Course Syllabus

Aerospace Senior Projects (ASEN 4018 & 4028)
Fall 2022 and Spring 2023

1 Document Scope

This document is the Syllabus for the two-semester Aerospace Engineering Sciences (AES) Department Senior Projects sequence. This sequence includes *ASEN 4018 Senior Projects I: Design Synthesis* (4 credits) and *ASEN 4028 Senior Projects II: Design Practicum* (4 credits). The sections below provide basic course information and define how projects are formulated and how grades are determined.

2 Aerospace Engineering Program

The Senior Project course provides a capstone experience, integrating disciplinary knowledges from previous courses to conduct a realistic engineering design/build/test project to satisfy a well-defined customer need. The course teaches systems engineering and project management methods by first-hand experience carrying out a non-trivial project with challenging performance objectives under firm time and budget limitations.
The Senior Project course also plays a key role in the evaluation of the AES curriculum and provides a method for direct student knowledge and abilities assessment that is used to continuously monitor and improve the entire AES curriculum, and to provide accreditation information as required by ABET (http://www.abet.org/). Overall program objectives and the specific objectives of the Senior Design course are outlined below. More details can be found in the AES department webpage http://www.colorado.edu/aerospace.

2.1 AES Program Educational Objectives

During their first few years after graduation, Aerospace Engineering Sciences graduates will have:

- *Established themselves in professional careers or received a graduate degree;*
- *Demonstrated ethical leadership, project management, and/or innovation; and*
- *Played significant roles in the research and development of engineering systems and products.*

2.2 Desired Outcomes

To meet the AES desired outcomes it is expected that students completing the undergraduate degree in Aerospace Engineering will be knowledgeable in the following areas and possess the stated skills:

K1 - The professional context of the practice of aerospace engineering and expectations of new graduates in aerospace engineering organizations, including an awareness of ethics issues, economics, and the business environment;
K2 - The history of aerospace engineering, providing a perspective on current events;
K3 - Aerospace engineering as a highly multidisciplinary endeavor, requiring a systems perspective to integrate technologies and manage complexity; and

K4 - Major principles and scientific methods underlying the technologies comprising aerospace vehicles and systems.

In addition, students will have developed the following general skills and abilities:
A1 - Written, oral, and graphical communication skills;
A2 - An ability to quantitatively estimate, model, analyze, and compute;
A3 - An ability to define and conduct experiments using modern laboratory instruments, and to interpret experimental results;
A4 - An ability to seek out and gather information, enabling independent and lifelong learning;
A5 - Interpersonal and organizational skills that enable individuals to work effectively in teams;
A6 - An ability to identify needs, requirements, and constraints, and to design appropriate engineering solutions;
A7 - An ability to formulate technical problems clearly, and to correctly apply appropriate methods and procedures for their solution;
A8 – An ability to program computers, and skills in the use of modern engineering analysis, simulation software and operating systems.

3 Senior Design Course Description

3.1 Objectives and learning goals

The overall course objective of the AES Senior Projects sequence (ASEN 4018/4028) is to teach students how to apply their undergraduate academic knowledge to the professional practice of engineering, with a focus on the aerospace field. Although there are many ways this could be done, ASEN 4018/4028 has been designed to focus on the following main learning goals:

1) Student's learning in the course should be organized around an engineering design project to develop an engineering solution to a well-defined customer need. Although engineering analysis is used, the focus of the course is on the synthesis of a solution with a recognized value to industry or society.
2) Learning should be first-person and experience-based, by doing rather than by hearing or seeing. Accordingly, students should have ownership of their project, with freedom to make their own decisions in the course of the project, and primary responsibility for the outcome. Customers should not dictate how to do the design, only what a successful product should do. Faculty should act as resources (domain expertise, application experience, development guidance) and interim evaluators of the quality of the work, but should not direct the work.
3) A broad, end-to-end engineering experience is desired, so that design decisions can be made in the context of the overall practicality and success in serving the prescribed need. The scope of the project should therefore include project definition, articulation of success criteria, conception of credible design options, selection of the best options relative to the project needs and constraints, predictive model development, risk identification and mitigation, feasibility analysis, detailed design requirements development, detailed design and component selection, procurement, manufacturing, integration, verification testing, and functional validation in a representative environment.
4) Student's design work should be informed by current industry best practices. A variant of the systems engineering method, suited to the constraints of the course, should be taught, both to assist in the project development itself, and to provide students with some experience in its use. Similarly, a representative set of development milestones and design products should be

utilized to break the process down into manageable steps, and to develop experience in documenting and communicating the design progress according to professional engineering standards.

