

**ABET**

# **ABET SELF-STUDY QUESTIONNAIRE: TEMPLATE FOR A SELF-STUDY REPORT**

2017-2018 Review Cycle

*This version has been updated to include the new references to the 2017-18 APPM, published on December 1, 2016*

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## TABLE OF CONTENTS

BACKGROUND INFORMATION .....	4
CRITERION 1 – STUDENTS.....	7
CRITERION 2 – PROGRAM EDUCATIONAL OBJECTIVES .....	17
CRITERION 3 – STUDENT OUTCOMES .....	23
CRITERION 4 – CONTINUOUS IMPROVEMENT .....	28
CRITERION 5 – CURRICULUM .....	125
CRITERION 6 – FACULTY .....	138
CRITERION 7. FACILITIES.....	150
CRITERION 8. INSTITUTIONAL SUPPORT .....	161
PROGRAM CRITERIA .....	178
Appendix A – Course Syllabi .....	180
Appendix B – Faculty Vitae .....	251
Appendix C – Equipment.....	281
Appendix D – Institutional Summary .....	297
Appendix E – BSAE Advising Course Log.....	301
Appendix F – Aerospace Engineering Advisory Board .....	303
Appendix G – Course Design Workshop for AE Faculty.....	305
Appendix H – AE Instrument for Peer Evaluation of Teaching .....	306
Appendix I – AE Faculty Petition for Department .....	310
Appendix J – AE Student Papers Presented at the IPPW .....	313
Appendix K – Annual Assessment Reports for GE Areas S & V .....	314

**ABET**  
**Self-Study Report**  
for the  
**Aerospace Engineering Program**  
at  
**San Jose State University**  
**California**

**June 2017**

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**Program Self-Study Report  
for  
EAC of ABET  
Accreditation or Reaccreditation**

## **BACKGROUND INFORMATION**

### **A. Contact Information**

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### **B. Program History**

The BSAE Program was formally installed in 1987 in the new Department of Aerospace Engineering. It grew quickly, one year enrolling more new freshmen students than any other program in the College. When it began, it offered the only BSAE degree between Seattle, Salt Lake City and San Luis Obispo. At its peak, the Program had four (4) regular faculty (3 tenure-track and one full-time temporary), ten laboratories, and over 400 students. It achieved accreditation in its 4<sup>th</sup> year, then had its review cycle aligned with the rest of the College, and has been continuously accredited since.

The Program was awarded national recognition (ASEE/AIAA Atwood Award) in 1993 for innovation in AE education.

With the end of the cold war in the early 1990's the Program experienced the same precipitous decline in enrollment, as did all other similar programs nationally. Consequently, in 1996 the Program merged with Mechanical Engineering to form the Department of Mechanical and Aerospace Engineering (MAE). While the merger worked well for several years it faltered due to the absence of AE representation in the administrative structure of the Department as well as the absence of a dedicated budget for the AE Program. This void hampered the AE Faculty in their ability to carry out their responsibilities, such as student advising, curriculum and laboratory development, supervision of MSAE projects/theses, as well as AE faculty recruitment. The situation

reached the point where the AE Faculty had no input in any of the decisions affecting the AE Program. The imbalance between the number of faculty in the AE and ME programs was not addressed in a timely fashion and as a result, it has escalated into a full conflict.

The last general review, conducted in AY 2011-2012 resulted at first in a weakness under Criterion 6, due to the insufficient number of tenure-line faculty in the Program – at the time only two – and a concern under Program Criteria, due to the lack of sufficient authority of the AE Faculty to define, revise, implement, and achieve Program Objectives. At the time of the Final Statement (14 August 2014) both the weakness and the concern had been resolved. A third tenure-line faculty member (Dr. Turkoglu) joined the AE Faculty in Fall 2013 and the AE Program was separated from the ME Program. The MAE Department became the ME Department and the AE Program became independent with a Director reporting directly to the Dean of the College, effective **19 August 2013**.

Dr. Mourtos was appointed AE Program Director by Dean Andrew Hsu. For all practical purposes, the AE Program operated as a department for three academic years (2013-14 through 2015-16). The Director participated in the College Council of Chairs and was given full authority as well as a budget to run the AE Program during this time. An AE faculty member represented the Program on each and every College committee.

In 2015, the AE Faculty petitioned to Dean Andrew Hsu, to become a Department (Appendix I). Dean Hsu, with consent from the Provost, re-established the Aerospace Engineering Department effective **22 August 2016**. The AE faculty held elections in April 2016 and Dr. Mourtos was elected unanimously Chair of the newly re-established AE Department. In AY2016-17 the AE Department was engaged in a successful faculty search, resulting in a fourth tenure-line faculty member, Dr. Vergine, joining our Program in Fall 2017. The Department has just received approval to recruit a fifth tenure-line faculty member in AY2017-18.

### **C. Options**

The BSAE program does not have formal concentrations. However, it has two focus areas: Aircraft Design and Space Transportation & Exploration.

### **D. Program Delivery Modes**

The BSAE Program is delivered as a traditional lecture / laboratory, daytime program.

### **E. Program Locations**

The BSAE Program is located on the main San Jose State University campus in downtown San Jose.

## **F. Public Disclosure**

BSAE Program Educational Objectives are posted in the Aerospace Engineering Office Suite, all AE laboratories, as well as on the BSAE website:

< <http://www.sjsu.edu/ae/programs/bsae/bsae-peo/> >

BSAE Student Outcomes are posted in the Aerospace Engineering Office Suite, all AE laboratories, as well as on the BSAE website:

< [http://www.sjsu.edu/ae/programs/bsae/bsae\\_program\\_outcomes/](http://www.sjsu.edu/ae/programs/bsae/bsae_program_outcomes/) >

Annual student enrollment and graduation data are posted on the University Institutional Effectiveness and Analytics webpage at <<http://iea.sjsu.edu>>

## **G. Deficiencies, Weaknesses or Concerns from Previous Evaluation(s) and the Actions Taken to Address Them**

None.

## GENERAL CRITERIA

### CRITERION 1 – STUDENTS

#### A. Student Admissions

All new, transfer, and returning students are admitted to San Jose State University by the Office of Admissions, which is part of Enrollment Services, under the Vice President of Student Affairs. Students are provisionally admitted based on self-reported data which is then checked and confirmed after the final transcript due date in July.

##### A.1 Freshman Admissions

Requirements for freshman admissions include the following: (1) high school diploma, (2) A-G requirements, and (3) SAT or ACT test. Approved high school courses for the A-G requirements are listed at [www.ucop.edu/doorways](http://www.ucop.edu/doorways) for all University of California and California State University schools, and are the following: (A) 2 years of history/social science, (B) 4 years of English, (C) 3 years of math, (D) 2 years of laboratory science, (E) 2 years of foreign language, (F) 1 year of visual and performing arts, and (G) 1 year of an elective. An Eligibility Index (EI) is computed from the grades earned in the A-G courses and the SAT/ACT score as follows:

$\text{SAT (sum of math and critical reading scores) + (800 x GPA)}$

or

$(10 \times \text{ACT composite score without writing score}) + (200 \times \text{GPA})$

The minimum EI required varies for resident and non-resident students. The minimum CSU eligibility for California residents is 2,900 (SAT) or 694 (ACT); for domestic out-of-state or international students, the required EI is 3502 (SAT) or 842 (ACT).

Certain high-demand majors went on impactation status in 2010, allowing them to have higher thresholds for admissions to avoid exceeding capacity. The Bachelor of Science in Aerospace Engineering required an EI of 3,800 for the Fall 2017 entering freshmen.

#### B. Evaluating Student Performance

##### B.1 Student Performance and Progress

Student performance and progress is monitored through high-level grade metrics, as well as individually through mandatory advising. At least three grade point averages (GPA) are continually monitored for all students by the College of Engineering, as well

as by the engineering departments: (a) Cumulative GPA, which includes all grades earned at SJSU and community college, if applicable; (b) Major GPA, which includes grades earned in math, science, and engineering courses that count towards the degree, and (c) Term GPA, which includes only courses taken during the current term. All students attend mandatory advising in the Department every semester, during which GPAs and transcripts are reviewed, recommendations for the next semester courses are agreed upon, required paperwork is addressed, and any informal advice and questions can be exchanged. More information on advising is found in Section D.

If a student's Cumulative GPA falls below 2.0 at any point, the SJSU Office of the Registrar puts the student on Probation status, at which point additional advising is required for continued registration. If the Cumulative GPA can be raised above 2.0 at any point thereafter, the student will be back in Good Standing. If the next Term GPA is greater than 2.0 with the next Cumulative GPA less than 2.0, the student will remain on Probation. If both the next Term and Cumulative GPAs are less than 2.0, the student is Disqualified. The one exception to the disqualification condition is for freshmen with less than 30 units and a Term GPA greater than 1.5. These students are allowed a second semester of Probation. These conditions are illustrated in Figure 1.B.1.

In addition, the department implements a policy for Probation in the Major, to supplement the university Probation policy. The intention of the policy was to systematically identify students who were doing poorly in their major courses, but managing to avoid university probation by doing well in the general education courses. Appropriate interventions can then be administered at an earlier point in their academic careers in an effort to get them back on track. The conditions for Probation and Disqualification in the Major are the same as for the university, but using the Major GPA instead of the Cumulative GPA. Engineering students on Probation in the Major are required to attend a Probation Workshop as well as mandatory advising before they can register for the next term. Students who are Disqualified from the Major (but still in Good Standing with the university) have their major changed to "Undeclared". At this point, they can follow the Change of Major policy to get back into their original major, or switch to a different major.

## **B.2 Enforcing Prerequisites**

Prerequisites for courses are checked automatically or manually, depending on the course. Many courses are implemented such that completion of the prerequisites is a pre-condition of registration. In this case, students will not be able to register without meeting the prerequisite. Often, transfer students in their first semester at SJSU will not have their prerequisites taken at community college in the system yet. In this case, students meet the course instructor with transcripts, and a permission code is provided to override the registration restriction if the instructor determines that the prerequisites have been met.



## Academic Probation and Disqualification Process

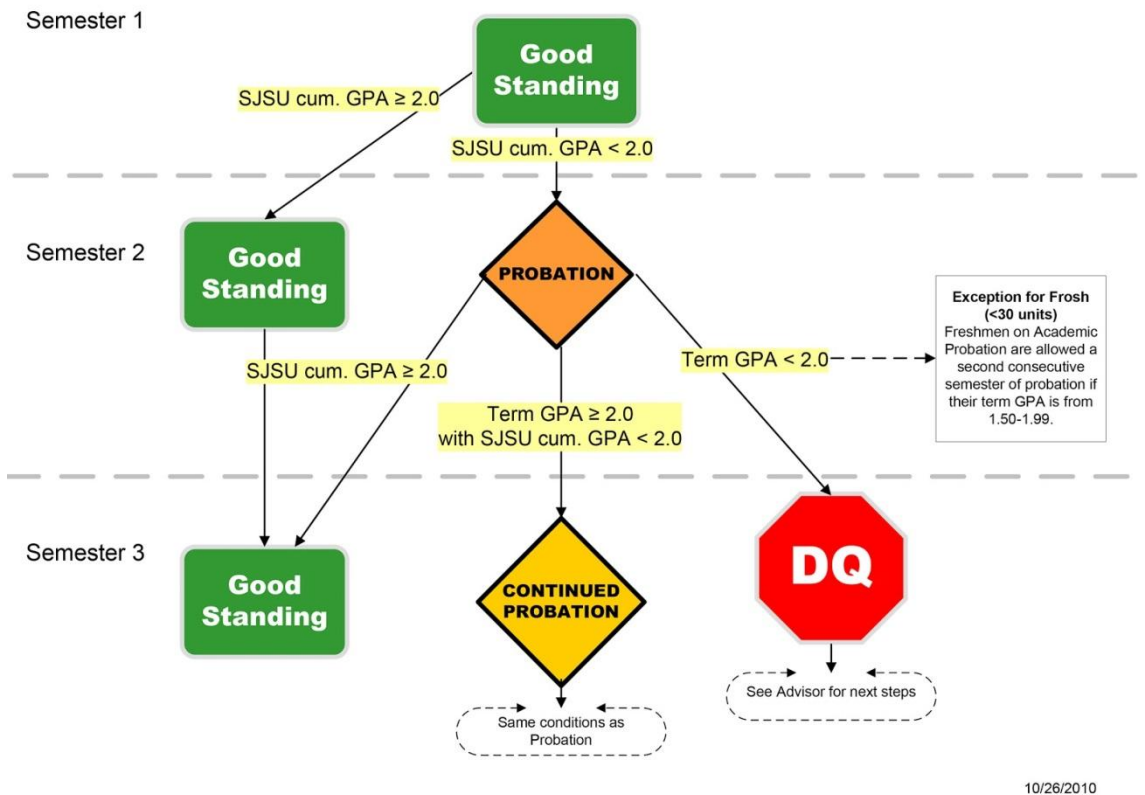


Figure 1.B.1 – SJSU Academic probation and disqualification flowchart (from [www.sjsu.edu/advising/docs/Probation\\_and\\_DQ\\_flowchart.pdf](http://www.sjsu.edu/advising/docs/Probation_and_DQ_flowchart.pdf))

It should be noted, however, that not all prerequisites carry the same weight in terms of student ability to have a meaningful, deep learning experience in a course. Some of the prerequisites listed are absolutely essential; others are simply desirable, listed only to encourage taking courses in a logical sequence. For example, the fundamental prerequisites for all BSAE core courses are Math32 (Calculus III) and Phys50 (Mechanics). No student can possibly succeed in any upper division AE course without a solid background in calculus and mechanics. Hence no student is allowed to take any upper division AE courses without successfully completing these two courses with a grade of “C”<sup>1</sup> or better. Special cases are discussed below.

