

COURSE SYLLABUS

ASEN 4028 SENIOR PROJECTS II: DESIGN PRACTICUM SPRING 2025

DOCUMENT SCOPE

This document is the Syllabus for ASEN 4028 Senior Projects II: Design Practicum, the second course of 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 grades are determined.

AEROSPACE ENGINEERING PROGRAM

The Senior Project course provides a capstone experience, integrating disciplinary knowledge from previous courses to conduct a realistic engineering design/build/test project to satisfy a well-defined customer Request for Proposal (RFP). 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 at the end of the syllabus. More details can be found in the AES department webpage <http://www.colorado.edu/aerospace>.

OVERVIEW

ASEN 4018/4028 provides a hands-on experiential learning process where students are guided through an end-to-end process to design, fabricate, and test an aerospace related system to satisfy a customer-defined need. The objective of senior projects is to design a solution to a problem where the engineering concepts/technologies/methods are not known in advance, and must be determined by the design team based on sound engineering modeling/analysis/prototyping. The course intends to go beyond theory and push student teams to develop, model, and fabricate a design based off of system requirements. Students will then test their designs to verify requirements are met, validate the system can complete mission objectives, and close the loop between model predictions and actual design performance.

Each team has a faculty advisor that will meet weekly with student teams to guide students through the design process as well as evaluate individual student contributions to the team 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. Many teams will have industry/department mentors who will provide teams with technical, systems, and program management advice. It is important to note that the project design and management 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 coordinators, 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. The IDR and TRR milestones act as gates, and teams must successfully complete these reviews in order to continue to the next review. 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 graded deliverables in the spring course are as follows:

GATE 4: INTERNAL DESIGN REVIEW (IDR)

- Teams will complete a series of 30 minute reviews with Subject Matter Experts. The intent of these reviews is to ensure detailed fabrication and integration plans are in place and will be successful.
- All teams are required to complete an electronics review, a software review, and a manufacturing review. Some teams will be required to complete a safety review.
- The PM should work with the team and assigned reviewers to schedule all required reviews.
- As the reviews are intended to be small, no more than 4 team members should attend reviews.
- Teams should prepare documents for each review per the assignment on Canvas.
- Successful completion of IDR will clear the team to continue to Gate 5: TRR.

GATE 5: TEST READINESS REVIEW (TRR)

- PowerPoint presentation to PAB
- Review most critical upcoming sub system/system test plans. Include sensor types, sensor locations, sampling frequencies, test set up, required hardware, and test locations
- Clear link between test plans and requirement verification
- Discuss any required safety plans
- Successful completion of TRR will clear the team to complete testing

SPRING FINAL REVIEW (SFR)

- PowerPoint presentation to PAB
- Final requirement verification and mission validation conclusions
- Close the loop between actual design performance and CDR models predictions
- Final budget and Gantt chart conclusions
- Future design and program recommendations

DOCUMENTATION: PROJECT FINAL REPORT (PFR)

- 30-page written report for the spring design synthesis portion of the project
- Requirement verification and mission validation conclusions
- Final design with recommendations incorporated
- Summary of final budget

PRE-REQUISITES*PRE-REQUISITES FOR ASEN 4028*

Students in ASEN 4028 (4 credits) are required to have senior academic standing and have passed ASEN 4018. 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.

COURSE MEETINGS*ASEN 4028, SPRING SEMESTER*

Lectures and Workshops: Tuesdays and Fridays (50 minutes)

Labs (generally team meetings): Mondays and Wednesdays (110 minutes each)

(see the course calendar for specific instances and times)

ATTENDANCE FOR ASEN 4028

Students are required to attend all lectures during the semester: note that Tuesday lectures are virtual, while Friday lectures are in person. Lab section times will be utilized for team meetings, advisor meetings, office hours, and design reviews. Students are required to attend their team's weekly advisor meeting as well as other necessary team meetings.

Updates in the Syllabus and other course announcements will be posted on the course Canvas website. Multiple technical workshops may be held and students should choose the most applicable ones.

SCHEDULING OF REVIEWS

All reviews will be scheduled during the regular class lab times. 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 submitted review materials may be presented. **No supplements or changes are allowed to review materials after the deadline.**

Projects with industry mentors and other external customer support may schedule additional reviews, with CC approval.

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

ASSIGNMENTS

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.

THE FOLLOWING ASSIGNMENTS WILL BE GIVEN, CORRESPONDING TO EACH DELIVERABLE:

Spring Semester:

Assign. 1: Gate 4: Internal Design Review (IDR)

Assign. 2: Gate 5: Test Readiness Review (TRR), accompanied by a peer review

Assign. 3: Spring Final Review (SFR), accompanied by a peer review

Assign. 4: Project Final Report (PFR) and Hardware Breakdown day, accompanied by a peer review

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 8.** In ASEN 4028 there are 2 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.

GRADES

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.

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.

ASEN 4028 ASSIGNMENT WEIGHTING (SPRING)

Product	Weight
Gate 4: Internal Design Review (P/F)	5%
Gate 5: Test Readiness Review	25%
Symposium (P/F)	5%
Spring Final Review	30%
Project Final Report (Spring)	20%
Individual Performance Evaluation	15%
Total	100%

STUDENT PROFESSIONALISM

Students are required to act professionally towards their teammates, project mentors, AES staff and faculty, and fellow students. Students are required to utilize building spaces and resources correctly and respectfully. Failure to treat fellow human beings professionally, or incorrectly utilizing building spaces or resources will result in a reduction to the Individual Performance 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.