5) Projects should be complex enough that the nature of modern engineering endeavors can be experienced, where cooperation within large teams is needed, and a wide range of skills must be brought to bear to produce a viable solution. Accordingly, projects should be multidisciplinary, requiring a breadth of expertise covering mechanical, electrical, and software engineering aspects, distinct roles to be identified on the team, and significant organization and cooperation within the team.
6) Provide a significant opportunity for all students to develop leadership and technical communication skills.

This set of learning goals touches on the ABET knowledge categories K1-K3, and all eight of the ABET Abilities (Section 2.2). Specific knowledge sub-categories under K4 that Senior Projects fulfills have been defined based on input from industry leaders as follows:

K4.1 - Development of engineering specifications from system level requirements.
- The design process, phases and approach
- Setting system goals and requirements
- Defining function, concept and architecture

K4.2 - Engineering design trades and system compromises
- Tradeoffs, judgment, risk and balance in resolution
- Disciplinary, multidisciplinary and multi-objective design
- Prioritization and focus
- System modeling to ensure goals can be met

K4.3 - Design and development of mechanical drawings and specifications
K4.4 - Design and development of software diagrams and specifications
K4.5 - Design and development of electrical schematics and specifications
K4.6 - Fabrication techniques and manufacturing processes
K4.7 - Development of fabrication and integration plans
K4.8 - Experimental measurement techniques & instrumentation
K4.9 - Development of experimental test and verification plans
K4.11 - Development of project management plans
K4.10 - Project management techniques and practices
K4.12 - Technical presentations and documentation

All students are expected to have a basic level of proficiency, defined as "*an ability to participate and contribute to*", all of the topics listed above at the completion of the AES senior projects sequence. Additionally, students should also gain a depth of knowledge, defined as "*skilled in the practice or implementation of*" one or more of these topics.
This course provides the opportunity for students to focus on a complex engineering problem (chosen from a slate of customer-sponsored projects) from conception through testing. Through this process students will learn and have the opportunity to apply fundamental concepts of engineering design, manufacturing and testing. Additionally, students will be expected to apply the knowledge they have learned from previous courses and develop their professional engineering skills during the course.

By the completion of senior projects, students are expected to be able to participate in and contribute to the core knowledge area (K4) in addition to K1-K3 and A1-A8 that constitute the learning goals for the course.
These learning goals are based on input from leaders of industry and academia that represent the skills a practicing engineer will require to be competitive over the next decade in any discipline of engineering.

3.2 Course Overview

ASEN 4018/4028 provides a hands-on experiential learning process where students are guided through an end-to-end process to conceive, design, manufacture, verify and validate an aerospace related system to satisfy a customer-defined need.
AES students have had some experience working on design cases studies in previous courses, where the objective is to show how a particular technical concept or method can be applied. The objective of senior projects is to design a solution to a larger problem (prescribed need), where the engineering concepts/technologies/methods are not known in advance, and must be determined by the design team based on sound engineering reasoning/modeling/analysis. Also, the course intends to go beyond theory to develop practical solutions that can be manufactured, operated, and tested to directly measure the appropriateness of the chosen approach and quantify its capabilities relative to the prescribed need.
Project ideas can be of two types: design of a new device, vehicle, or system to solve a particular problem, or design of an experimental testbed to characterize new technologies or physical processes. Both of these projects utilize established technology and design principles; they are not, in and of themselves, research projects.
Each project must have a specific ***customer*** who articulates a need and establishes overall goals of the design project, including functional objectives and appropriate constraints. Customers can be industry professionals or AES faculty. Student proposed projects are not accepted.

Because every project is different, the course teaches students about the engineering process using a "mentoring" approach, as opposed to the familiar "lecture/lab" method. Each group will have one faculty advisor who shall meet weekly to guide students through the process, offer advice as needed, and evaluate individual student contributions to the group effort. Lectures in support of design development are offered by AES faculty and guest speakers from industry. Workshops are conducted, as needed, to provide specific technical assistance that benefits multiple projects. These and other resources are used by the project teams to carry out their design to meet customer objectives and satisfy the course deliverables. It is important to note that *the conduct of each project is the responsibility of the student team*.
Individual and group work on each project is evaluated by the ***Project Advisory Board***, composed of the project faculty advisors, the Course Coordinator (CC), and AES technical staff. The PAB conducts formal reviews of project milestones at specific times during the semester, and these results are the primary source of data for compiling the team grade. Individual grades will be computed as differential adjustments from the team grade, using faculty and external mentor evaluations, peer and self-evaluations, and PAB discussions. The evaluation process is based on the specific learning goals listed in sections 2.2 and 3.1. Not all learning goals will be assessed at each milestone, so students will receive specific details on the aspects to be evaluated in each assignment. More details on grading can be found in section 6.0.