**Engr.100W** is placed in the first junior semester of the four-year plan to encourage students to take it as soon as possible, as some form of writing is required in every upper division course. It is a desirable but not an essential co-requisite for AE160. Listing Engr.100W as a co-requisite to AE160 results in approximately 90% of the students taking the course in their first junior semester, which satisfies the original intent of urging students to take Engr.100W as soon as possible. A few students, however, are not able to take Engr.100W in their first junior semester for reasons beyond their

<sup>1</sup> “C-” or better in older catalogues.

control. Typically, these are transfer students who take the WST in the summer prior to transferring to SJSU. They are not allowed to preregister for the course before the results of their WST are posted. By the time the WST results are posted, there are very few spaces left in any of the Engr.100W sections offered for the fall, and these spaces may or may not fit the students' schedule. Not allowing these students to take AE160 would unnecessarily add an entire year to their graduation. Students who do not manage to take Engr.100W in their first junior semester take it either in the spring junior semester or during the summer following their junior year. In very few cases, students have been allowed to take Engr.100W as a co-requisite with senior design, again to avoid adding an entire year to their graduation. Under no circumstances, however, are any students allowed to register in their senior design courses without at least taking Engr.100W concurrently.

## **C. Transfer Students and Transfer Courses**

### **C.1 Transfer Admissions**

Requirements for transfer admissions include the following: (1) upper division standing, or 60 or more transferable semester units (90 or more quarter units), (2) overall GPA of 2.0 in transferable courses, and (3) completion of 30 units of general education, including a "C" or better in four basic skills: oral communication, written composition, critical thinking, and mathematics. Engineering majors are exempt from critical thinking, thus transfer applicants to engineering programs are waived from the critical thinking requirement.

In Fall 2014, a campus study identified that a significant fraction of transfer students in the College of Engineering enroll in lower division math and science courses during their first year at SJSU. Furthermore, over 60% of our transfer students do not graduate within 3 years of enrolling at SJSU. In response, all engineering degree programs have initiated the use of supplemental courses for transfer admissions to address both of these concerns for the Fall 2016 cohort. The Aerospace Engineering Program has proposed the use of Calculus I, Calculus II, and Physics I (Mechanics), as such courses. Completion of the supplemental courses, as well as the overall GPA will be factored into the calculation of the score that will be used to rank transfer applicants, as follows:

$$\text{Score} = (\text{GPA} * 150) + (\text{Supplemental Course 1} * 200) + (\text{Supplemental Course 2} * 200) + (\text{Supplemental Course 3} * 200)$$

Admitted students are selected based on ranking and program capacity.

### **C.2 Change of Major into Aerospace Engineering**

To change major into Aerospace Engineering, a Study Plan is required that includes three chemistry, physics, math or engineering courses, totaling between 9 to 12 units, specified by the advisor. The student is required to take these courses at SJSU and

obtain a GPA higher than 2.7 in the three courses, with no individual grade lower than “C”. Change of Major decisions are made after the end of each semester after the semester grades have been posted and verified. The Change of Major forms for the students who have met the requirements are then approved by the Department Chair and College Associate Dean (necessary for more than 90 units) before being sent to the Registrar’s Office where the change of major is recorded.

Starting in Fall 2016, a new Change of Major process was implemented for Undeclared freshmen wishing to declare any engineering major, to streamline advising and maximize placement options for this group. In three semesters or less, these students will be required to complete the following courses, at which point they apply for Change of Major to their first, second, and third choice majors. The courses required to apply to Aerospace Engineering are:

Math 30 (Calculus I), Math 31 (Calculus II), Phys 50 (Mechanics), and Engl 1A (Composition)

Students who do not meet the requirements for the Change of Major are encouraged to choose a different major in which they can be more successful.

### **C.3 Evaluation of Transfer Credit**

Transfer coursework is reviewed when a transfer student begins enrollment at SJSU. Before the student arrives for mandatory Transfer Orientation, they are emailed a Prep Worksheet for Transfer Orientation, which outlines the process of listing and determining transferable credit. During orientation, the student brings the completed worksheet and documentation and meets successively with the campus, the College, and the major advisor in the Department. Professional advising staff in the Engineering Student Success Center (ESSC) are also available during this time to review student work, general education courses, and major requirements.

The University administers transfer acceptance according to the CSU policies. The Department is responsible for ensuring that engineering and support course transfers are properly documented. Some courses within the CSU or UC system have been articulated and no paperwork is required. All lower division courses from CCC have been articulated. Transfer equivalencies for upper division course or courses outside the CCC must be documented with various types of equivalency forms: international and domestic forms are different. In either case, the student must provide a catalogue description and course grade; these documents are submitted to the department which houses the equivalent course, and their evaluator makes a judgment and returns the form to the department. If the course is considered equivalent it is entered into the Major Form; if not, the student is required to take the SJSU course instead.

#### **C.3.1 California Community College Transfer Credit**

There are currently initiatives to facilitate transfer of credit between institutions of California public higher education, including the CCC, CSU, and the UC. The

Intersegmental General Education Transfer Curriculum (IGETC<sup>2</sup>) is a 37 semester-unit pattern for CCC students that fulfills all lower division general education requirements at all CSUs and UCs. Alternatively, the CSU GE Breadth Requirements<sup>3</sup> in the lower division can be fulfilled at the CCC, each of which maintains a list of courses that can be used in each of these areas.

Common Course-ID (C-ID) descriptors have been developed for prerequisite math and science courses, as well as courses in the lower division engineering core. C-IDs specify CCC course number, along with the minimum required content, evaluation methods, and number of units, and are approved by a faculty disciplinary committee. C-ID equivalent courses at any CCC earn transfer credit at any CSU or UC campus that has declared them to be equivalent to an existing course in the curriculum.

Finally, course-to-course articulation agreements are permitted between individual CCCs and CSUs. CCC transfer articulation course credit for SJSU (as well as other CSUs and UCs) can be found on a webpage at [www.assist.org](http://www.assist.org). Transfer students are all aware of the website, and it is used extensively at the CCCs in pre-transfer advising.

### **C.3.2 Non-California Community College Credit**

Students transferring courses from institutions other than California Community Colleges must have their transcripts reviewed by their Major Advisor or an ESSC Advisor to determine who should evaluate their transfer credit and make the decision of whether their work is substantially equivalent to SJSU requirements. This is done by filling out an Equivalency Form which is circulated to the department which offers the relevant course at SJSU, along with the transcript; sometimes a catalog description or other course materials may be required. The chairperson, or designee, of the program responsible for the discipline at SJSU must attest to the equivalency of the course before credit is given. Courses from International institutions are evaluated on a separate document from those from domestic institutions. Admissions and Records assign the course to upper or lower division status and indicate the equivalent transfer units that can be allowed for the course. However, the same process of reviewing the content is carried out by the relevant department at SJSU.

## **D. Advising and Career Guidance**

Continuing students are required to obtain advising from their major department's academic advisor – a faculty member – every semester before they can register for classes for the subsequent semester. All College of Engineering students have a registration hold until they see an advisor, at which point they are cleared to register. Advising related to course selection for the subsequent semester may begin as early as the third week of each semester, after the deadline to add, when student schedules have been finalized. Students are requested, via email, to sign up for advising

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<sup>2</sup> <<http://www.calstate.edu/transfer/requirements/csustudents.shtml>>

<sup>3</sup> <<http://www.calstate.edu/transfer/requirements/csustudents.shtml>>

appointments on line, thus enabling advising of the vast majority of the students before the date on which registration for the subsequent semester begins. A small fraction (approximately 10%) of the students do not respond to these messages and trickle in for late advising once they realize there is a hold on their registration. In some instances, this may impact their ability to register for high-demand classes, especially the lower division math, chemistry, physics, biology and engineering courses outside the department.

The Major Advisor, who is a faculty member, provides guidance on which courses to take as well as reviews the student's road map. They also provide guidance in selecting technical electives, finding internships, and considering career options.

The meeting with the advisor includes the following at a minimum:

- Decide which classes to enroll in for the following semester
- Discuss possible program emphasis
- Suggest elective courses
- Make the student aware of university rules pertinent to student graduation
- Explain the university's general education requirements. Students are recommended to receive advising from a general education advisor at the Engineering Student Success Center.
- Notify the student that the graduation packet needs to be completed and submitted if he/she plans to graduate within three semesters
- Update student communication data.

Each semester the advisor updates the student's BSAE Course Log, a sample of which is included in **Appendix E**, indicating the courses agreed to be taken in the following semester. Once the advising has occurred, the advising hold is removed to enable the student to register for his/her courses.

Advising may also include special recommendations to the student regarding

- Career advice
- Internship suggestions
- Study skills for improved performance

The College of Engineering has an Engineering Student Success Center (ESSC), which provides supplementary advising and student support programs. The services provided by the ESSC include the following:

- Remedial advising
- "Pre-engineering" advising (students who are not yet calculus-ready)
- Lower division pathways (custom roadmaps for the lower division general education and major requirements)
- Change of major
- General engineering checklists (for graduation applications)
- University policies (probation, disqualification, reinstatement)
- Referrals (counseling, accessibility education center, career center)
- MESA engineering program

- Student organization support and WIE

The ESSC is staffed by professional advisors, instructor advisors, and peer mentors, and offers advising appointments, drop-in hours, and workshops. The webpage for the ESSC is found on the College of Engineering webpage:

<<http://engineering.sjsu.edu/student-success/engineering-student-success-center>>

Student Advising is also available through the Academic Advising and Retention Services (AARS), which primarily helps with GE, University probation, progress to degree and other aspects of advising that are not specific to engineering. AARS advisors hold advising hours in the ESSC as well, which ensures that the College and the University are aware of all policies which affect our students. Both faculty and staff advisors also maintain relationships with counselors in the Accessible Education Center (AEC) so that special student situations can be handled.

The Learning Assistance Resource Center (LARC) provides tutoring in most lower division math, science and engineering courses, often hiring students from the College as tutors. In addition, the Writing Center, established in 2008 and located in Clark Hall, provides excellent instruction and tutoring for students in upper division (and graduate) courses with writing components.

AE students see the same advisor every semester, who keeps track of their progress on their BSAE Course Log (Appendix E). Ms. Hunter advises all freshmen and sophomores; Dr. Mourtos advises all transfers, juniors, and seniors, including those applying for graduation. Advisors maintain a soft copy of each student's Course Log on their laptop; they also email an updated copy to the student after each advising session. To see their advisor, AE students may make an appointment online<sup>4</sup>, request one via email or simply use the drop-in advising hours on a first-come / first-serve basis. Students are encouraged to email any advising questions or come back for another advising session. Many students receive advising multiple times during each semester.

## **E. Work in Lieu of Courses**

SJSU policies comply with Executive Order No. 1036, governing system-wide credit awarded for examinations, experiential learning, and instruction in non-collegiate settings. This executive order also establishes a framework for annual review and revision of academic credit for external examinations (such as Advanced Placement), and gives campuses additional clarity on how to apply ACE-recommended academic credit for military service. Campuses are encouraged to use this policy in determining the number of credits veterans have upon admission.

For Credit by Exam (CBE) the student registers and pays and if she/he passes the course prior to the Drop Deadline, earns a Credit By Examination (CBE) which shows on the transcript. Administration of such exams is at the discretion of the Instructor and not all course grades can feasibly be based on examinations only. Waiver Exams (WE) are

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<sup>4</sup> <<http://www.sjsu.edu/ae/students/advising/index.html>>

administered by the Testing Center. These satisfy the requirement, but do not earn baccalaureate credit. CBE and WE are rarely if ever applied to engineering requirements.

Military credit may be used to satisfy Area E (Human Understanding) with submission of the DD214 or DD295 showing one year of active duty.

SJSU grants credit toward its undergraduate degrees for successful completion of examinations of the Advanced Placement Program of the College Board. Students who present scores of three or better will be granted up to six semester units (nine quarter units) of college credit. The number of units granted, course equivalence, and satisfaction of requirements vary. The Table below shows only the AP courses which give credit within the Engineering programs. Many other AP courses do provide GE credit. Note that the Chemistry credit is not for the required Chem 1A course so it is not included on this Table 1.E.1

Table 1.E.1 – AP courses which are credited within engineering programs

<b>Exam</b>	<b>Units</b>	<b>Course</b>
Calculus AB*	3	MATH 030
Calculus BC*	6	MATH 030 & 031
Computer Science A	3	CS 046A
Physics C, Mechanic#	4	PHYS 050
Physics C, Elec & Mag#	4	PHYS 051

Similar documentation exists for IB and CLEP coursework.

## **F. Graduation Requirements**

The graduation requirements for the Bachelor of Science in Aerospace Engineering are described in this section.

### **F.1 University Graduation Requirements**

The following graduation requirements apply to all undergraduate majors at San Jose State University, including all majors in the College of Engineering:

- General Education
- American Institutions
- Major Coursework
- Minor Coursework (if applicable)
- GPA requirements: Overall GPA of 2.0 or better in all college coursework, units taken at SJSU, and in major coursework

- Residence requirements: At least 30 units must be earned while matriculated at SJSU, of which 24 must be upper division, 12 must be in the major, and 9 must be in general education
- Unit requirements: At least 120 semester units of credit
- Upper division requirements: At least 40 units must be in the upper division, of which 18 must be in the major

## **F.2 General Education, American Institutions, and Major Coursework**

Please see Criterion 5 for Curriculum.

## **F.3 Application for Graduation and Verification**

Approximately one year prior to graduation, students submit a graduation application to the Registrar's Office at San Jose State University, consisting of the following:

- Application for Graduation (requires signature of applicant and major advisor)
- Major Form (requires signature of major advisor)
- Minor Form (if applicable, requires signature of minor advisor)
- General Education Checklist (requires signature of ESSC advisor)

Any articulated courses from community college and/or transcripts for equivalent courses that have not been submitted to the university at the time of the graduation application are due with the Graduation Application.

The Registrar's Office then emails a Graduation Worksheet to the student prior to the graduation date. The Graduation Worksheet lists the requirements left to complete the degree, and serves as the contract between the student and the university.

