to be your learning partner in this course. If you are having difficulties with any of the topics in this course, please contact me!

Prerequisites:

AME 308, Statics, Strength of Materials, Stress Analysis, Heat Transfer, Dynamics and Vibrations, Matrix Algebra, Senior Standing

Technical Requirements:

Hardware:

- PC/Mac to run SolidWorks online through Vmware
- PC running windows 10 – 64 bit only if you wish to install and run SolidWorks locally on your computer through the SEK (discussed on Blackboard).
- Microphone, Speakers
- Internet Connection
- Scanner/Digital Camera/Phone Camera

Software:

- Internet Browser
(https://help.blackboard.com/Learn/Student/Getting_Started/Browser_Support)
- Adobe Acrobat Reader ((<https://get.adobe.com/reader/>))
- Microsoft Office may be helpful

- Any software to create multi-page PDF files. One such program is MS Word.
- SolidWorks 2022-2023 version accessed through Vmware or installed locally.

Grading and Policies:

Labs:	22%
Projects:	28%
Exams #1	0%
Exams #2	30%
Final Project:	20%

Labs and Projects:

- Every week, labs will be assigned. However, not all problems will be graded. Only a handful of them will be graded randomly throughout the semester. You are required to turn in all lab problems. I will not announce in advance which problems will be graded.
- All labs are due the following week, at or before the start of the class.
- Late lab reports will not be accepted under any circumstances.
- There are 7 or 8 projects.
- Projects are usually due anywhere from one week to two weeks after they are assigned depending on the complexity of the project. The due dates will be on the project.
- Late projects lose 25% of their values per day (or fraction of) that are late.
- If you work on the labs or projects during the lecture, you will receive zero for that assignment.
- You are encouraged to form study groups.
- Helping one another does not mean nor extend to copying someone else's work or allowing someone else to copy your work.

Exams:

- There are 2 midterm exams.
- Both exams will **not** be during regular class meetings.
- The exams are tentatively scheduled for:
Exam I: 8th week of instructions (Wednesday, March 1, 2023, 7:30-9:50 AM);
Exam II: 12th week of instructions (Wednesday, April 5, 2023, 7:30-9:50 AM)
- The two exams are closed note and consist of modeling and analysis problems.
- For the first exam, you are required to draw parts and assemblies parametrically and correctly with all design intents being met. This exam is modeled after the SolidWorks certification exam. When the dimensions of the object change, the object should adjust accordingly and build without any errors. The problems will ask for the physical properties of the object, such as weight, moment of inertia, centroid, etc. The questions do not carry any partial credit.
- The second exam is usually made up of finite element analysis questions. You will be asked to mesh the part or assembly correctly with a proper type of element. Then, find the stress, displacement, temperature, frequency, etc. There are also some conceptual (theoretical) questions. This exam usually has partial credit.

- Both exams are done through Blackboard as scheduled above. The exams will be available in Blackboard at the start of class (on the indicated dates and times).
- For exam I, you need to submit on Blackboard your SolidWorks part and assembly files.
- For Exam II, all questions will be answered on paper, like a traditional exam. In addition, you need to submit on Blackboard your SolidWorks part and assembly files. The exam will be in-person.
- The work you submit on exams must be your own. During the exam, you may not collaborate with others in any way or use any resources not allowed.
- Make-up exams will not be given under any circumstances.

Final Project:

- The final project is a group project.
- You will be asked to design a part with certain restrictions, such as size, stress, displacement, etc.

Contesting of Grades:

- Contesting of grading of all materials (exams, projects and labs) must be done within one week after the graded material is returned.
- Upon regrading, there is no guarantee that your grade will be raised, but it will not be lowered.
- After 7 days, the material in question will not be regraded.

Response Time and Feedback:

- I respond to emails as quickly as possible (usually within 24 hours, but most of the times by the end of the “day”). I do not respond to emails after about 7:00 pm, but will respond the next day; if you tend to work near the deadlines, I may not be available. On weekends, I generally reply to emails, but they may take a bit longer than usual.
- Most assignments and exams are graded within a few days (up to one week maximum) after they are turned in on Blackboard.