The graded deliverables in the course are as follows.

3.2.1 Project Definition Document (PDD)

- Written document
- Define specific project objectives and scope

3.2.2 Preliminary Design Review (PDR)

- Oral team presentation based on a PowerPoint document
- Show functional requirements, system interdependencies, and identify risks
- Present trade studies with analyses completed to select a baseline approach
- Propose initial baseline design
- Present plan for prototyping and modeling

3.2.3 Critical Design Review (CDR)

- Oral team presentation based on a PowerPoint document
- Identify and address critical project elements for success
- Preliminary prototyping and testing results
- Feasibility analyses and models
- Proposed detailed design
- Test planning
- Costing and program planning

3.2.4 Fall Final Report (FFR)

- 30-page written report for the Fall design synthesis portion of the project
- Final CONOPS, FBD, functional requirements, and critical project elements
- Summary of detailed design with figures
- Gantt chart for spring

3.2.5 Internal Design Review

- Meetings with manufacturing, electronics, and software SMEs
  - Status report on parts procurement and fabrication
  - Detailed system integration plan
- If required per CDR, presentation to PAB safety board

3.2.6 Test Readiness Review (TRR)

- Oral team presentation based on a PowerPoint document
- Review test objectives, designs, and plans
- Safety analysis of test plans

3.2.7 Spring Final Review (SFR)

- Oral team presentation based on a PowerPoint document
- Comprehensive description of the whole project
- Emphasis on test results and evaluation relative to project objectives and requirements.
- Validation of engineering models
- Convey an in-depth understanding of the project

3.2.8 Project Final Report (PFR)

- Written document summarizing final recommended design
  - Should incorporate design changes based off of V&V/findings during testing
- Serves as the basis for future work
- Appendix provides an archive of detailed project information
- Lessons learned and best practices

3.2.9 Senior Design Symposium (SDS)

- Symposium open to industry and other invitees
- Brief oral presentations to convey project highlights
- Poster presentation session to demonstrate project and discuss details

3.2.10 AIAA Region V Conference Paper (or equivalent with permission)

- Required paper written according to AIAA guidelines
- Submission and presentation at the AIAA Region V Student Conference is voluntary (based on advisor recommendation)

3.3 Pre-Requisites

3.3.1 Pre-Requisites for ASEN 4018

Students in ASEN 4018 (4 credits) are required to have senior academic standing at the beginning of the fall semester. Senior standing in AES implies that you have completed all the Aerospace Engineering Sciences required courses through the junior year with a grade of C or better. If you are deficient in any of the pre-requisites for this course you must submit a course petition form to your AES undergraduate advisor, who can provide guidance and details on this process. The petition will be reviewed by the Associate Chair of Undergraduate Operations and a decision will be made in a timely manner. The student must provide a compelling reason why an unmet pre-requisite would not hamper the conduct of a Senior Project for a petition to be considered. [If you took a class that counts as a pre-requisite in the spring of 2020 we will be using the p+ grade as the passing requirement].

3.3.2 Pre-Requisites for ASEN 4028

ASEN 4018 (with a C grade or better) and the consent of the senior projects CC are pre-requisites for ASEN 4028**. Students who have not successfully completed ASEN 4018 with at least a grade of C will not be allowed to register for ASEN 4028.** In such cases students will be required to begin the course sequence again in the next academic year starting with ASEN 4018. [If you took a class that counts as a pre-requisite in the spring of 2020 we will be using the p+ grade as the passing requirement].

3.4 Course Meetings

3.4.1 ASEN 4018, Fall semester

Lectures and Workshops: generally Tuesdays and Thursdays (50 minutes)
Labs (generally team meetings): Mondays and Wednesdays (110 minutes each)
(see the course calendar for specific instances and times)

3.4.2 Attendance for ASEN 4018

Students are required to attend all lecture and lab periods during the first three weeks of the semester. These are of critical importance to team formation, project definition, and effective bystander intervention training. After the third week of the semester students are expected to attend ALL Tuesday and Thursday lectures and any workshops that are applicable based on their team role. Not attending those may have serious consequences for your team, the success of your design, and for your grade. Updates in the Syllabus and other course announcements will be posted on the course Canvas website. Multiple technical workshops may be held and students can choose the most applicable one. Students are required to attend all of their scheduled team meetings; this includes additionally scheduled team meetings where the advisors are not present. During the preliminary and critical design review weeks, students are expected to attend half of the reviews of other teams in their lab section. This schedule will be made by the TF team. This is an important way to observe effective techniques, and to avoid unfortunate mistakes.