Degrees are conferred three times per year: August (Summer), December (Fall), and May (Spring). The date of the diploma reflects the term for which all degree requirements were completed.

Sample forms for the Graduation Application Form are found in Appendix F.

## **G. Transcripts of Recent Graduates**

The program will provide transcripts from some of the most recent graduates to the visiting team along with any needed explanation of how the transcripts are to be interpreted. **These transcripts will be requested separately by the Team Chair.** State how the program and any program options are designated on the transcript. (See 2017-2018 APPM, Section I.E.3.a.)



## CRITERION 2 – PROGRAM EDUCATIONAL OBJECTIVES

As discussed below, the BSAE Program Educational Objectives (PEO) have been developed to be consistent with the mission of San José State University (SJSU), the mission of the College of Engineering (CoE), the mission of the Department of Aerospace Engineering, and the expectations of our constituents.

### A. San José State University

San José State University is a major comprehensive public university located in the city of San José and in the heart of Silicon Valley, one of the world's innovation centers. Its distinctive character has been forged by its long history (it is the oldest public institution of higher learning in California), by its location, and by its vision – a blend of the old and the new, of the traditional and the innovative. Among its most prized traditions is a commitment to offer access to high-quality higher education to all persons who meet the criteria for admission. The result is a diverse student population whose members are from various age groups, ethnicities, and economic backgrounds; and a faculty dedicated to teaching and learning.

#### A.1 San José State University Mission

The mission statement of San Jose State University is:

*In collaboration with nearby industries and communities, SJSU faculty and staff are dedicated to achieving the university's mission as a responsive institution of the state of California: To enrich the lives of its students, to transmit knowledge to its students along with the necessary skills for applying it in the service of our society, and to expand the base of knowledge through research and scholarship.*

Source: <[http://www.sjsu.edu/about\\_sjsu/mission/](http://www.sjsu.edu/about_sjsu/mission/)>

##### A.1.1 University Learning Goals

The University Learning Goals set an expectation that SJSU students will develop:

- A. Specialized Knowledge
  - a. Depth of knowledge required for a degree, as identified by its program learning outcomes.
- B. Broad Integrative Knowledge
  - a. Mastery in each step of an investigative, creative or practical project (e.g. brainstorming, planning, formulating hypotheses or complex questions, designing, creating, completing, and communicating).

- b. An understanding of the implications of results or findings from a particular work in a societal context (e.g. social or economic implications of a scientific finding).
  - c. Students graduating with a baccalaureate degree will have demonstrated an understanding of critical components of broad academic areas, the arts, humanities, social sciences, and sciences and their integration.
- C. Intellectual Skills
- a. Fluency in the use of specific theories, tools, technology and graphical representation.
  - b. Skills and abilities necessary for lifelong learning: critical and creative thinking, effective communication, conscientious information gathering and processing, mastery of quantitative methodologies, and the ability to engage effectively in collaborative activities.
- D. Applied Knowledge
- a. The ability to integrate theory, practice, and problem-solving to address practical issues.
  - b. The ability to apply their knowledge and skills to new settings or in addressing complex problems.
  - c. The ability to work productively as individuals and in groups
- E. Social and Global Responsibilities
- a. The ability to act intentionally and ethically to address a global or local problem in an informed manner with a multicultural and historical perspective and a clear understanding of societal and civic responsibilities.
  - b. Diverse and global perspectives through engagement with the multidimensional SJSU community.

## **A.2 Davidson College of Engineering Mission**

The Mission of the College of Engineering is to transform lives by preparing engineering students and professionals to be ready and able to fully contribute to the innovation, entrepreneurship and leadership of Silicon Valley and beyond. Through a cutting-edge learning environment, applied research, and scholarly activity, we develop lifelong learners who are excellent in their fields, globally informed and socially responsible.

*Source: <<http://engineering.sjsu.edu/files/public/media/strategic-plan/five-year-strategic-plan-2014-2019.pdf>>*

The College of Engineering undertook a strategic planning process under the leadership of Dean Andrew Hsu in the fall semester of 2013. The college faculty and staff, with feedback from students, alumni, and industry partners, collectively developed a five-year strategic plan that will serve as a road map to guide our decision-making and shape future programs and initiatives. The three strategic priorities that emerged are: 1) creating innovative and experiential learning environments, 2) engaging in scholarly activity and relevant research, and 3) strengthening industry and community partnerships.

### **A.3 Department of Aerospace Engineering Mission**

The mission of the Aerospace Engineering Department is to serve society, the public sector, and private industry by:

- Providing undergraduate and graduate aerospace engineering education that prepares students with the knowledge, modern applications, and lifelong learning skills required to serve the aerospace engineering profession and industry.
- Contributing to the development and application of knowledge through faculty scholarship.
- Preparing students for the modern professional-practice environment.

### **B. Program Educational Objectives**

The BSAE Program Education Objectives reflect our constituent's expectations that our graduates will:

1. Hold positions of technical responsibility, as members or leaders of multi-disciplinary teams engaged in aerospace engineering problem solving, modeling, systems analysis, design, development, testing or research.

*[Aligned with University Learning Goals: Specialized Knowledge, Broad Integrative Knowledge, Intellectual Skills, Applied Knowledge, Social and Global Responsibilities]*

2. Have enhanced and continue to enhance their professional skills by pursuing / completing a graduate degree or other post-graduate training.

*[Aligned with University Learning Goal: Intellectual Skills]*

3. Are well rounded in their understanding of multicultural and global perspectives and work effectively with engineers and customers from around the world, while providing for issues such as public safety, honest product marketing, and respect for intellectual property.

*[Aligned with University Learning Goals: Broad Integrative Knowledge, Intellectual Skills, Social and Global Responsibilities]*

The BSAE Program Educational Objectives are posted on the AE Department website

<<http://www.sjsu.edu/ae/programs/bsae/bsae-peo/>> and are as follows:

### C. Consistency of the Program Educational Objectives with the Mission of San José State University

The BSAE Program Educational Objectives and closely aligned with the University Learning Goals. The relationship is shown in Section B above as well as in Figure 2.1 below.

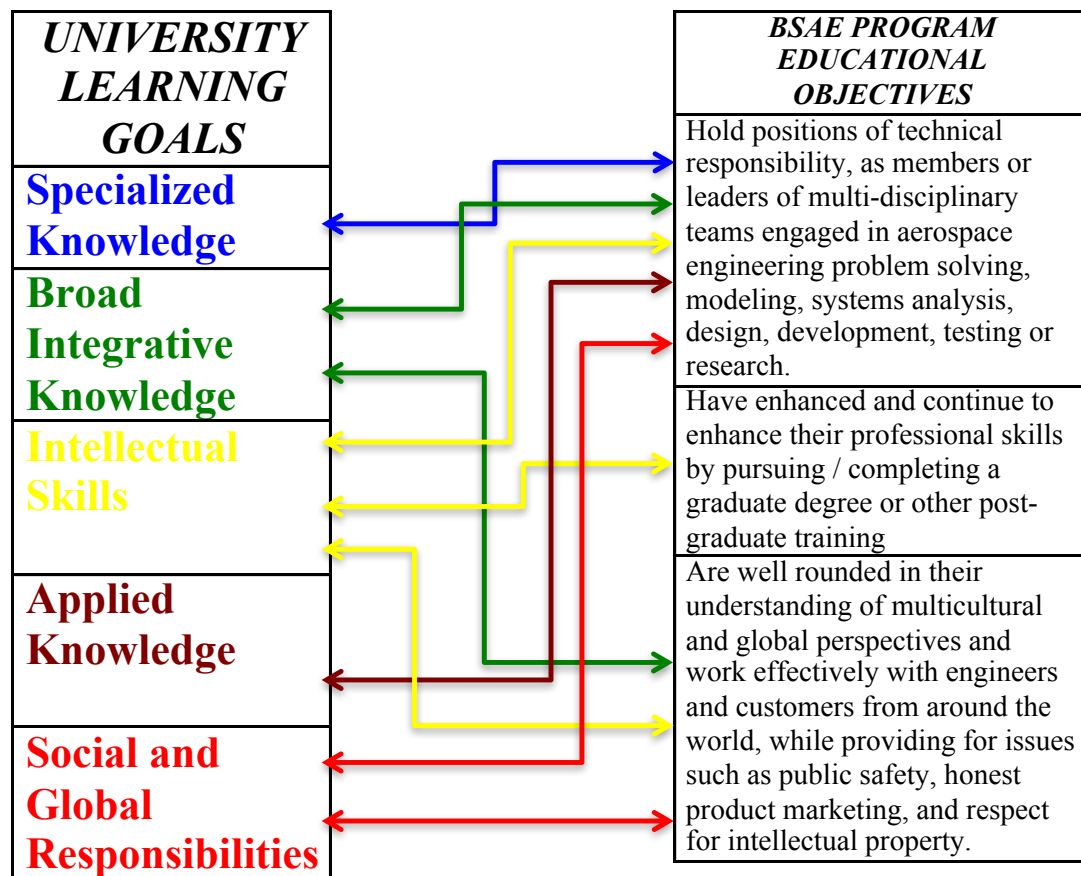


Figure 2.1 – BSAE Program Educational Objectives / University Learning Goals map.

## **D. Program Constituencies**

The BSAE Program has identified the following as its constituencies:

### ***AE Students***

The primary goal of the BSAE Program, as reflected in the University mission and the PEO, is twofold: to prepare students for (a) a successful career in their chosen field, and (b) responsible citizenship in a multicultural, globalized world. Hence, it is only reasonable that student input is taken into consideration when defining the PEO. This input is solicited through exit interviews of graduating seniors, when students are mature enough and have had some experience in job searching.

### ***AE Program Faculty***

The AE faculty manage the educational process and have an understanding of the current skills and knowledge required to practice in the field as well as a vision for the future. Moreover, the AE faculty are responsible for Program assessment and the implementation of a process for the continuous improvement of the Program. Hence, their input is important in defining the PEO.

### ***AE Program Alumni***

The alumni, especially a few years after graduation, are likely to gain additional perspectives about AE in general and more specifically, about the Program from which they graduated. Alumni have a unique view of how the Program has supported their career goals and professional accomplishments. Hence, their input is critical in ensuring to the appropriateness of the PEO.

### ***AE Employers***

PEO should be strongly influenced by the needs and opinion of current and potential employers of our graduates. Employer satisfaction with our graduates reflects a positive image for our Program and gives a competitive advantage for our graduates.

### ***AE Advisory Board (AEAB)***

The AE Program has its own Advisory Board (see Appendix F). It consists of representatives from key companies and government organizations (Space Systems Loral, Lockheed-Martin, Cessna, and NASA), as well as smaller companies (Kespry, etc.) which employ our graduates. The AEAB was formed in 2005 and the goal is to convene twice a year to:

- Provide guidance on current AE industrial trends and the kinds of skills aerospace engineers need to have to succeed in today's industry.
- Assess how well the BSAE Program prepares students in these skills.

- Help establish an ongoing, productive relationship between the AE Program and their companies / government organizations through student internships, faculty research grants, and equipment donations for instructional purposes.

## **E. Process for Review of the Program Educational Objectives**

The process for reviewing the BSAE PEO involves the following:

- Exit surveys – Graduating seniors are surveyed every spring by the Department and the College. For the College survey, the results are disaggregated by program. Both surveys provide input for validating current PEO or introducing new ones.
- Alumni surveys – Alumni are typically surveyed every six years to solicit input on PEO.
- AE Advisory Board meeting – The Board represents the various companies and government organizations in which our graduates are employed and re-evaluates the PEO every six years.
- AE Department meeting or retreat – The AE faculty convene in a Department meeting or retreat to re-evaluate the BSAE PEO based on feedback received from our constituencies and revise / update the PEO as necessary.

## CRITERION 3 – STUDENT OUTCOMES

### A. Student Outcomes

The student outcomes for the BSAE degree are posted on the AE Department website at:

< [http://www.sjsu.edu/ae/programs/bsae/bsae\\_program\\_outcomes/](http://www.sjsu.edu/ae/programs/bsae/bsae_program_outcomes/) > and are as follows:

At the time of graduation students are expected to have an...

**Outcome A** – Ability to use mathematics, science, and engineering principles to identify, formulate, and solve aerospace engineering problems.

*[Aligned with University Learning Goals: Specialized Knowledge, Intellectual Skills, Applied Knowledge]*

**Outcome B** – Ability to design and conduct aerospace engineering experiments, as well as to analyze and interpret data from such experiments.

*[Aligned with University Learning Goals: Specialized Knowledge, Intellectual Skills, Applied Knowledge]*

**Outcome C** – Ability to perform conceptual and preliminary design of aircraft or spacecraft to meet a set of mission requirements within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

*[Aligned with University Learning Goals: Specialized Knowledge, Broad Integrative Knowledge, Intellectual Skills, Applied Knowledge, Social and Global Responsibilities]*

**Outcome D** – Ability to collaborate with people from different cultures, abilities, backgrounds, and disciplines to complete aerospace engineering projects.

*[Aligned with University Learning Goals: Broad Integrative Knowledge, Intellectual Skills, Applied Knowledge, Social and Global Responsibilities]*

**Outcome E** – Ability to communicate effectively through technical reports, memos, and oral presentations as well as in small group settings.

*[Aligned with University Learning Goals: Intellectual Skills, Applied Knowledge]*

**Outcome F** – Understanding of professional and ethical responsibility.

*[Aligned with University Learning Goals: Broad Integrative Knowledge, Intellectual Skills, Social and Global Responsibilities]*

**Outcome G** – Broad education to understand current events, how they relate to aerospace engineering, as well as the impact of engineering solutions in a global and societal context.

*[Aligned with University Learning Goals: Broad Integrative Knowledge, Intellectual Skills, Social and Global Responsibilities]*

**Outcome H** – Recognition of the need for, and ability to engage in life-long learning.

*[Aligned with University Learning Goal: Intellectual Skills]*

**Outcome I** – Ability to use the techniques, skills, and modern engineering tools (analytical, experimental, and computational) necessary for engineering practice.