Participation, Make-Up, and Late Work:

- Treat this class as a serious professional obligation. In short, if you would not miss your job or turn in a late job project for some reason, try not to miss class meetings or hand in late work for that reason..
- All of us in the class, you, me, your peers, have a responsibility to create an environment in which we can all learn from each other. I expect everyone to participate in class so we can all benefit from the insights and experiences that each person brings..
- Even though class participation is not part of your grade, you are encouraged to participate in the class and attend the lectures regularly.
- Before asking for help, please be sure to have read the posted reading assignments.
- If you miss something for a non-serious reason, take responsibility for getting the material you missed, and do not request make-up work or to hand in late work. As it mentions above, I do not give make-up exams, accept late labs and there is a penalty for late project submission. Course materials and activities will be easily available on Blackboard. You are always welcome to set up an appointment to discuss things you don't understand after your efforts to catch up.

- If there is a serious situation, please let me know as soon as possible. Serious situations include things like pre-arranged, official USC-related activities, pre-arranged professional activities, pre-arranged major family obligations, religious obligations, emergencies, or severe illness. For serious situations that are foreseen, like pre-arranged activities, we'll try to make alternative arrangements. For serious unforeseen situations like illnesses or emergencies, plan to provide documentation. Make-ups and late work accommodations for serious unforeseen situations will be case-by-case, with no guarantees.
- Please let me know if circumstances arise which make it difficult for you to fulfill your class obligations. Although the course requirements must be met, I will make every effort to work with you within university policy guidelines, just as I would do for a person who worked for me.
- I do not answer any homework, lab or project questions via email. So, please do not ask.

Other Issues:

Be respectful to your classmates and the instructor. Students are expected to be on time for class and to remain once class starts. Cell phones, laptops, and tablets should be turned off during class, unless they are used for the purpose of the class. The class hours are dedicated to AME 408 only. Therefore, during class and lab, you are not supposed to surf the web, play games on the web nor do homework for other classes. If you are caught doing so, you will be asked to leave the class. Also, during lecture, you are not supposed to be working on projects or lab assignments.

Regular class attendance is obviously recommended.

Course Outline:

1. Introduction
2. Introduction to CAD (Solid Modeling) and FEA
3. Part and assembly modeling using SolidWorks
4. Basic concepts of engineering analysis
5. Linear Static Analysis
6. Adaptive Analysis and Mesh Control
7. Dynamic Analysis
8. Linear Buckling Analysis
9. Thermal Analysis
10. Design Optimization

Statement for Students with Disabilities

Any student requesting academic accommodations based on a disability is required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP. Please be sure the letter is delivered to me (or to TA) as early in the semester as possible. DSP is located in STU 301 and is open 8:30 a.m.–5:00 p.m., Monday through Friday. Website and contact information for DSP: http://sait.usc.edu/academicsupport/centerprograms/dsp/home_index.html, (213) 740-0776 (Phone), (213) 814-4618 (Video Phone), (213) 740-6948 (TDD only), (213) 740-8216 (FAX), ability@usc.edu.

Statement on Academic Integrity

Cheating of any kind, no matter how small, will not be tolerated in this class and academic integrity will be enforced to the highest possible level. USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. SCampus, the Student Guidebook, (<http://scampus.usc.edu>) contains the University Student Conduct Code (see University Governance, Section 11.00), while the recommended sanctions are located in Appendix A (http://scampus.usc.edu/files/2015/03/appendix_a.pdf). Should there be any suspicion of academic dishonesty, no matter how small or remote, an automatic grade of F will be given for the given assignment or exam and students will be referred to the Office of Student Judicial Affairs and Community Standards for further review. The more information please visit: <https://sjacs.usc.edu/>

Emergency Preparedness/Course Continuity in a Crisis

In case of a declared emergency if travel to campus is not feasible, USC executive leadership will announce an electronic way for instructors to teach students in their residence halls or homes using a combination of Blackboard, teleconferencing, and other technologies (<https://emergency.usc.edu>).

University Student 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 (<https://studenthealth.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 (<https://studenthealth.usc.edu/sexual-assault/>).
- *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: <https://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 (<https://equity.usc.edu>).
Provides Information about how to get help or help a survivor of harassment or discrimination, rights of protected classes, reporting options, and additional resources for students, faculty, staff, visitors, and applicants. The university prohibits discrimination or harassment based on the following protected characteristics: race, color, national origin, ancestry, religion, sex, gender, gender identity, gender expression, sexual orientation, age, physical disability, medical condition, mental disability, marital status, pregnancy, veteran status, genetic information, and any other characteristic which may be specified in applicable laws and governmental regulations.
- *Bias Assessment Response and Support*
Incidents of bias, hate crimes and microaggressions need to be reported allowing for appropriate investigation and response (<https://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 (<https://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 (<https://campussupport.usc.edu/>).
- *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 (<https://diversity.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 (<https://dps.usc.edu>).
- *Office of the Ombuds - (213) 821-9556 (UPC) / (323-442-0382 (HSC)*
A safe and confidential place to share your USC-related issues with a University Ombuds who will work with you to explore options or paths to manage your concern (<https://ombuds.usc.edu>).