3.4.3 ASEN 4028, Spring semester

Lectures: As needed
Labs: time TBD, will be two hours twice a week

3.4.4 Attendance for ASEN 4028

During the spring semester students will be working with their teams on fabrication and construction. There are no regular lectures scheduled at this time, but opportunities for industry speakers or seminars will arise. Team meeting times will nominally be held during the regular class meeting times. A schedule will be posted in the Spring calendar. **The calendar shows mandated attendance as lecture and lab times colored in red.**

3.4.5 Scheduling of Reviews

All reviews will be scheduled during the regular class times, both labs, workshops, and lectures. **All students must attend the reviews (PDR, CDR, TRR, SFR) of at least half of the project teams in their lab section**, unless a prior arrangement has been made with the CC. Attendance at reviews per the schedule released by the TFs is a component of your individual grade. Because the reviews start the day that the assignments are submitted, and it is necessary to process and distribute the reviews to the PAB, **late review materials will not be accepted**. If you have not completed your review preparations, you should submit what you have by the deadline. To maintain fairness, only the on-time submitted review materials may be presented. **No changes or supplements after the deadline will be allowed**.
Projects with industry and other external customer support may schedule additional reviews, with CC approval.

3.5 Major Course Dates

A course calendar will be made available on the course Canvas web site. Students should utilize this resource for detailed scheduling information

3.6 Course time commitment

AES senior projects is a 4 credit course each semester, and like all courses students are expected to commit 4 hours per week for each credit. This means students should expect to commit at least **16 hours** each week to senior projects. This includes class and group meeting times. However, accomplishments are graded, not time spent, and they often require additional time outside of class and group meetings. In many cases motivated students commit 20 hours each week to senior projects.

3.7 Assignments and Requirements

3.7.1 The following assignments will be given, corresponding to each deliverable:

Fall Semester:
Assign. 1: Project Definition Document (PDD)
Assign. 2: Preliminary Design Review (PDR), accompanied by a peer review and self-evaluation
Assign. 3: Critical Design Review (CDR), accompanied by a peer review and self-evaluation
Assign. 4: Fall Final Report (FFR)

Spring Semester:
Assign. 6: Internal Design Review (IDR)
Assign. 7: Test Readiness Review (TRR), accompanied by a peer review and self-evaluation
Assign. 8: AIAA Paper
Assign. 9: Symposium Presentation and Poster (SPP)
Assign. 10: Spring Project Review (SPR), accompanied by a peer review and self-evaluation
Assign. 11: Project Final Report (PFR),

3.7.2 Presentation/Report Requirements.

Presentations are given by the team. However, due to time constraints, only a portion of the team can present at each review. **Each student is required to orally present at least once each semester. The maximum number of student presenters per review is 6**. In ASEN 4018 there are 2 opportunities and in ASEN 4028 there are 3 opportunities to present.
Final reports (Fall and Spring) are written by the whole team. **Each team member must be lead author of at least one substantial section of each of these major reports**. Team members may be co-author on one or more sections. These contributions must be properly attributed, in a separate section for that purpose, as report authorship is used in part to establish individual grade adjustments from the group grades.

4 Resources

4.1 Available meeting, design and construction space

4.1.1 Senior Project Labs

Each team will be assigned space in the senior projects labs for construction and assembly of their projects. Please respect your peers and do not disturb any items that do not belong to your team. Each team will also have a storage cabinet where they can put any supplies or sensitive equipment. Remember this is a shared space and you should return tools and clean up any messes when finished. Use of paints, thinners, epoxies or other potentially hazardous materials is not permitted in this space without prior approval of Matt Rhode, Trudy Schwartz, Robert Hodgkinson, Josh Mellin or KatieRae Williamson. **All work conducted in these spaces must be in accordance with all pertinent department and university safety policies**.

4.1.2 AES Machine Shop

The AES machine shop is typically accessible daily when Matt Rhode, Nate Coyle or a designated assistant is available, and after completing the required safety training and machining workshop.