*[Aligned with University Learning Goals: Specialized Knowledge, Broad Integrative Knowledge, Intellectual Skills, Applied Knowledge]*

The mapping of the BSAE Student Outcomes with the original eleven ABET Student Outcomes is shown in Table 3.1, while Figure 3.1 shows the relationship of the BSAE Student Outcomes with the University Learning Goals.

Table 3.1 – BSAE Student Outcomes / Original ABET Student Outcomes map.

BSAE Student Outcomes	A	B	C	D	E	F	G	H	I
Original ABET Outcomes	(a), (e)	(b)	(c)	(d)	(g)	(f)	(h), (j)	(i)	(k)



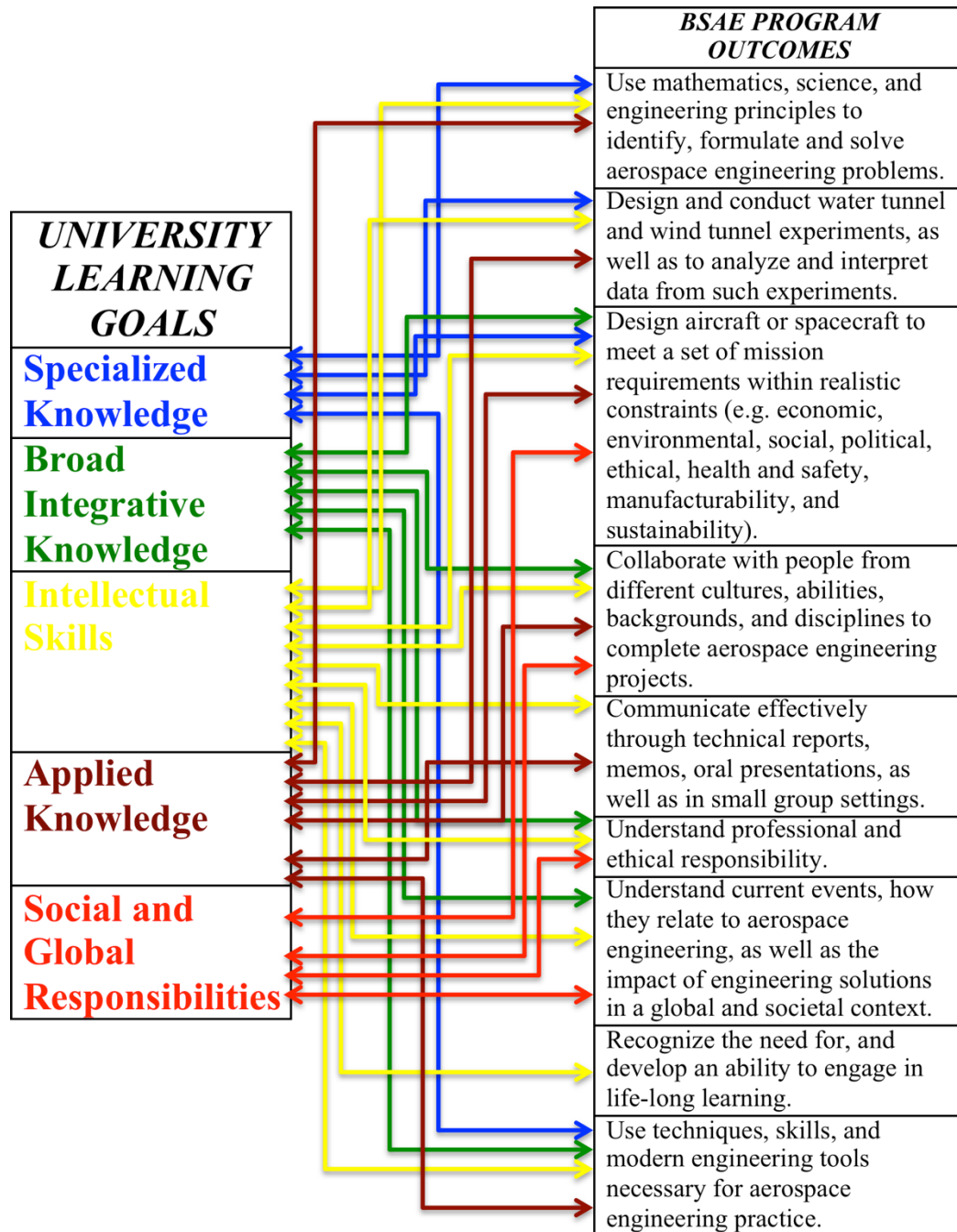


Figure 3.1 – BSAE Student Outcomes / University Learning Goals map.

The original BSAE Student Outcomes (a) and (e) were merged into BSAE Outcome A because the AE faculty felt that ability to identify, formulate, and solve AE problems very much depends on ability to apply mathematics, science and engineering principles. Similarly, the original ABET Outcomes (h) and (j) were merged into BSAE Outcome G

because the broad education necessary to evaluate the impact of engineering solutions in a global / societal context also contributes to, and depends on one’s understanding of current events and how these events are influenced by technology.

## **B. Relationship of Student Outcomes to Program Educational Objectives**

The PEO are linked to the Student Outcomes as shown in Table 3.2.

Table 3.2 – Mapping of BSAE Student Outcomes to the PEO.

	Student Outcomes								
<i>BSAE</i>	A	B	C	D	E	F	G	H	I
<i>PEO # 1</i>	O	O	O	O	O	O		O	O
<i>PEO # 2</i>	O							O	O
<i>PEO # 3</i>			O	O		O	O		

To “*hold positions of technical responsibility, as members or leaders of multi-disciplinary teams engaged in aerospace engineering problem solving, modeling, systems analysis, design, development, testing or research*” (PEO # 1) students must have an ability to apply math science and engineering (Outcome-A), laboratory skills (Outcome-B), design skills (Outcome-C), modern tools (Outcome-I), as well as an ability to communicate well (Outcome-E), and work effectively with others (Outcome-D). Furthermore, they will be expected to act professionally and ethically in everything they do in their work (Outcome-F). Lastly, considering the pace at which the aerospace engineering field and other related fields are evolving with emerging technologies, students will need solid lifelong learning skills to continue to learn new things on their own in the workplace as well as outside the workplace (Outcome-H).

To “*continue to enhance their professional skills by pursuing / completing a graduate degree or other post-graduate training*” students again need a solid foundation in math, science and engineering (Outcome-A), problem solving skills (Outcome-A), familiarity with and ability to use modern tools (Outcome-I), and of course, lifelong learning skills (Outcome-H).

To ensure they “*are well rounded in their understanding of multicultural and global perspectives and work effectively with engineers and customers from around the world, while providing for issues such as public safety, honest product marketing, and respect for intellectual property*”, students must have an understanding of how their work affects public safety, their communities in general but also the world-at-large (Outcomes-C, G). They must have the interpersonal and team skills, including openness to different perspectives and a sensitivity to different cultures, so they can work effectively with colleagues and customer at work as well as interact with community and / or government members, some of whom may come from different parts of the world (Outcomes-D, G). These outcomes are certainly strengthened through their interaction with a very multicultural student body at SJSU as well as their General Education

coursework, especially in their senior year, where General Education outcomes in areas S (Self & Society) and V (Technology & Civilization) are integrated into their senior design projects (AE171A&B / AE172A&B and Engr.195A&B).

# CRITERION 4 – CONTINUOUS IMPROVEMENT

## A. Student Outcomes

### A.1 Process for Outcome Assessment and Evaluation

The process for assessing and evaluating each outcome is illustrated in Figure 4.1. and discussed below. The Department Chair coordinates the assessment of all the BSAE student outcomes. Each faculty member takes responsibility to coordinate several courses as well as to champion several outcomes. The responsibilities for each of these roles were revisited in the AE Department meeting on March 9, 2016 and are described below.

### A.2 Course Coordinators

The responsibilities of course coordinators are described in the following sections.

#### A.2.1 Course syllabus

Ensure a current and approved course syllabus, following our common AE format, is posted on the BSAE / MSAE website. Each syllabus must contain the following information and in the following order:

- Course number and title
- Instructor information
- Credit (# of units)
- Class days and time
- Classroom
- Prerequisites and co-requisites
- Textbook or notes availability
- Course website (if available)
- Course description as approved by the AE faculty
- Course goals as approved by the AE faculty
- Course learning objectives (CLOs) as approved by the AE faculty
  - A minimum of 12
  - Clear, measurable, and AE-specific
  - Include several CLOs at level 4 in Bloom's Taxonomy to ensure students completing the course have working knowledge of the material.
- Approximate weekly schedule
- Grading
- Any other relevant information pertaining to CANVAS, labs, projects, etc.

Note: AE Department and SJSU policies are posted and kept updated on a separate link on the AE website.

### Flow Chart for Outcome Assessment and Evaluation

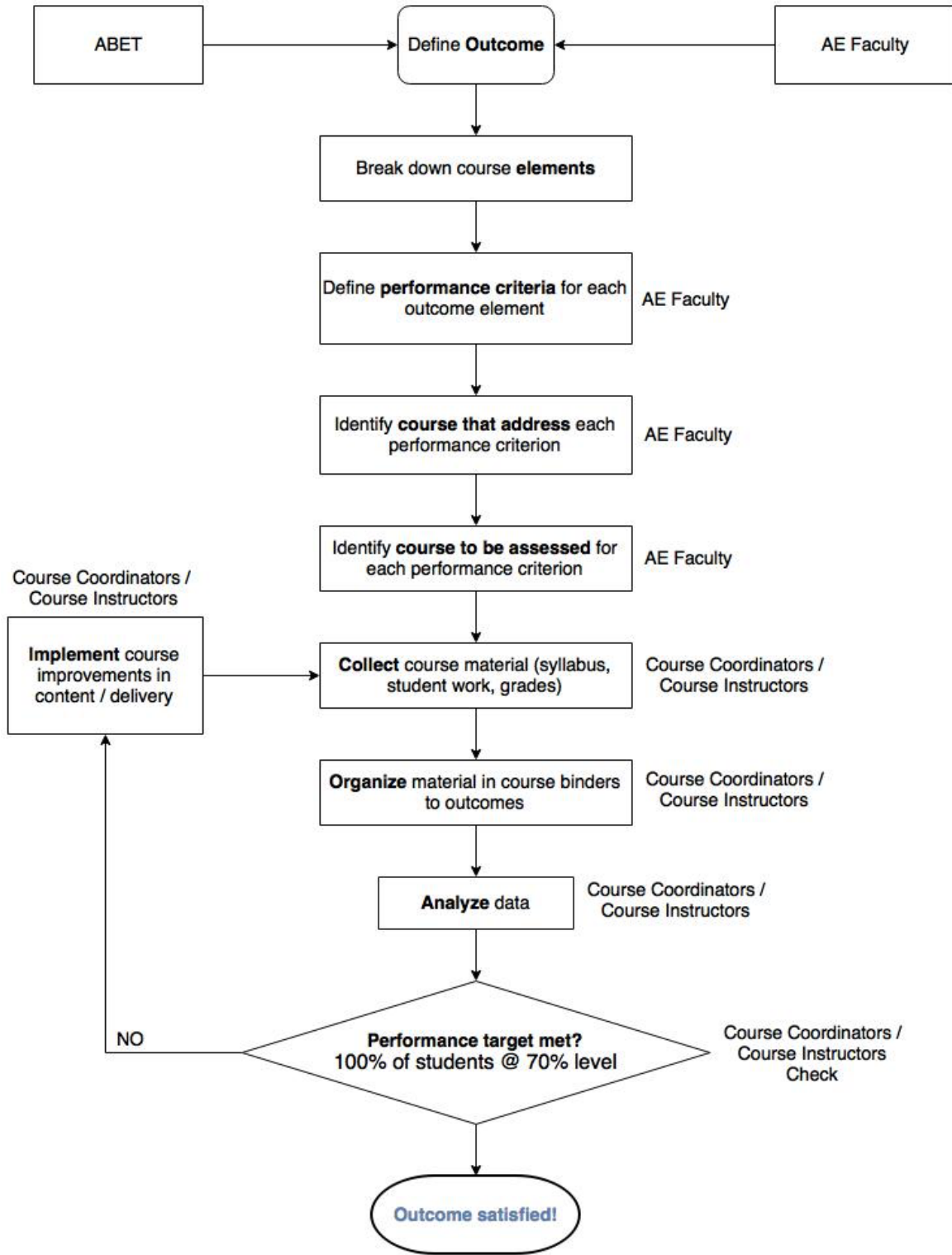


Figure 4.1 – Outcome assessment flow chart.

### A.2.2 Peer evaluations

Visit each course they coordinate and taught by a lecturer at least once during the semester and conduct a peer evaluation using the AE Peer Evaluation Form (Appendix H). A copy of the form should be given to and discussed with the PTF member. Another copy should be given to the AE Department Chair for placement in the faculty member's departmental file.

### A.2.3 Course assessment

- **If teaching** the course in the current semester: collect and analyze data and provide a write up – including recommendations and timeline for implementation of improvements – to the chair for inclusion in AE Annual Assessment Report, ABET Self-Study Report, and AE Self-Study Report (WASC).
- **If not teaching** the course in the current semester: work with faculty member currently teaching the course to ensure that appropriate data is collected and analyzed and a write up – including recommendations and timeline for implementation of improvements – is provided to the chair for inclusion in AE Annual Assessment Report, ABET Self-Study Report, and AE Self-Study Report (WASC).
- **Course binder:** Set up a course binder that includes:
  - ✓ The approved course syllabus
  - ✓ The course outcome analysis
  - ✓ The course grading spreadsheet with student names removed
  - ✓ Sample student work for each outcome addressed in the course (homework assignments, reports, exams, etc.) for one “A”, one “B”, and one “C” student.