And again, please let me know if you need help. This is a big campus with a lot of stuff available, and every faculty and staff member wants to see you succeed, especially in a time where things are really difficult and uncertain.

Student Rights and Responsibilities:

All members of the university faculty and staff have a primary mission of helping students to make progress toward a degree or credential. Nevertheless, each student is individually responsible for meeting all university requirements and deadlines, as presented in the current USC University Catalog and any other announcements of the university, center or department in which he/she is enrolled.

The University intends that every member of the campus community be afforded a work and study environment free of discrimination based on race, color, religion, national origin, sex, sexual preference, marital status, pregnancy, age, disability or veteran status. All persons are to be protected from abusive or harassing behavior.

Information regarding student rights and responsibilities and grievance procedures can be found at <https://equity.usc.edu> (*Office of Equity and Diversity (OED)/Title IX Compliance*).

<u>Week</u>	<u>Topics</u>	<u>Labs</u>	<u>Assignments</u>
1	1- Introduction 2- Check Computers and SW 3- Options in SW 4- SW basic 5- Sketches, cursor feedback 6- Dimension 7- Extrude, Cut	1- SW Tutorial: Lesson 1, 3 2- SW Tutorial: Advance drawing 3- Set 1-2: Exercises 1, 2, 5, 8, 10 Tag Name: Lab1	1- Read Chapters 1, 2
2	1- Constant radius fillet 2- Multi-Contour sketches 3- Arc, Tangent Arc 4- Trim 5- Offset & Convert Entities 6- Mirror in a sketch 7- Copy & paste features 8- Link Values 9- Draft while Extruding 10- Drawing	1- Set 3-4: Exercises 3, 4, 5 (use multi-contours), 5 (do not use multi-contours), 6, 7, 9 , 11, 12 , 13, 14 , 15, 16, 17 , 19, 20 , 21a, 21b Tag Name: Lab2	1- Project 1 - Assigned 2- Read Chapters 3, 4
3	1- HandWheel example (Ch 5) 2- 3 Point Arc 3- Diameter Dimension 4- Plane at end of Curve 5- Sweep 6- Circular Pattern 7- Section Properties 8- Roll Back & Re-order of Features 9- Revolve Feature 10- Chamfer Feature 11- Density and Mass Properties 12- Equations 13- Go over Idler Arm (Guide, Ex. 20) 14- SW98 Plus Demo 15- Dynamic Mirror 16- Linear Pattern 17- Variable Fillet	1- Set 5: Exercises 22, 23, 24, 25, 26, 27 , 28a, 29a-e 2- Appendix 1 , Appendix 3 Tag Name: Lab3	1- Project 2 - Assigned 2- Read Chapter 5 3- Read SW Tutorial: Revolves & Sweeps

<u>Week</u>	<u>Topics</u>	<u>Labs</u>	<u>Assignments</u>
4	1- Draft Feature 2- Shell 3- Planes 4- Rib 5- Mirror Feature 6- Text 7- Re-order of Features 8- Multi-Thickness Shell 9- Hole Wizard 10- Configurations 11- Design Table	1- Set 6: Exercises 28b , 30a, 30b, 32a , 32b, 33, 34 , 35, 36 , 37a 2- Set 7: Exercises 38, 39 , 40 , 41 Tag Name: Lab4	1- Read Chapters 6, 7 2- Read SW Tutorial: Pattern Features 3- Try Set 6: Exercises 31, 32c, 37b
5	1- Loft Feature 2- Split Entity 3- Loft with Guide Curves 4- Curve through XYZ 5- Ellipse 6- Sweeps with Guide Curves 7- Project Curves onto a Face	1- SW Tutorial: Loft 2- Set 9: Exercises 51 , 52, 53 3- Appendix 2 4- Set 8a: Exercises 42, 44 , 45, 46, 47 Tag Name: Lab5	1- Project 3 - Assigned 2- Read Chapters 9, 8a 3- Try Set 8a: Exercise 43
6	1- 3D Curves 2- Basic Assemblies 3- Bottom-Up Assemblies 4- Collision Detection 5- Basic Exploded View	1- Set 8b: Exercises 48 , 49, 50 2- SW Tutorial: 3D Sketching 3- SW Tutorial 3D Sketching with Planes 4- Set 10: Exercises 54 , 55, 57 , 58 Tag Name: Lab6	1- Project 4 - Assigned 2- Read Chapters 8b, 10a, 10b 3- Try Set 10: Exercise 56
7	1- Advanced Assemblies 2- Top-Down Assemblies 3- Creating parts in the context of an assembly 4- Assembly Features 5- Work on Project 4	1- Set 11: Exercises 59, 60 , 61, 62, 63 2- SW Tutorial: Advanced Design Tag Name: Lab7	1- Read Chapter 11
8	1- Exam # 1 2- Introduction to FEA 3- Brief overview of CW interface	1- CW Tutorial: Static Analysis of a part (only if rusty on CW)	1- Read Introduction to FEA (Theory)