4.1.3 AES Electronics Shop

The AES electronics shop can provide limited space for electronics fabrication, integration and test. Access must be requested through Trudy Schwartz or Robert Hodgkinson and space will be provided as available.

4.1.4 AES Wood Working and Composites Lab

The AES department has developed a wood working and composite fabrication lab to be used for both teaching and research. Contact Matt Rhode or Nate Coyle to obtain access to the shop.

4.1.5 PILOT Resources

All AES students have access to the PILOT, which includes the lab plaza, breakout room, various 3D printers, laser cutters, and testing equipment. Some software, such as SolidWorks, LabVIEW, etc. are available in the PILOT plaza. Equipment for prototyping is available. Students must contact Josh Mellin (Joshua.Mellin@Colorado.EDU) or KatieRae Williamson (KatieRae.Williamson@colorado.edu) if PILOT resources are needed. Senior Projects students can also use these spaces for their computer work.

4.1.6 Faculty Labs / Special Equipment

In some cases, e.g. when faculty are acting as project customers, research labs may be made available for student use. This option is typically assessed on a project by project basis. If you are working in a faculty lab please respect the fact that others, most likely graduate students, may be using the same space for their research. Please coordinate with the faculty who is providing the lab to learn the rules and expectations for people using the lab.

4.2 Web Sites

The course web site can be found at https://canvas.colorado.edu/. All course materials will be posted there, as well as announcements, assignments, and the corresponding grades. Grades are visible only to individual students.

The archive web site is: http://www.colorado.edu/aerospace/current-students/undergraduates/senior-design-projects. You may need to copy and paste the link directly into your browser. Teams have the opportunity to develop their own team websites on that server. Links to deliverables from previous projects may be helpful in the development of your own reports and presentations.

4.3 Email List Server

The course roster provided by the University as part of Canvas will be utilized as the course email list. You do not need to subscribe to that list. Messages will be sent to your official CU email account. Replies to this email will not go to the group but will be directed to the CC.

Any course-wide announcements or postings will be available on the class Canvas web site.

4.4 Project Costs

Details about the financial requirements and expectations for senior projects can be found in the **Financial Management Requirement Document** which is available through the course website. A brief overview is provided below.

4.4.1 Budget

All projects are allotted a budget of $4,000 (AY 2022/2023) for project purchases. The budget will come from funds committed by a customer. Customers may provide additional operational funding as delineated in the **Customer Requirements Document** which is available from the CC or the course website.
Students may apply for additional support from:

- the EEF and UROP programs within the University of Colorado.
- Corporations often provide in-kind donations or university discounts.

It is the responsibility of the teams to inquire about such support.
If students would like to pursue other external funding opportunities they must coordinate those efforts with the CC and the customer before proceeding.

4.4.2 Procedures

All teams are required to have a Financial Lead (FL) who will be responsible to ensure their team follows the established procedures in the **Financial Management Requirement Document** and accounting for all the financial transactions. Note the FL should also have additional technical role on the team as this is not a full-time role.

5 Student Requirements

5.1 Project Teams

The AES department will endeavor to provide enough projects through external and internal funding sources to support **10-12 person teams**. The intent is to staff each project with an approximately equal number of students; exact numbers depend on current enrollment. Students will be placed on project teams from the slate of current projects through an automated process. The process will require students to rank projects and positions of interest to them. **The algorithm used for placement is developed using the optimization problem employed in matching prospective medical residents to residencies.**
In the first week of class, the slate of projects will be presented, and students will be asked to rank projects according to their interest. The matching will be done as described above. Once teams are formed, each team shall choose a Project Champion to lead team meetings until final selection of a Project Manager is made later in the semester.
Each of the following roles must be represented, in addition to any other roles that are deemed necessary. No person can perform more than one of these key roles.

- Project Manager (PM)
- Systems Engineer (SE)
- Manufacturing and Prototyping Lead (ML)

- Technical Leads (these are project-specific and determined by each team, and typically cover the major design areas in the course: mechanical (includes fluid/thermal/optical), electronics, and software)

All members of the team must have a technical contribution to the project. Team organization may be changed as project needs evolve, but each member must have a clear leadership role in the project at all times.

5.2 Safety

Safety shall be a primary concern for all students, faculty, and staff in Senior Projects. Students must take the required training if they plan to use shops, and all students must attend an environmental health and safety training workshop. Any work conducted in senior projects must be done in accordance with all university safety policies which can be found at http://ehs.colorado.edu/. Any activity on the project that has a potential safety impact, as solely determined by any member of the PAB, must be cleared by the PAB safety board before any testing, fabrication, or prototyping.