## A.3 Outcome Champions

The responsibilities of outcome champions are as follows:

- Assume **ownership** and **overall responsibility** for their outcome.
- Strive to ensure that the program (BSAE or MSAE) **meets the performance target** for their particular outcome.
- Look for ways to **improve student performance** in the particular outcome, regardless of whether the performance target is met or not.
- Combine data and analyses from all courses in which their outcome is assessed to write an **overall assessment** for the specific outcome. This overall assessment must provide one of two conclusions:
  - The performance target **is met** for Outcome X.
  - The performance target **is not met** for Outcome X.
- **Recommend** course and/or curriculum improvements to strengthen the outcome and improve student performance.

## A.4 Outcome Elements and Performance Indicators

Because outcomes are rather comprehensive and difficult to assess as stated, AE faculty have broken down each outcome into **outcome elements** (Table 4.1). These elements represent the different abilities specified in a single outcome that would generally require different assessment measures. The process of dividing outcomes into elements allows for sufficient resolution in the assessment of each outcome. Moreover, it makes possible the effective implementation of specific course and curriculum improvements that address areas of concern.

Furthermore, for each outcome element AE faculty have defined **performance indicators**, i.e. student actions that explicitly demonstrate mastery of the abilities specified in an outcome element (Table 4.1). These criteria are categorized using the 6 levels of Bloom’s taxonomy in the cognitive domain or 5 levels in the affective domain. In several outcomes where the embedded skills were unclear, AE faculty have introduced rubrics to facilitate the assessment of the performance criteria associated with a particular outcome element. The BSAE Student Outcomes analyzed into elements and performance indicators are shown in Table 4.1.

Table 4.1 – Student outcomes, outcome elements and performance criteria

A: Ability to use mathematics, science, and engineering principles to identify, formulate and solve aerospace engineering problems.			
<i>Outcome Elements: Ability to...</i>			
A-1: Apply mathematics.	A-2: Apply physics.	A-3: Apply engineering principles.	A-4: Identify, formulate and solve AE problems.
<i>Performance Indicators</i>	<i>Performance Indicators</i>	<i>Performance Indicators</i>	<i>Performance Indicators</i>
A-1.1: Apply calculus	A-2.1: Draw free-body diagrams	A-3.1: Apply aerospace structures principles	A-4.1: Engage in the solution of problems (spend adequate time on task, ask questions, etc.).
A-1.2: Derive and use differential equations	A-2.2: Apply Newton’s laws of motion	A-3.2: Apply aerospace dynamics principles	A-4.2: Define (open-ended) problems in appropriate engineering terms.
A-1.2: Use linear algebra	A-2.3: Apply physics concepts (e.g. angular momentum, friction, et.)	A-3.3: Apply aerodynamics principles	A-4.3: Explore problems (i.e., examine various issues, make appropriate assumptions, etc.).
		A-3.4: Apply flight mechanics principles	A-4.4: Develop a plan for the solution (i.e., select appropriate theories, principles, approaches).
		A-3.5: Apply aerospace propulsion	A-4.5: Implement the solution plan and check the accuracy of calculations.

		principles	
		A-3.6: Apply stability and control principles	A-4-6: Evaluate results and reflect on personal strengths and weaknesses.

<b>B: Ability to design and conduct aerospace engineering experiments, as well as to analyze and interpret data from such experiments.</b>			
<i>Outcome Elements: Ability to...</i>			
<b>B-1: Design H<sub>2</sub>O and wind tunnel experiments.</b>	<b>B-2: Conduct H<sub>2</sub>O and wind tunnel experiments.</b>	<b>B-3: Analyze data from H<sub>2</sub>O and wind tunnel experiments.</b>	<b>B-4: Interpret data from H<sub>2</sub>O and wind tunnel experiments.</b>
<i>Performance Indicators</i>	<i>Performance Indicators</i>	<i>Performance Indicators</i>	<i>Performance Indicators</i>
<b>B-1.1: Define goals and objectives for the experiment.</b>	<b>B-2.1: Given an experimental setup, become familiar with the equipment, calibrate the instruments to be used, and follow the proper procedure to collect the data.</b>	<b>B-3.1: Given a set of experimental data, carry out the necessary calculations and tabulate/plot the results using appropriate choice of variables and software.</b>	<b>B-4.1: Given a set of results in tabular or graphical form, make observations and draw conclusions regarding the variation of the parameters involved.</b>
<b>B-1.2: Research relevant theory and published data from similar experiments.</b>			<b>B-4.2: Given a set of results in tabular or graphical form, compare with theoretical predictions and/or other published data and explain any discrepancies.</b>
<b>B-1.3: Select the dependent and independent variables to be measured.</b>			
<b>B-1.4: Select appropriate methods for measuring/controlling each variable.</b>			
<b>B-1.5: Select a proper range for the independent variables.</b>			



B-1.6: Determine an appropriate number of data points for each type of measurement.			
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C: Ability to perform conceptual and preliminary design of aircraft or spacecraft to meet a set of mission requirements within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
<i>Performance Indicators</i>
C-1: Research, evaluate, and compare vehicles designed for similar missions.
C-2: Follow a prescribed process to develop the conceptual / preliminary design of an aerospace vehicle.
C-3: Develop economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability constraints and design a vehicle that meets these constraints.
C-4: Select an appropriate configuration for an aerospace vehicle with a specified mission.
C-5: Apply AE principles (e.g. aerodynamics, structures, flight mechanics, propulsion, stability and control) to design various vehicle subsystems.
C-6: Develop and compare alternative configurations for an aerospace vehicle, considering trade-offs and appropriate figures of merit.
C-7: Develop final specifications for an aerospace vehicle.

D: Ability to collaborate with people from different cultures, abilities, backgrounds, and disciplines to complete aerospace engineering projects.
<i>Performance Indicators</i>
D-1: Committed to the team and the project, dependable, faithful, reliable. Attends all meetings; arrives on time or early. Comes to the meetings prepared and ready to work.
D-2: Leadership: takes initiative, makes suggestions, provides focus. Creative, brings energy and excitement to the team. Has a “can do” attitude. Sparks creativity in others.
D-3: Gladly accepts responsibility for work and gets it done; spirit of excellence.
D-4: Has abilities the team needs. Makes the most of these abilities. Gives fully, doesn’t hold back.
D-5: Communicate ideas clearly when speaking and writing. Understands the direction of the team.
D-6: Personality: positive attitudes, encourages others, seeks consensus, brings out the best in others.

E: Ability to communicate effectively through technical reports, memos, and oral presentations as well as in small group settings.	
<i>Outcome Elements: Ability to ...</i>	
E-1: Communicate in writing	E-2: Communicate orally
<i>Performance Indicators</i>	<i>Performance Indicators</i>
E-1.1: Produce well-organized reports, following guidelines.	E-2.1: Give well-organized presentations, following guidelines.

E-1.2: Use appropriate graphs and tables following published engineering standards to present results.	E-2.2: Make effective use of visuals.
E-1.3: Use clear, correct language and terminology while describing experiments, projects or solutions to engineering problems.	E-2.3: Present the most important information about a project / experiment, while staying within allotted time.
E-1.4: Describe accurately in a few paragraphs a project / experiment performed, the procedure used, and the most important results (abstracts, summaries).	

<b>F: Understanding of professional and ethical responsibility.</b>
<i>Performance Indicator</i>
Given a job-related scenario that requires a decision with ethical implications students can identify any ethical issues raised by reference to professional codes of ethics (e.g. NSPE, ASME), identify possible courses of action, discuss the pros and cons of each course of action, decide what is the best course of action, and justify their decision.

<b>G: Broad education to understand current events, how they relate to aerospace engineering, as well as the impact of aerospace engineering solutions in a global and societal context.</b>
<i>Performance Indicators</i>
G-1: Identify regional, national, or global contemporary problems that involve aerospace engineering.
G-2: Discuss possible ways aerospace engineering could contribute to the solution of these problems.
G-3: Describe the environmental impact of aerospace vehicles, including those they have designed in course projects.
G-4: Describe the health / safety impact of aerospace vehicles, including those they have designed in course projects.

<b>H: Recognition of the need for, and ability to engage in life-long learning.</b>	
<i>Outcome Elements:</i>	
H-1: Recognition of the need for...	H-2: Ability to engage in...
<i>Performance Indicators</i>	<i>Performance Indicators</i>
H-1.1: Willing to learn new material on their own	H-2.1: Develop a systematic approach to studying a new topic, reflect regularly on their learning process and make any necessary adjustments to improve the efficiency of this process.
H-1.2: Participate in professional societies	H-2.2: Access information effectively and efficiently from a variety of sources.

H-1.3: Read non-course related AE related articles / books, attend short courses, workshops, seminars, conferences and plan to attend graduate school.	H-2.3: Research and learn new material on their own by reading articles, books, contacting experts, etc.)
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I: Ability to use the techniques, skills, and modern engineering tools (analytical, experimental, and computational) necessary for aerospace engineering practice.
<i>Performance Indicators</i>
I-1: Use modern software to analyze aerospace systems and conduct computer simulations, parametric studies, and ‘what if’ explorations.
I-2: Use modern equipment and instrumentation in AE laboratories.

## A.6 Student Performance Targets

To satisfy Criterion 3, AE faculty have defined **performance targets** for student achievement of performance criteria as follows: *The scores earned by all students, in selected key assignments and test questions, which pertain to a particular performance criterion, in each course where this performance criterion is assessed, must be at least 70%.*

## A.7 Gateway Assignments

To ensure that all students meet the performance target as defined above, gateway assignments are implemented in key required courses. Students must receive a minimum score of 70% in these assignments to pass the course, regardless of their performance in other course assignments or exams. These gateway assignments were first implemented in AY 2010-2011 and are shown in Table 4.2.

Table 4.2 – Gateway assignments

Outcome B	AE 160 AE 162	4 – Lab Reports 4 – Lab Reports
Outcome C	AE 171A&B AE 172A&B	Design Reports & Design Briefings
Outcome E	Engr. 100W AE 171A&B AE 172A&B	Exit Exam Design Briefings
Outcome F	AE 171A&B AE 172A&B	4 – Case Studies with related assignments
Outcome G	AE 171A&B AE 172A&B	4 reflections in AE171A and AE172A for GE Area S + 4 reflections in AE171B and AE172B for GE Area V

## A.8 BSAE Student Outcome Assessment and Evaluation Timeline

Table 4.3 shows the timeline for the BSAE Student Outcome assessment. Two outcomes are assessed and evaluated each academic year. Recommendations made, based on the evaluation of the data, are implemented in the following academic year. A new

assessment and evaluation is performed after implementing course improvements to re-check whether performance targets are met.

Table 4.3 – Timeline for Student Outcome assessment

Outcomes									
	A	B	C	D	E	F	G	H	I
AY 11-12	X					X			
AY 12-13		X					X		
AY 13-14			X					X	
AY 14-15				X			X		X
AY 15-16	X				X				
AY 16-17		X				X			
AY 17-18			X				X		

## A.9 Outcome Assessment and Evaluation

### OUTCOME A

**Assessment Summary:** Overall, Outcome A is satisfied in the BSAE Program.

#### AY 2011 – 2012 Assessment, Evaluation, and Recommendations

#### Outcome Element A-1: Ability to apply mathematics

##### *Performance Indicator A-1.1: Apply calculus.*

*AE160 – Dr. Nikos J. Mourtos – Fall 2011*

*Assessment Summary:* The performance target is **not met** for Performance Indicator A-1.1.

##### *Course Activities (AE 160)*

- Integrate surface pressure / shear stress distributions to calculate normal force, axial force, lift force, drag force, and pitching moment coefficients.
- Use the integral form of the continuity and momentum equation to calculate the average velocity in a cross-section of the flow and the drag of 2-D bodies from wake profiles.
- In addition to solving problems in class, students use these skills in their lab reports to calculate (a) lift from measured pressure distributions on an airfoil at different angles of attack (AE162) and (b) drag from measured wake profiles on an airfoil at different angles of attack (AE160).

*Assessment Tools:* Quiz 2 – Calculation of Aerodynamic Forces and Moments.

##### *Student Performance Results*

Enrolled = 39	Passed (C- or better) = 33 (85%)				
	Students who scored 70% or higher				
	Quiz 2.0	Quiz 2.1	Quiz 2.2	Quiz 2.3	Total # of Students

AE 160 – Fall 2011	6 (18%)	3 (9%)	5 (15%)	5 (15%)	19 (58%)
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### *Analysis*

The data show that not all the students who received a passing grade in the course met the performance target in this performance criterion. Clearly, our juniors are deficient in their ability to integrate simple functions. Students were given four opportunities (quizzes) to demonstrate their ability to calculate aerodynamic forces by integration of simple functions. Students who performed well on the first test (Quiz 2.0), did not necessarily take any of the subsequent tests. Despite numerous examples shown on the board, workouts performed in small groups in class, and workshops offered outside of class before each quiz, only a small number of students met the performance criterion each time. It should be noted that when they solve problems that involve the calculation of aerodynamic forces, whether by integration of the pressure and shear stress distribution or application of the momentum equation, students apply the aerodynamics equations correctly. It is their inability to integrate correctly that prevents them from getting the correct answer to various problems.

### *Recommendations*

- Post additional example problems on the course website.
- Continue workouts in small groups and student coaching during class.
- Continue to offer problem-solving workshops outside of class.
- Make attendance and successful completion of problems in these workshops a condition for allowing students to re-take quizzes.

*Implementation:* Fall 2012

*AE160 – Prof. Nikos J. Mourtos – Fall 2015*

*Assessment Summary:* The performance target is **met** for Performance Indicator A-1.1

*Assessment Tools:* Quiz 2, Workout Problem # 9, Lab Report # 3.

### *Student Performance Results*

	Students who scored 70% or higher <i>NB: Only students who passed the course are included in the statistics below</i>		
	Quiz 2	Workout Problem 9	Lab Report 3
N=89; passed=72 (81%)	68 (94%)	65 (90%)	70 (97%)

### *Analysis*

Students must average at least 60% on all their tests to pass the course. They earn at best a “C” if they average in the range of 60% - 69%. Students need an average of 70% or higher on their tests to earn a “B” or an “A” in the course.