INDIVIDUAL ASSESSMENTS

PEER REVIEWS

Each semester two confidential *Peer Reviews* will be solicited from student team members after select major presentations (ASEN 4028: TRR, SFR/PFR/Hardware Breakdown Day). 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 (TRR, SFR, PFR), and in the Individual 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.

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	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.
	90 – A-	
80-89.9	87 – 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.
	83 – B	
	80 – B-	

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.

INCOMPLETE GRADES

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

RESOURCES

AVAILABLE MEETING, DESIGN AND CONSTRUCTION SPACE

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, or Robert Hodgkinson. **All work conducted in these spaces must be in accordance with all pertinent department and university safety policies.**

AES MACHINE SHOP

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

AES ELECTRONICS SHOP

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

AES ELECTRONICS AND MANUFACTURING SHOP

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

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 Nate Coyle to obtain access to the shop.

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. Senior Projects students can also use these spaces for their computer work.

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.

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.

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.

PROJECT COSTS

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

BUDGET

All projects are allotted a budget of \$4,000 (AY 2024/2025) for project purchases. The budget will come from funds committed by a customer.

In many cases students 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.

PROCEDURES

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

STUDENT REQUIREMENTS

PROJECT TEAMS

The AES department will endeavor to provide enough projects through external and internal funding sources to support **9-12 person teams**. 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.

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.

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.

COURSE FACULTY AND STAFF

COURSE COORDINATORS (CC)

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PROJECT ADVISORS

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TECHNICAL EXPERTS AND SUPPORT STAFF

Electronics Trudy Schwartz AERO 150B Trudy.Schwartz@Colorado.edu	Electronics Bobby Hodgkinson AERO 150D hodgkinr@colorado.edu
Embedded Systems and Electronics Elizabeth Mcpherson Elizabeth.Mcpherson@colorado.edu	Software Dennis Akos dma@colorado.edu
Financial Accounting Help desk hours to be posted on Canvas aerofinancehelp@colorado.edu	Manufacturing Nate Coyle (Machine Shop) Nathan.Coyle@Colorado.edu
Manufacturing and Engine Test Cell Office: AERO 155A RhodeM@colorado.edu	Projects Lab & 3D Printing Gerald Yoho Gerald.Yoho@Colorado.EDU

TEACHING FELLOWS

Teaching Fellow Kathleen Mccutchan _____	Teaching Fellow Carson Kohlbrenner _____
Teaching Fellow Andrew Kabos _____	

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 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.

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.

SYLLABUS STATEMENTS

HONOR CODE

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the [Honor Code](#). Violations of the Honor Code may include but are not limited to: plagiarism (including use of paper writing services or technology [such as essay bots]), 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. Understanding the course's syllabus is a vital part in adhering to the Honor Code.

All incidents of academic misconduct will be reported to Student Conduct & Conflict Resolution: StudentConduct@colorado.edu. Students found responsible for violating the [Honor Code](#) will be assigned resolution outcomes from the Student Conduct & Conflict Resolution as well as be subject to academic sanctions from the faculty member. Visit [Honor Code](#) for more information on the academic integrity policy.

ACCOMMODATION FOR DISABILITIES, TEMPORARY MEDICAL CONDITIONS, AND MEDICAL ISOLATION

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. Students should expect to receive accommodations for a timed assessment (e.g., exam) only if their faculty instructor(s) receive the student's accommodations letter at least 5 business days before the assessment, as a departmental policy, in order to facilitate administering the assessment. 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.

If you have a temporary illness, injury or required medical isolation for which you require adjustment, please notify your instructor as soon as possible.

ACCOMMODATION FOR RELIGIOUS OBLIGATIONS

Campus policy requires faculty to provide reasonable accommodations for students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. Please communicate the need for a religious accommodation in a timely manner. If you require a religious accommodation, please notify your instructor as soon as possible. See the [campus policy regarding religious observances](#) for full details.

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.

CLASSROOM BEHAVIOR

Students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote, or online. Failure 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, marital status, political affiliation, or political philosophy.

For more information, see the [classroom behavior policy](#), the [Student Code of Conduct](#), and the [Office of Institutional Equity and Compliance](#).

SEXUAL MISCONDUCT, DISCRIMINATION, HARASSMENT AND/OR RELATED RETALIATION

CU Boulder is committed to fostering an inclusive and welcoming learning, working, and living environment. University policy prohibits [protected-class](#) discrimination and harassment, sexual misconduct (harassment, exploitation, and assault), intimate partner abuse (dating or domestic violence), stalking, and related retaliation by or against members of our community on- and off-campus. The Office of Institutional Equity and Compliance (OIEC) addresses these concerns, and individuals who have been subjected to misconduct can contact OIEC at 303-492-2127 or email CUREport@colorado.edu. Information about university policies, [reporting options](#), and [OIEC support resources](#) including confidential services can be found on the [OIEC website](#).

Please know that faculty and graduate instructors are required to inform OIEC when they are made aware of incidents related to these concerns regardless of when or where something occurred. This is to ensure that individuals impacted receive outreach from OIEC about their options and support resources. To learn more about reporting and support for a variety of concerns, visit the [Don't Ignore It page](#).

MENTAL HEALTH AND WELLNESS

The University of Colorado Boulder is committed to the well-being of all students. If you are struggling with personal stressors, mental health or substance use concerns that are impacting academic or daily life, please contact [Counseling and Psychiatric Services \(CAPS\)](#) located in C4C or call (303) 492-2277, 24/7.

Free and unlimited telehealth is also available through [Academic Live Care](#). The [Academic Live Care](#) site also provides information about additional wellness services on campus that are available to students.

ABET SENIOR DESIGN COURSE DESCRIPTION

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.*

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.

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.

Clearly, 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.