5.3 Text

There is no required text for this course. Recommended reading includes:
"*TeamWork, what must go right/what can go wrong*" by C.E. Larson, F.M.J. Lafasto, SAGE Publications, 1989.
"Decision Making & Problem Solving Strategies", John Adair, Kogan-Page, 2007.
"Design-Driven Innovation", Robert Verganti, Harvard Business Press, 2009.
"Design-Inspired Innovation", James Utterback, et al., World Scientific, 2007.
"Open Innovation", Henry Chesbrough, Harvard Business School Press, 2003.

Project managers are encouraged to read
"*The TEAM Handbook*," by P.R. Scholtes, B.L. Joiner, B.J. Streibel, Oriel Inc. 2003.
"Just Enough Project Management" by Curtis R. Cook, McGraw-Hill 2005.
"Guide to the Preparation of Operational Concept Documents", ANSI/AIAA G-043A-2012

Systems Engineers are encouraged to read
"*Systems Engineering and Analysis*," B.S.Blanchard, and W.J.Fabrycky, Prentice Hall, 2006.
NASA Systems Engineering Website: http://spacese.spacegrant.org/

5.4 Weekly Time Sheets

In industry your work is often divided among several projects with separate sources of funding. Time cards are widely used to associate efforts with the proper accounts. This is not the case in senior projects, with one source of funding and no billing for personnel time. However, a variant of time cards will be used in this course to assist in managing your time wisely. The weekly time sheet (WTS) records the number of hours spent on the project, as well as a brief summary of the week's accomplishments and your plans for the next week. This helps maintain a healthy level of effort for project success, and encourages everyone to assess and plan their own work. The WTS will be submitted to the Canvas web site, and a Teaching Fellow will collate these for distribution to the teams and advisors. A template for the WTS will be posted.

6 Course Faculty and Staff

6.1 Course Coordinators (CC)

Kathryn Wingate – Section 011 and 012
Email: Kathryn.Wingate@colorado.edu
Office Hours: TBD

Chris Muldrow - Section 012 projects with EnerSys and ASTROBi
Email: muldrow@colorado.edu
Office Hours: TBD

6.2 Project Advisors (2021/22)

Section 011

Marcus Holzinger Office: AERO 457 Email: Marcus.Holzinger@colorado.edu	**Allie Anderson** Office: AERO N303 Email: Allison.P.Anderson@colorado.edu
Alexandra LeMoine Office: AERO 211 Email: Alexandra.LeMoine@colorado.edu	**John Mah** Office: AERO N207 Email: John.Mah@colorado.edu

Section 012

Dale Lawrence Office: AERO 273 Email: Dale.Lawrence@colorado.edu	**Erik Knudsen** Office: AERO 217 Email: Erik.Knudsen@colorado.edu
Melvin Rafi Office: AERO 213 Email: Melvin.Rafi@colorado.edu	**Matt Rhode** Office: AERO 155A Email: RhodeM@colorado.edu

6.3 Technical Experts and Support Staff

Electronics **Trudy Schwartz** Office: AERO 150B Email: Trudy.Schwartz@Colorado.edu	Electronics and Manufacturing **Bobby Hodgkinson** Office: AERO 150D Email: hodgkinr@colorado.edu

Software **Josh Mellin** Office: AERO 141E Email: Joshua.Mellin@Colorado.EDU	Fabrication and PILOT **KatieRae Williamson** Office: AERO 141E Email: KatieRae.Williamson@colorado.edu
Financial Accounting **Jacqui Stang** Office: AERO 224 Email: Jacquelyn.Stang@colorado.edu	Manufacturing **Nate Coyle** Office: Machine Shop Email: Nathan.Coyle@Colorado.edu

6.4 Other Course Resources

Teaching Fellow **Andreas Brecl** Email: Andreas.Brecl@colorado.edu	Teaching Fellow **Gina Staimer** Email: Gina.Staimer@colorado.edu
Teaching Fellow **Jasmin Chadha** Email: Jasmin.Chadha@colorado.edu	

6.5 Course Faculty and Staff Roles

Course faculty and staff roles and responsibilities are defined in the Faculty Advisor Guidelines document. This is briefly summarized below.