In Fall 2015, of the 72 students who passed the course:

- Only 5 % (4) failed to meet the 70% average performance target in Quiz 2, which involved integration of surface pressure and shear stress distributions to calculate lift and drag coefficients.
- Only 10% (7) failed to meet the 70% average performance target in workout problem 9, which involved integrating the pressure distribution on the top and bottom surfaces of a wind tunnel to calculate airfoil lift and the wake profile behind the airfoil to calculate drag.
- Only 3% (2) failed to meet the 70% average performance target in Lab Report 3, which involved integration of the wake profile behind an airfoil at various angles of attack to calculate drag.

It appears that (a) the example problems presented in class, (b) the problem-solving sessions in small groups during and outside of class, (c) the problem-solving workshops offered by Sigma Gamma Tau officers outside of class, as well as (d) the ability to correct and resubmit lab reports, are working towards achieving an almost 100% performance target for Performance Indicator A-1.1.

*Recommendation:* None

*Implementation:* N/A

***Performance Indicator A-1.2: Derive and solve differential equations.***

*AE140 – Prof. Jeanine Hunter – Spring 2014*

*Assessment Summary:* The performance target is **met** for Performance Criterion A-1.2

*Course Activities*

- Derivation of the differential equations, which define simple planar particle motion: radial motion on a rotating disk, one degree of freedom radar tracking an aircraft, point mass moving in a cylindrical space station, etc.
- Derivation of the differential equations, which define the 3-D position of a particle moving over the surface of the rotating Earth. Students derive coupled 2<sup>nd</sup>-order ODEs in the translational positions relative to a reference frame fixed to the surface of the Earth. Then they simplify the equations so they can be solved closed-form.
- Using Euler angles, derivation of differential equations, which define rigid body (rotational) motion about aerospace vehicle center of mass.
- Numerical integration of rigid body (differential) equations of motion using various algorithms and integration step sizes.

*Student Performance Results*

	Students who scored 70% or higher
Final Exam, Problem 1	81%

### *Analysis*

One of the most conceptually difficult problems is the derivation and solution of the equations for particle motion over the rotating Earth. This is a complex three-dimensional problem, which poses a challenge for many students. Writing the ODEs involves defining Newtonian and non-Newtonian reference frames, writing particle position with respect to the Earth's surface, differentiating the position vector twice to obtain acceleration and finally combining it with the applied gravity force to obtain the system of coupled ODEs defining particle motion. Solving the coupled ODEs is a systematic but lengthy procedure, which I teach in class.

To teach students to work correctly with three-dimensional particle motion, I combine intuition-building exercises with the mathematical solution. I bring a globe to class and the students fine-tune their intuition by thinking about what happens physically when a particle moves with respect to a rotating rigid body. Typically there are opposing points of view and much animated discussion as their intuitive solutions converge.

### *Recommendations*

Since only 81% of the students met the performance target, there is room for improvement. Even though these are challenging problems, undergraduate students should be able to master them. Usually the difficulty is in setting up the problem, occasionally in differentiating. To help the students develop the skill of setting up the dynamics problems, I will have the students derive and solve more ODEs as practice exercises in class. With this additional practice, they should be able to solve these equations without error.

*Implementation:* Spring 2015

*AE140 – Prof. Jeanine Hunter – Spring 2016*

*Assessment Summary:* The performance target is **met** for Performance Criterion A-1.2

### *Course Activities*

- a. Derive the second order differential equations of particle motion over the surface of the rotating Earth. The equations are simplified and solved closed-form
- b. Intuitively predict the influence of Coriolis acceleration on ground track, and analytically confirm
- c. Derive rigid body rotational equations of motion (also second order ODEs)
- d. Predict the robustness of cylindrical body spin stability to disturbances
- e. Numerically integrate the particle and rigid body (differential) equations of motion using various algorithms and integration step sizes

### *Student Performance Results*

	Students who scored 70% or higher
Exam 1, problem 1	83%
Final exam, problem 4	97%

### *Analysis*

AE140, Rigid Body Dynamics, is a conceptually difficult class, which requires excellent skills in mathematics. During the semester, the students write equations of motion and then create numerical simulations of these equations. Among the vehicles simulated are: a spacecraft or missile particle moving with respect to a rotating Earth; a cylindrical spinning spacecraft, disturbed by the impulse of a micro-meteorite strike; and a helicopter rotor blade in gyroscopic precession. Physical intuition is developed as a result of these simulations, creating a base of knowledge, which is essential to support their control theory and capstone design classes.

For the past three years, the learning outcomes in AE140 have been much more positive. This is due to the addition of AE138 into our curriculum. AE138 is a pre-requisite for AE140 and replaces ME101, the original first course in dynamics for many of the SJSU engineering students. AE138 teaches vector-based dynamics, a powerful and unambiguous way to write equations of motion. Since the introduction of AE138, the students' ability to comprehend and learn the AE140 material has improved significantly. With a background in vector dynamics, the AE140 students develop confidence in their ability to write rigid body equations of motion, training their technical intuition in the process.

*Recommendations:* None

*Implementation:* N/A

***Performance Indicator A-1.3: Use linear algebra.***

*AE169 – Prof. Periklis Papadopoulos – Spring 2014*

*Assessment Summary:* The performance target is **met** for Performance Indicator A-1.3.

*Course Activities*

- a. Determine eigenvalues and eigenvectors.
- b. Perform matrix operations.
- c. Develop an appropriate Taylor table for a given numerical method.
- a. Determine truncation error.

*Assessment Tools:* Workouts, midterms and final project in each course.

*Student Performance Results*

	Enrolled	Passed (averaged 60% or higher on their tests)	Averaged 70% or higher on their tests
Spring 2011	23	19 (83%)	18 (94% of those who passed)
Spring 2012	16	12(75%)	12



			(100% of those who passed)
Spring 2013	47	41 (87%)	39 (87% of those who passed)
Spring 2014	45	42 (93%)	40 (93% of those who passed)

In academic years 2011-2012, 2012-2013, and 2013-2014 students were given several in class examples and workouts requiring the use of linear algebra. Student understanding of linear algebra is fundamental to the AE169 class. Theory, class examples and homework problems, all require the use of linear algebra. The student performance results indicate that the vast majority of the students who pass the class demonstrate mastery of fundamental linear algebra concepts.

*Recommendation:* None

*Implementation:* N/A

AE 157 – Prof. Turkoglu – Spring 2016

*Assessment Summary:* The performance target is **not met** for Performance Indicator A-1.3

#### *Course Activities*

- Describe transient response analysis in aircraft and satellites.
- Formulate basic control actions and frequency response of aerospace automatic control systems.
- Analyze stability and stability margins in aerospace vehicle motions.
- Outline the fundamentals of modern control theory as it is applied to aerospace vehicles
- Determine the natural frequencies and damping ratios of aerospace vehicle dynamics.
- Derive transfer functions and plot vehicle time and/or frequency response.
- Use frequency response design techniques to design closed-loop control systems: rate-damping, attitude control, altitude control.
- Design a satellite control law using classical/modern automatic control system design principles (such as PID, pole placement ... etc.).

#### *Student Performance Results*

In Exam 1, Question 4 student's linear equation handling, matrix analysis, matrix inversion and matrix manipulation/formation skills were tested.

	Students who scored 70% or higher
N=80; Passed = 78 (85%)	14 (21%)

### *Analysis*

Only 21% of the students were able to demonstrate successful linear algebra application skills in the first exam. Application of linear algebra concepts as well as tools is a skill-set, which is picked up in Math129A or its equivalent at community colleges, and is a prerequisite to AE157. Unfortunately, students are prepared to tackle advanced control theory problems, which solely depend on linear algebra and algebraic spaces. During the semester, when students are advised to review their linear algebra skills, it is observed that they do not spend enough time outside the class to read, study and practice the material to master the application skills on linear algebra concepts. This trend is also observed in general reading assignments and tasks, as well. Students have been offered weekly problem solving workshops to help their problem solving skills. However, despite the fact that participation in these workshops is strongly encouraged, students either do not have time to attend or show no interest in spending extra time to review their linear algebra skills under the guidance of a teaching assistant.

Solving more problems in class helps students in their understanding of linear algebra concepts, however, AE157 is a class in which Linear Algebra is a prerequisite and students are expected to come well equipped with analytical tools to tackle controls problems, rather than learning linear algebra skills alongside with control concepts. Furthermore, hand-holding students leads students to memorize problem set-ups rather than focusing on understanding the core concepts underneath. This is observed, for example, when a concept is presented in a slightly different way/shape, requiring the same tools/skills, previously presented in class but nevertheless students are not able to apply these tools/skills.

### *Recommendations*

- Perform diagnostic assessment in the beginning of the semester to test students' skills in linear algebra.
- Organize a meeting with the Math129A Coordinator in the Math Department to share our experience of ill-prepared students in linear algebra.
- Create reference material (e.g. notes, videos, etc.) as a review of fundamental linear algebra concepts to bring lagging students up to speed.

*Implementation: Spring 2017*

## **Outcome Element A-2: Ability to apply physics**

### ***Performance Indicator A-2.1: Draw free-body diagrams.***

*AE114 – Prof. Jeanine Hunter – Spring 2014*

*Assessment Summary:* The performance target is **met** for Performance Indicator A-2.1

*Course Activities*

- Construction of the shear force and bending moment diagrams by making imaginary cuts in the beam and drawing a free-body diagram of each beam section (method of sections).
- Creating a free-body diagram of each node of a spacecraft truss (pin joints carry no moment, so this diagram includes only applied and reaction forces).

*Student Performance Results*

	Students who scored 70% or higher
2012 Final exam, problem 1	89%
2014 Final exam, problem 3	70%

*Analysis*

Students are familiar with free-body diagrams from physics. Most students are quite competent at drawing the diagram once the need is identified. The difficulty is that the weaker students do not perceive the need to isolate and analyze a particular body. For example, sometimes students do not perceive the need to move the given forces to the neutral axis of a structural element. Next year, AE will be teaching the statics/strengths of materials prerequisite (AE112), and this concept will be emphasized.

Whole wing problems (e.g., 2014 Final exam, problem 3) are much more challenging and require the students to recognize the need to analyze the cross-section as a whole, then isolate various free-bodies. The students' difficulties on this problem were caused directly by their failure to properly isolate the central rib and solve for the reaction forces and shear flows.

*Recommendations*

Performance on this indicator can be improved by improving topic coverage in the prerequisite and by placing more emphasis on it during class time and in the homework problems.

*Implementation:* Spring 2015

*AE 112 – Prof. Boylan-Ashraf – Fall 2015*

*Assessment Summary:* The performance target is **met** for Performance Indicator A-2.1

*Course Activities*

- a. Create free-body diagrams of structural members under various combinations of applied axial, torsion, and bending.
- b. Construct shear force and bending moment diagrams used in the analysis of transversely loaded beams and shafts with various support conditions.

*Student Performance Results*

	Students who scored 70% or higher
Quiz 1	96%

*Analysis*

One of the initial challenges for students in this class is understanding how to correctly draw complete free-body diagrams. Once this hurdle is overcome, applying classical Newtonian mechanics equations and basic elements of vector analysis to analyze static equilibrium of solid and structural systems in two and three dimensions are straightforward procedures for the students. Drawing Free-Body Diagrams is a key problem-solving strategy for this class –they help students visualize physical situations, infer the motion of objects, and keep track of multiple forces more easily. Once students have mastered this, they are more able to analytically describe and model the stresses and strains within axial stress members, torsional shafts and beams, acting either in isolation or in various structural configurations.

*Recommendations*

During the first two weeks of the semester, it was very clear and surprising to the instructor the varying levels of student preparedness and self-efficacy. Students are fearful to make mistakes and they rely on the instructor to fix their mistake without a deep understanding of why how to “not do it again”. In future classes, reflection will be used as a pedagogy to learn the complex but very essential skill of drawing free-body diagrams. Reflection is a form of thinking in which students will explore the meaning of their past experiences and their consequences for future action. The instructor believes that engaging in reflection can benefit students in many ways, including improved learning, motivation, and persistence. Reflection activities will be often used to give students the opportunity to identify, revisit, and re-examine drawing their free-body diagram experiences.

*Implementation:* Fall 2016

***Performance Indicator A-2.2: Apply Newton’s laws / physics concepts (e.g. angular momentum, friction, etc.).***

*AE140 – Prof. Jeanine Hunter – Spring 2014*

*Assessment Summary:* The performance target is **not met** for Performance Indicator A-2.2

*Course Activities*

- Derive the translational equations of motion (of a particle or center of mass of a rigid body) moving in inertial space and observed in either a Newtonian or non-Newtonian reference frame.
- Identify and use Coriolis and centripetal acceleration components in solving problems of particle motion over the surface of the Earth.
- Predict the difference between inertial and relative motion and model this motion with Newton’s Laws.
- Derive the rotational equations of motion of a spinning rigid body in two cases: a spinning spacecraft (no gravity – angular momentum conserved); a gyroscope or top with the forcing function of gravity torque: (angular momentum not conserved).

- Use the equations of rotational motion to model a spin-stabilized missile.

### *Student Performance Results*

	Students who scored 70% or higher
2012 Final exam, problem 1	97%
2012 Final exam, extra credit problem	74%
2014 Final exam, problem 3	65%

### *Analysis*

In AE140, we primarily use Newton's Laws to write equations of motion because they are straightforward to apply. While other formulations (Lagrange, Kane) may be faster, Newton's method is more intuitive and appropriate for this class level. As a result, there are many opportunities in AE140 for the students to apply Newton's Laws of Motion. We begin with the general case of particle motion with respect to a rotating rigid body, then the specific example of particle motion with respect to the rotating Earth.

In freshman physics and the pre-requisite dynamics class, the students have applied Newton's Laws to simpler problems, so they should understand the basics. The difficulty, however, is one of problem representation: multiple reference frames moving with respect to one another. How do you differentiate a position vector that is rotating and translating with respect to a Newtonian frame of reference?