<u>Week</u>	<u>Topics</u>	<u>Labs</u>	<u>Assignments</u>
9	1- More on CW Interface 2- Creating More Than 1 Study 3- Local & Global Mesh Controls 4- Convergence Plots 5- Split Face 6- Loads and BC in Local Directions 7- Probe Command 8- Iso & Section Plots 9- Cosmos File Structure	1- Set 1: Exercises 1, 2, 3, 8a, 8b, 8c Tag Name: Lab9	1- Project 5 - Assigned 2- Read Linear Static Analysis Properties (Theory) 3- Read Failure Criteria (Theory) 4- Read Chapters 1, 2, 3
No Class - Spring Break			
10	1- FEA Modeling Strategies 2- Shell Meshing 3- Symmetry 4- Linear vs. Quadratic Elements 5- Helix 6- Prescribed Displacement 7- Soft Spring	1- CW Tutorial: Static Analysis of a Sheet Metal Part 2- CW Tutorial: Static Analysis of an Assembly 3- Set 1: Exercise 5, 6, 10 4- Set 2: Exercises 5, 6, 7, 4, 10, 3 5- Set 2: Exercises 1, 2, 8, 9 (See if you know how to do these) Tag Name: Lab10	1- Project 6 - Assigned 2- Read FEA Modeling Strategies (Theory) 3- Read Chapters 4, 5A, 5B, 6 4- CW Tutorial: Symmetry Restraints 5- CW Tutorial: Mixing Solids and Shells
11	1- Structural Members 2- Beam Meshing	1- Set 2: Exercises 11, 12, 13, 14 2- SW Tutorial: Weldments 3- CW Tutorial: Beam Diagrams 4- CW Tutorial: Truss Structure 5- CW Tutorial: Creating Surfaces from Solid Geometry 6- CW Tutorial: Converting a Thin Solid Body into Sheet Metal and Surface Body Tag Name: Lab11	1- Final Project - Assigned 2- CW Tutorial: Bearing Loads 3- CW Tutorial: Non-Uniform Pressure 4- CW Tutorial: Spot Weld Connectors
12	1- Exam #2 2- Frequency and Buckling Analyses	1- CW Tutorial: Frequency Analysis 2- Set 3: Exercises 1, 2, 3, 9, 11, 14, 15, 16, 17 Tag Name: Lab12	1- Project 7 - Assigned 2- Read Frequency Analysis (Theory) 3- Read Linear Buckling Analysis (Theory) 4- Read Chapters 7, 8

<u>Week</u>	<u>Topics</u>	<u>Labs</u>	<u>Assignments</u>
13	1- Thermal Analysis 2- Transient & Steady State 3- Thermal Stress Analysis	1- CW Tutorial: Thermal Analysis 2- CW Tutorial: Thermal Stress Analysis 3- CW Tutorial: Transient Thermal Stress Analysis 4- Work on the final project Tag Name: Lab13	1- Project 8 - Assigned 2- Read Heat Transfer Analysis (Theory) 3- Read Chapter 9
14	1- Shape Optimization 2- Work on Final Project	1- Set 4: Exercises 1, 2, 3 2- CW Tutorial: Shape Optimization Tag Name: Lab14	1- CW Tutorial: Parameters and Design Scenarios 2- CW Tutorial: Advanced Design Scenarios
15			1- CW Tutorial: Thermostat 2- Look at Set 4: Exercise 7