The CCs, in agreement with the Chair of the Department, will select and approve the slate of senior design projects for the academic year based on financial support and course compatibility. The CC will work with potential customers to define projects suitable for the course.
The CCs will ensure that all project teams are viable and have approximately the same number of students.
The CCs will update and distribute the course materials, as needed, for the current academic year, and will organize the course workshops, lectures, and PAB reviews and grading activities.
The CCs will maintain, post, and submit all grades in the course, with the assistance of the Teaching Fellows.
The Projects Advisory Board (PAB) consists of one Team Advisor for every two to three projects, the CC, the technical experts and the TFs. The role of the PAB is:

- to provide advice and guidance to the project teams
- to provide a cross section of relevant professional expertise in the evaluation of the student projects
- to provide timely, actionable feedback on the quality of team progress, and
- to determine group and individual grades for the course.

Students should look to the faculty and staff for:

- Experience in engineering analysis, design, development, and testing using a systems engineering approach.

- Expectations of professional practice, communications, project management, and organizational skills
- Specific technical expertise in various areas, and suggestions where additional expertise may be found.

The student team runs the project. Faculty will provide feedback and will ask teams to defend their decisions with engineering arguments in an effort to help them make the informed design choices that lead to a successful project.

6.6 General AES Faculty support

All faculty members in the AES department are committed to providing students in senior projects with technical guidance in their area of expertise, if provided with reasonable requests. Contact information and a short overview on the technical interests of each faculty member can be found on the AES department webpage. Additional information can be found on the research center and individual faculty web pages.
If you have difficulties reaching a faculty member whom you would like to meet with you, contact the CC for your section or your faculty advisors who can help to coordinate this effort.

7 Grades

7.1 Grading Procedures

The requirements for each graded product in the course are specified in the corresponding assignment document. These are provided on the course Canvas web site. The grades are determined based on the criteria found there.
All grades are determined by your faculty advisor in agreement with the Project Advisory Board (PAB) as a whole, along with the CC. In the event that consensus cannot be reached, the CC has the final authority in setting grades.

7.2 Grade Components

The final semester grades are determined from a group grade basis on each assignment, with differential adjustments, based on individual contributions to the group effort, to obtain individual student grades. Grading in Senior Projects is necessarily somewhat subjective, but grades are normalized over the whole class in PAB grading meetings to maintain consistency and fairness. The CC keeps the grades on file, and will post them on Canvas web site for individual student access only. The team adviser will provide feedback to individual students about their grade outcomes upon request. The weighted contribution to the total grade for each element of the course is provided below. Advisors provide evaluations of the student performance evaluation at the end of the term.

7.2.1 ASEN 4018 assignment weighting (Fall)

Product	Weight
Project Definition Document	10%
Preliminary Design Review	25%
Critical Design Review	25%
Fall Final Report	20%
Student Professionalism Evaluation	10%
Student Performance Evaluation	10%
Total	100%

7.2.2 ASEN 4028 assignment weighting (Spring)

Product	Weight
IDR Reviews (P/F)	10%
Test Readiness Review	15%
AIAA Conference Paper	5%
Spring Final Review	20%
Symposium	10%
Project Final Report	20%
Student Professionalism Evaluation	10%
Student Performance Evaluation	10%
Total	100%

7.3 Student Professionalism Evaluation

Students are required to act professionally towards their teammates, project sponsors, AES staff and faculty, and other students. Students are also required to complete the following OIEC trainings: Effective Bystander Intervention.
Students are required to utilize building spaces and resources correctly and respectfully. Failure to complete the trainings, treat fellow human beings professionally, or incorrectly utilize building spaces or resources will result in a reduction to the Student Professionalism Evaluation grade. Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail to adhere to such behavioral standards may be subject to discipline.

End of Project Disposition
At the end of the ASEN 4028 teams and students are required to sign a consent document where students agree to allow the Aerospace Engineering Sciences department to copy and distribute materials that were created by the team in ASEN 4018 and ASEN 4028 to future students, future PAB members, aerospace industry members, and to publish them on the department website http://www.colorado.edu/aerospace/current-students/undergraduates/senior-design-projects.

Before final grades are issued, all students must be cleared on the course disposition list showing that all equipment (hardware and software) borrowed during the course has been returned to the appropriate owners, work areas have been cleaned up, and purchasing card accounts have been closed.