One consistent challenge has been the lack of preparation from ME101, the pre-requisite class. Traditionally, ME101 has used texts and pedagogy which approach particle and rigid body problems primarily as *mechanisms*. While this approach is appropriate for further work in ME and CE, it falls far short of the preparation needed to model six degree-of-freedom rigid body motion in AE.

To mitigate this lack of preparation, I work many, many examples in class. We develop an umbrella method of representing the problems so that the students can approach the problems with confidence. Later in the semester, we take the same approach when we solve rigid body problems using Newton's Law of Rotational Motion.

### *Recommendations*

Over the past three years, a dynamics working group composed of SJSU and Stanford engineering faculty has explored ideas to improve undergraduate dynamics instruction. Experimental sections of the SJSU dynamics pre-requisite have been taught using a vector algebra approach which emphasizes reference frame definition and relative motion. The data show that this pedagogy gives AE students excellent preparation for rigid body dynamics. Unfortunately, not all ME101 sections use the advanced pedagogy and only about half of the AE students come into the rigid body dynamics class truly prepared. The difference in preparation is striking, with students engaging in peer-tutoring to bring their classmates up to the needed level of knowledge. We are working with the ME department to ensure that all of the AE students have adequate preparation.

AE 138 – Prof. Jeanine Hunter – Fall 2015

Assessment Summary: The performance target is **met** for Performance Indicator A-2.2

*Course Activities*

- a. Write position, velocity and acceleration vectors in Newtonian and non-Newtonian reference frames
- b. Relate reference frames and transform attitudes through a direction cosine matrix
- c. Predict the difference between inertial and relative motion and model this motion with Newton’s Laws.
- d. Write particle equations of motion using Newton’s Second Law, simulating a point mass or center of mass of an aerospace vehicle

*Student Performance Results*

	Students who scored 70% or higher
Exam 1	51%
Exam 2	77%
Final Exam	97%

*Analysis*

Following the groundbreaking work of Stanford dynamicists Kane and Mitiguy, AE138 provides a solid and comprehensive introduction to vector-based mechanics. Although the students are familiar with vectors, many physics classes treat vectors as a nonessential tool, preferring scalar solutions instead. So upon entering AE138, most students have a significant learning curve to first master vector algebra and then apply it to dynamics. The first midterm finds many students with inadequate preparation, however as the semester progresses, the students and I do many dynamics examples in class which cements their vector algebra skills.

An integral part of the learning value of the class is the project, assigned mid-semester. Students significantly deepen their understanding of vector dynamics as a result of the project, supported by the homework assignments. Some projects involve hardware development, although most are analytical. At the end of the semester, many teams choose to demonstrate their projects to the class (with great enthusiasm), explaining the dynamics principles they have used. Course grading includes 25% for project, so some students demonstrate competence of the course material through the project as well as the exams.

*Recommendations:* None

*Implementation:* N/A

**A-3: Ability to apply aerospace engineering principles**

*Outcome Performance Indicators:*

***Performance Indicator A-3.1: Apply aerospace structures principles.***

AE114 – Prof. Jeanine Hunter – Spring 2014

Assessment Summary: The performance target is **met** for Performance Indicator A-3.1

### *Course Activities*

- Use area properties of a wing section to calculate the orientation of the principal axes, and thereby the principal stresses.
- Calculate shearing strain/stress and angle of twist of a beam / circular shaft / aircraft tail section subject to a torsional load. Use the torsional beam in the lab to verify this result experimentally.
- Calculate shear flow in a multiple cell wing section, satisfying both the angle of twist compatibility condition and the equations for static equilibrium.
- Compute the symmetrical and nonsymmetrical bending stresses on a wing section. Symmetrical bending stresses are also determined experimentally on the cantilever beam.
- Solving whole-wing problems by isolating each member: rib, web skin, or stringer/spar; determining reaction forces and moments; and then sizing the member to carry the load.
- Calculate the stiffness matrix, nodal displacements and axial force for a three-bar truss element of a spacecraft structure.

### *Student Performance Results*

	Students who scored 70% or higher
2012 Final exam, problem 1	85%
2014 Final exam, problem 4	71%

### *Analysis*

During the course of the semester, we cover several techniques of aerospace structural analysis and design in AE114. These techniques are necessarily simplified relative to actual vehicle analysis, but nonetheless pose new concepts and challenges for the students. For example, 2014 final exam problem 4 is a whole wing problem in which students design the stringers (bending material) and ribs & web skin (to carry torsion). Using the principle of superposition, bending and torsion loads can be analyzed separately, and then the results combined. Although the process is straightforward, three-dimensional design/analysis is still a challenge for many students.

### *Recommendations*

Some of the class topics have been well-learned; however the learning of some concepts still has room for improvement. Whole wing analysis is a challenging comprehensive topic. To improve the understanding of this essential topic, more time is necessary. Allowing more time for working multiple whole wing problems in class and for homework should improve the student's competence in this area.

*Implementation:* Fall 2015

*AE 114 – Dr. Boylan-Ashraf – Spring 2016*

*Assessment Summary:* The performance target is **met** for Performance Indicator A-3.1

### *Course Activities*

- a. Determine tensile and compressive members of a spacecraft truss structures using both method of joints and method of sections.
- b. Calculate principal stresses and principal strains using transformation equations and Mohr's Circle of beam-column type wing and fuselage structures.
- c. Calculate aircraft material specimen displacements due to thermal affects.
- d. Analyze statically indeterminate axially-loaded aircraft assemblies and determine tensile and compressive elements.
- e. Calculate deformations in axially-loaded wing assemblies.
- f. Calculate stresses in thin-walled monocoque and semi-monocoque structures.
- g. Analyze statically indeterminate torsional shafts and determine angle of twist.
- h. Draw shear force and bending moment diagrams of fuselage beam structures.
- i. Examine combined (axial, torsional, and bending) fuselage loading and analyze principal stresses.
- j. Calculate bending deflection in wing and fuselage beam structures using integration and superposition methods.

### *Student Performance Results*

	Students who scored 70% or higher
Exam 1	86%
Exam 2	47%
Exam 3	73%
Final Exam	92%

### *Analysis*

This course provides an overview of aircraft structural external loads analysis using classical methods for statically indeterminate structures. This course is a continuation of AE 112 with an emphasis on deterministic stress analysis. The first exam was a review of AE 112 topics and the majority of the students performed satisfactorily. However, Exam 2 was a challenge for more than half the class due to exposure to unfamiliar topics covered for the very first time (strain gauge rosettes, principal strains, thermal strains, and axial deformation) –mental motivation toward critical thinking was the biggest hurdle.

To get over the fear of new topics since Exam 2, the course was broken up into numerous small goals. During each lecture students had to meet a certain “small” achievement goal, such as determining the correct angle in strain transformation equations – although a trivial goal for some students, yet a necessary piece of information in learning about rosettes. This is done through in-class problem solving or shot-gun exercises. Breaking up the course into small manageable pieces for the students seemed to take away the feeling of being overwhelmed of learning new concepts.

*Recommendations:* None

*Implementation:* N/A

***Performance Indicator A-3.2: Apply rigid body dynamics principles.***



AE140 – Prof. Jeanine Hunter – Spring 2014

Assessment Summary: The performance target is **not met** for Performance Indicator A-3.2.

### Course Activities

- Develop direction cosine matrices and use them to describe an aerospace vehicle's orientation and mass properties distribution.
- Derive the equations of motion of a particle or rigid body using the energy methods or Lagrange's Method. This involves finding the translational / rotational kinetic and potential energies of the particle / rigid body.
- Derive the stability condition on spinning rigid bodies, for example: how fast must a top or spin-stabilized missile spin to maintain spin equilibrium? How does energy dissipation affect the motion (e.g., Explorer I)?
- Model gyroscopic instruments: directional gyro, vertical (pitch and roll attitudes), rate gyro.

### Student Performance Results

	Students who scored 70% or higher
2012 Final exam problem 3 (Stability condition)	47%
2012 Final exam problem 6 (gyroscopic instruments)	91%
2014 Final exam, problem 4 (Lagrange)	59%

### Analysis

Attitude orientation is a key concept in rigid body dynamics. Practical applications range from spacecraft antenna pointing to radar tracking. In AE140, students learn to represent rigid body attitude using direction cosine matrices and Euler angles. This concept is new to the students unless they have had the pre-requisite with the advanced pedagogy. Except for quaternions (beyond the scope of this class), there is no other way to represent the orientation of rigid body parameters (attitude, angular rate, mass properties) from one reference frame to another, so this skill is essential. However, this is one of the most challenging topics in AE140, so we spend considerable time on it during the semester since only half of the students have been adequately prepared. I teach three methods of constructing direction cosine matrices and the students have multiple opportunities to practice this skill. Mistakes occur early in the semester (and ideally are corrected) as students learn to visualize the three-dimensional motion.

In the last two weeks of the semester, we use Lagrange's equation to write equations of motion of both particle and rigid body problems. So that the problems are self-checking, we re-do the many problems we have done in class using Newton's Laws. Mistakes in this topic are either in formulation of the Lagrangian (difference of kinetic and potential energies) or in differentiation. Applying Lagrange's equation requires partial differentiation with respect to the state and state rate, as well as time differentiation. Sometimes students mix up these differentiations or misapply the chain rule.

### Recommendations

With proper preparation, students would come into AE140 understanding how to represent relative attitude using direction cosines of Euler angles. Unprepared students make two types of errors in constructing the direction cosine matrix: errors in writing the matrix transpose (careless errors) or errors in understanding the necessary transformations (conceptual). Again, we are working with the ME department to ensure that all students have appropriate preparation in the dynamics pre-requisite.

Writing equations of motion using Lagrange's equation is an excellent exercise for this level of engineering student because it provides an alternate way to Newton's approach and because it demonstrates the efficacy of a highly mathematical approach. Errors often occur when initially using this method, but since the students know the answer from Newton's formulation, they can usually correct their mistakes. This year, I presented the method and worked a few examples, then assigned problems. Next year, I will have the students work an example as a co-operative learning exercise (in small groups) to improve their understanding.

*Implementation: Spring 2015*

AE 140 –Prof. Jeanine Hunter – Spring 2016

*Assessment Summary:* The performance target is **met** for Performance Indicator A-3.2.

*Course Activities*

- a. Model particle motion with respect to the rotating Earth
- b. Identify and use Coriolis and centripetal acceleration components in solving problems of particle motion over the surface of the Earth
- c. Model a spinning spacecraft (body of revolution) in free motion using Euler angles: precession, nutation and spin
- d. Simulate the analytically derived equations in Matlab or MotionGenesis
- e. Compute mass properties (moments & products of inertia) and use these properties to predict rotational stability
- f. Derive the rotational equations of motion of a spinning rigid body in two cases: a spinning spacecraft (no gravity – angular momentum conserved); a gyroscope or top with the forcing function of gravity torque: (angular momentum not conserved).
- g. Use the equations of rotational motion to model a spin-stabilized missile
- h. Model a spinning body in forced motion (i.e., with applied moments due to gravity, drag, differential lift, etc.)
- i. Model the motion of a helicopter rotor blade in gyroscopic precession
- j. With Lagrange's equation, write the equations of motion of a particle or rigid body

*Student Performance Results*

	Students who scored 70% or higher
Exam 1	64%
Exam 2	69%
Final Exam	86%

*Analysis*

AE140 is the second class in a two-course dynamics sequence. In AE140, students solidify their knowledge of dynamics. They learn to look at six degree of freedom (DOF) dynamic systems as three DOF particle motion (of vehicle center of mass) and three DOF rotational motion (about the center of mass). Within this framework, we analyze many aerospace systems: spacecraft, aircraft, missiles, helicopters, as both particles and rigid bodies.

The low exam scores in the beginning of the semester appear to be the result of the inability to visualize motion in three dimensions. In addition to being a challenging class mathematically, a goal of the class is to merge the students' intuition about 6-DOF motion with the results of their analyses. This takes time, but by the end of the semester, most of the students are able to understand the motion both spatially and analytically.

Although group project grades are not included in the table above, applying their knowledge by doing a project has key learning value for the students. As a result of the project, their knowledge is much more solid by the final exam.

#### *Recommendation*

Encourage development of rigid body dynamics visualization tools as project topics.

*Implementation:* Spring 2017

#### ***Performance Indicator A-3.3: Apply aerodynamics principles.***

*AE160 – Aerodynamics I – Prof. Nikos J. Mourtos – Fall 2010 & Fall 2011*

*AE162 – Aerodynamics II – Prof. Nikos J. Mourtos – Spring 2011 & Spring 2012*

*AE164 – Compressible Flow – Prof. Nikos J. Mourtos – Fall 2010 & Fall 2011*

*Assessment Summary:* The performance target is **met** for Performance Indicator A-3.3.

#### *Course Activities*

##### AE 160

- Calculate aerodynamic forces and moments on bodies by integrating surface pressure and shear stress distributions.
- Use flow similarity to design wind tunnel tests.
- Use the momentum equation to calculate (a) lift from given pressure distributions on the top and bottom of an aerodynamic body and (b) drag from given velocity profiles ahead and downstream of an aerodynamic body.
- Predict transition from laminar to turbulent flow on an aerodynamic surface.
- Calculate the skin friction drag and estimate the pressure drag of aerodynamic bodies.

##### AE 162

- Analyze the elementary flows (uniform, source / sink, doublet, vortex, corner) as well as combinations of them.

- Use experimental data, thin airfoil theory results, and computer programs to predict aerodynamic characteristics of airfoils (ex. lift and drag at various angles of attack, pitching moment about various points, ac location, etc.)
- Use the Biot-Savart law to calculate induced velocities in the vicinity of line vortices.
- Apply Prandtl's lifting-line theory to calculate the aerodynamic characteristics of airplane wings.
- Use the method of images to discuss and calculate aerodynamic interference for (a) wings flying in the vicinity of each other, (b) wind-tunnel boundaries, and (c) ground effects.