7.4 Individual Assessments

7.4.1 Peer Reviews

Each semester two confidential *Peer Reviews* will be solicited from student team members after select major presentations (ASEN 4018: PDR, CDR; ASEN 4028: TRR, SFR). In these peer reviews you will be asked to evaluate the overall contribution of each team member to the success of the project, as well as yourself.
Peer reviews will be utilized by the PAB in their assignment of individual grades of select assignments (PDR, CDR, FFR, TRR, SPR, PFR), and in the individual Faculty Performance Evaluation grades at the end of each term. Accordingly, peer evaluations can strongly affect individual student grades, just as individual contributions can strongly affect the quality of a team project. You are encouraged to identify roles in the project where your contributions are meaningful and recognized, and to be fair in your evaluations of your peers.

7.5 Grading Scale

Letter grades are only assigned at the end of each term, not on individual deliverables. Team numerical and letter grades are assigned according to the following absolute scale:

Grade		Interpretation
90-100	93 – A 90 – A-	Excellent work= Exemplary **engineering design** contributions. Likely to meet all major project objectives, and to close the design loop with full project validation. An engineering understanding of the project is evident, and design products meet professional standards. Exceeds course expectations.
80-89.9	87 – B+ 83 – B 80 – B-	Good work = Good **engineering design** contributions, but non-engineering contributions dominate. Likely to meet some of the major project objectives, and to verify all of the design requirements, but full validation is not likely. An engineering understanding of some project elements is evident, and some design products meet professional standards. Meets course expectations.
70-79.9	77 – C+ 73 – C 70 – C-	Minimal work = some contributions can be identified, but little **engineering design** content is evident. Likely that none of the major project objectives will be met and verified. An engineering understanding is lacking, and design products are of generally of substandard quality. Below course expectations. **A C grade is the required minimum in ASEN 4018 to progress to ASEN 4028**.
60-69.9	67 – D+ 63 – D 60 – D-	Poor work = little contribution to the team or to the system design can be identified. Likely that the system will not be completed in time, and that no meaningful testing will be possible. Design products are unacceptable, and little engineering understanding is conveyed. Far below course expectations.
< 60	F	A failed effort.

Note that individual grades can differ substantially from the team (average) grade, based on individual contributions as judged by the PAB, with input from peer evaluations.

7.6 Incomplete Grades

According to University policy incomplete grades (IF) cannot be given in ASEN 4018 or ASEN 4028.

8 Aerospace Engineering Sciences & University Policies 2022:

9 Classroom Behavior

Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. For more information, see the policies on classroom behavior and the Student Conduct & Conflict Resolution policies.

10 Requirements for COVID-19

As a matter of public health and safety, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements and all public health orders in place to reduce the risk of spreading infectious disease. CU Boulder currently requires COVID-19 vaccination and boosters for all faculty, staff and students. Students, faculty and staff must upload proof of vaccination and boosters or file for an exemption based on medical, ethical or moral grounds through the MyCUHealth portal.

The CU Boulder campus is currently mask-optional. However, if public health conditions change and masks are again required in classrooms, students who fail to adhere to masking requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to Student Conduct and Conflict Resolution. For more information, see the policy on classroom behavior and the Student Code of Conduct. If you require accommodation because a disability prevents you from fulfilling these safety measures, please follow the steps in the "Accommodation for Disabilities" statement on this syllabus.

If you feel ill and think you might have COVID-19, if you have tested positive for COVID-19, or if you are unvaccinated or partially vaccinated and have been in close contact with someone who has COVID-19, you should stay home and follow the further guidance of the Public Health Office (contacttracing@colorado.edu). If you are fully vaccinated and have been in close contact with someone who has COVID-19, you do not need to stay home; rather, you should self-monitor for symptoms and follow the further guidance of the Public Health Office (contacttracing@colorado.edu).

11 Accommodation for Disabilities

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the Disability

Services website. Contact Disability Services at 303-492-8671 or dsinfo@colorado.edu for further assistance. If you have a temporary medical condition, see Temporary Medical Conditions on the Disability Services website.

12 Preferred Student Names and Pronouns

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

13 Honor Code

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code academic integrity policy. Violations of the Honor Code may include, but are not limited to: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code (honor@colorado.edu); 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found on the Honor Code website.

14 Sexual Misconduct, Discrimination, Harassment and/or Related Retaliation

CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. The university will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by or against members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or email cureport@colorado.edu. Information about university policies, reporting options, and the support resources can be found on the OIEC website.
Please know that faculty and graduate instructors have a responsibility to inform OIEC when they are made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about their rights, support resources, and reporting options. To learn more about reporting and support options for a variety of concerns, visit Don't Ignore It.

15 Religious Holidays

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance.
See the campus policy regarding religious observances for full details.