#### AE 164

- Use thermodynamics and conservation equations to calculate flow parameters at various points of a flow field.
- Calculate stagnation and critical conditions at various points of a flow field for isentropic flow, adiabatic flow, flow with heat addition and flow with friction.
- Calculate the flow properties downstream of a Mach wave, an oblique shock wave, a Prandtl-Meyer expansion wave, and a normal shock wave.
- Calculate the lift and drag coefficients on supersonic airfoils using shock - expansion theory.
- Calculate the flow properties downstream of a reflected / refracted shock wave.
- Calculate the flow conditions in a shock tube behind the incident and the reflected shock waves.
- Calculate the speed of the incident and the reflected shock waves in a shock tube.
- Calculate the location of a shock in a Laval nozzle (assuming there is one).

*Assessment Tools:* Quizzes, midterms and final exams in each course.

#### *Student Performance Results*

	Enrolled	Passed (averaged 60% or higher on their tests)	Averaged 70% or higher on their tests
AE 160 – Fall 10	24	15 (63%)	4 (27% of those who passed)
AE 160 – Fall 11	39	33 (85%)	22 (67% of those who passed)
AE 162 – Spring 11	23	22 (96%)	11 (50% of those who passed)
AE 162 – Spring 12	43	34 (79%)	19 (56% of those who passed)
AE 164 – Fall 10	15	14 (93%)	7 (50% of those who passed)
AE 164 – Fall 11	19	19 (100%)	11 (58% of those who passed)

In AY 2011-2012 a new rule was posted on the syllabi of AE160, AE162, and AE164 that students must average a minimum of 60% in their tests to earn the lowest passing grade (C-). The rule was instituted because in the past several students received passing grades based on their total number of point in each course, which is based, among other things, on lab and project reports. Since lab and projects are performed in teams, it is

more appropriate to make student understanding of the basic concepts, as reflected in their tests, a separate criterion for passing each course.

However, a higher standard (70%) is used to evaluate student performance in the table above, to ensure that students have a working knowledge of the material. The table shows the improvement in student performance using the 70% standard in AY 2011-2012 following the implementation of student-led, active learning workshops to help students improve their problem-solving skills.

*Recommendation*

- Post additional example problems on the course website.
- Continue workouts in small groups and student coaching during class.
- Continue to offer problem-solving workshops outside of class.
- Make attendance and successful completion of problems in these workshops a condition for allowing students to re-take quizzes.

*Implementation:* Fall 2012

- AE160 – Prof. Nikos J. Mourtos – Fall 2015
- AE162 – Prof. Nikos J. Mourtos – Spring 2016
- AE164 – Prof. Sean Montgomery – Fall 2015

*Assessment Summary:* The performance target is **met** for Performance Indicator A-3.3.

*Course Activities*

AE 164

- Use the 1<sup>st</sup> and 2<sup>nd</sup> laws of thermodynamics to calculate heat transfer, work done and entropy changes in a thermodynamic system.
- Use thermodynamics and conservation equations to calculate flow parameters at various points of a flow field.
- Calculate stagnation and critical conditions at various points of a flow field for isentropic flow, adiabatic flow, flow with heat addition and flow with friction.
- Calculate the flow properties downstream of a Mach wave, an oblique shock wave, a Prandtl-Meyer expansion wave, and a normal shock wave.
- Calculate the lift and drag coefficients on supersonic airfoils using shock - expansion theory.
- Calculate the flow properties downstream of a reflected / refracted shock wave.
- Calculate the flow properties at various locations of an (a) ideally expanded, (b) over-expanded and (c) under-expanded nozzle.
- Identify when heat transfer occurs as conduction, convection, or radiation solve basic heat transfer problems.

*Student Performance Results*

	Students who scored 70% or higher <i>NB: Only students who passed each course are included in the statistics below</i>							
	Quiz 1	Quiz 2	Quiz 3	Quiz 4	Quiz 5	Quiz 6	Final Exam	Test Average

AE 160 – Fall 15 N=89 Passed = 72 (81%)	61 (85%)	68 (94%)	69 (96%)	54 (75%)	59 (82%)	46 (64%)	18 (25%)	58 (81%)
AE 162 – Spring 16 N=78 Passed=72 (92%)	61 (85%)	63 (88%)	53 (74%)	58 (81%)			41 (57%)	53 (74%)
	Exam 1	Exam 2	Quiz 1	Exam 3	Exam 4	Exam 5		
AE 164 – Fall 15 N=59 Passed=59 (100%)	53 (90%)	56 (95%)	39 (66%)	54 (92%)	54 (92%)	57 (97%)		59 (100%)

AE160 / AE162 – Students must average at least 60% on all their tests to pass the course. They earn at best a “C” if they average in the range of 60% - 69%. Students need an average of 70% or higher on their tests to earn a “B” or an “A” in the course. Some students pass the course because they compensate for their poor exam performance (60%-69%) with a much better show in their lab and project reports. Since these assignments are performed in teams, however, they are not included in this analysis. In Fall 2015, 19% of the students who passed the course failed to meet the 70% average performance target in their exams. In Spring 2016, 26% of the students who passed the course failed to meet the 70% average performance target in their exams. Students do better on the quizzes because they get a second chance in each of them and many do improve their scores, if they do poorly the first time. Students do not, however, have a second chance for the final exam, which accounts for 20% of the grade. As the results in the table above show, many students do poorly on the final exam primarily due to poor time management throughout the semester and especially towards the end of the term, as assignments pile up.

Reasons contributing to students’ low performance on tests in general, include:

- Poor preparation in the course prerequisites. For example, students integrate functions incorrectly or draw free body diagrams incorrectly. (AE160)
- Poor understanding of the material / poor problem-solving skills. (AE160, AE162)
- Inadequate time-on-task (e.g. 26% of students reported pending only 1 to 3 hours per week outside of class studying). (AE160, AE162)
- Inadequate preparation for each test. (AE160, AE162)
- Poor study / test-taking skills. (AE160, AE162)

Since this is a recurring problem in many AE courses, the following activities have been implemented in AE160 and AE162:

- Numerous example problems are presented in class and are included in the course notes and on the course website for pre and post review by the students.

- Students work in small groups to solve problems during class (workouts). During these workouts, the instructor walks around the room and coaches students. If students do not finish these problems during class, they are allowed to finish them outside of class and submit them at the beginning of the following class meeting.

These workout problems account for 10% of their final course grade.

However, as many students admit in their reflections, either they do not come to class prepared, in which case they cannot take full advantage of the workouts and/or do not follow up with further studying after each class. In Fall 2015, 26% of the students reported spending anywhere from 1 (one) to 3 (three) hours outside of class studying for AE160. Clearly, this is not adequate time for a junior level aerospace engineering course. Furthermore, as they state in their reflections, most students do not practice additional problem solving on their own.

In addition, problem-solving workshops are offered several times during the week, to accommodate students' schedules. Each workshop is focused on a specific course topic and is offered by Sigma Gamma Tau officers, who are trained by the instructor. During these workshops students are given a problem to solve individually but are allowed to ask as many questions as they need and receive help as appropriate. Participating students must complete at least one problem correctly during the workshop, if they wish to retake a quiz.

*Recommendation:* None

*Implementation:* N/A

AE 164 – Students must average at least 70% on all their tests to pass the course. There are five exams and one quiz. Each exam lasts 80 to 105 minutes, except for the third exam, which is broken into two 80-min sections. There is also a short quiz on flow with heat addition and flow with friction, which is included in the table above.

In Fall 2015, 100% of AE 164 students met the 70% exam average performance target. For each of the 5 exams, 90% or more of the students scored at least 70%. For the quiz on flow with heat addition and flow with friction, only 66% of the students scored at least 70%. Students reported that poor performance was a combination of a lack of studying and the brevity of the class time on these topics. Many students did not have enough time to complete exams 2 and 3, so students were allowed to makeup the last two problems of these exams. Additionally, two students each made up one of the other exams. Without these makeup exams, 95% of the students met the 70% average exam performance target. Including the makeup exams, 100% of the students met the performance target.

For the most part, the exam results seem to match the students' comprehension of aerothermodynamics. At the end of the course, students presented group projects where they researched, analyzed, or designed something related to aerothermodynamics. The presentations demonstrated many students could speak competently about aerothermodynamics over a wide range of applications. Furthermore, many students demonstrated interest in the subject and an ability to learn much more about it on their own. Students wrote an essay about what happens to the flow around a body moving at high speed and how various parameters such as the Mach number and the shape of the body affect the flow. They had to account for viscous effects and heat transfer in their descriptions. Because students had to write sentences about aerothermodynamics

instead of numbers, the essays made it easy to see what students understood well, what they could reason about intelligently even if they did not reach the right conclusion, and what they did not understand. All students understood the main principles well and some students even understood the more subtle aspects very well.

*Recommendation:* None

*Implementation:* N/A

***Performance Indicator A-3.4: Apply flight mechanics principles.***

*AE165 – Prof. Derek Lang – Spring 2012*

*Assessment Summary:* The performance target is **met** for Performance Indicator A-3.4.

The students had a working comprehension of flight mechanics principles and applied them to a range of aircraft and spacecraft performance analyses. On the aircraft side, students used aerodynamic and propulsion characteristics to compute takeoff, climb, range and endurance, descent, and landing problems. On the spacecraft side, students utilized the rocket equation to predict multi-stage launch vehicle flight, calculated orbital parameters, and in-orbit maneuvers. The students had more difficulty when problems involved assessing contributing factors, e.g., the effect of altitude on thrust, which was needed to solve for climb performance. They performed better when problems were broken down into smaller steps. Orbital mechanics was also particularly difficult for them to conceptualize, since this was outside their past experience.

*Recommendations*

- Increase the number of multi-step problems to help students develop an ability to tackle more complex problems.
- Spend more time discussing how mathematics represents physical behavior.

*AE 165 – Prof. Jeanine Hunter – Spring 2016*

*Assessment Summary:* The performance target is **met** for Performance Indicator A-3.4.

*Course Activities*

- Compute the maximum rate of climb, maximum velocity, service and absolute ceilings for various aircraft
- Calculate  $(L/D)_{max}$ , range and endurance for several aircraft as these parameters vary with altitude
- Find minimum turn radius and maximum turn rate for a steady, level turn
- Determine of aircraft longitudinal static stability coefficients from geometry and aerodynamic data
- Compute eccentricity, semi-major axis length, angular momentum for a planar Keplerian orbit
- Find spacecraft particle velocity as a function of orbit radius and orbit parameters
- Calculate circular orbit velocity and planetary escape velocity

*Student Performance Results:*

	Students who scored 70% or higher
Exam 1	59%



Exam 2	92%
Final Exam	94%

### *Analysis*

Flight Dynamics is an introductory class in aircraft performance, aircraft stability and orbital mechanics. The particular challenge of this class is its combination of three distinct topics in flight mechanics. The two aircraft topics (performance and stability & control) will be connected explicitly in subsequent classes, while orbital mechanics is an application of particle dynamics for Earth-orbiting spacecraft. The low scores on the first exam indicate that the students were somewhat slow to embrace the new applications that they encountered in Flight Mechanics. However, by working many examples in class and often letting the students work problems in a group and present their solutions to the class, students did master the material, as indicated by their performance on Exam 2 and the Final Exam.

Another essential element of student success is integrating the AE165 and AE162 (Aerodynamics II) course projects. Since most students take AE162 and AE165 concurrently, the projects are assigned jointly, using the same aircraft. The students calculate aerodynamic forces on their aircraft in AE162, and then use those forces to predict vehicle performance and open-loop stability in AE165.

*Recommendation:* None

*Implementation:* N/A

### ***Performance Indicator A-3.5: Apply propulsion principles.***

*AE167 – Prof. Marc Murbach – Spring 2012*

*AE 167 – Prof. Alex Carlozzi – Spring 2016*

*Assessment Summary:* The performance target is **met** for Performance Indicator A-3.5.

### *Course Activities*

- Perform thermodynamic analysis of ramjet, turbojet, and turbofan engines
- Analyze the performance of subsonic and supersonic inlets
- Analyze the performance of combustors, afterburners, and exhaust nozzles
- Analyze the performance of axial flow compressors
- Carry out flight performance calculations for rockets
- Analyze the performance of solid and liquid rockets

### *Student Performance Results:*

Students who scored 70% or higher						
Quiz 1	Quiz 2	Quiz 3	Quiz 4	Quiz 5	Quiz 6	Quiz 7
69 (89%)	55 (79.3%)	66 (89.4%)	61 (84.9%)	59 (81.7%)	38 (64.4%)	63 (85.8%)

### *Analysis*

Based on my personal observations and one-on-one conversations with students, I

would say the most significant contributor to poor quiz performance would be the lack of time spent outside of class (reading the textbook, looking at example problems, solving problems in addition to those assigned for homework.) One of my top performing students said he committed at least 5 hours per week, outside of class, to AE 167 related activities. Another contributing factor to poor quiz and homework performance is a lack of preparation before each class. At the beginning of class, I would occasionally ask if anyone had read or looked at the material we would be discussing that day. At best, 5-10% of the students raised their hands. Students who read ahead get the most out of class lectures, since they are able to contribute to in-class discussions and ask questions related to topics not clear to them. Many students did not take advantage of my office hours. Throughout the semester, only about 20% of my office hour time was spent helping and talking to students. I made a conscious effort to continuously invite students to see me during my office time to clear up any questions, concerns, or lack of understanding of course material.

On the other hand, I was pleased to see the vast majority (at least 80%) of students taking advantage of the in-class time spent for solving workout problems. Many would come to me for help, or to check their final answers. Group work and student collaboration was impressive (which is expected for an upper division course comprised primarily of graduating seniors.)

Biweekly quizzes are a more effective way to solidify and assess student learning and comprehension as compared to one mid-term plus a final exam. Students also favored this approach. This proved especially true when more challenging topics (axial flow compressors, velocity triangles, etc...) were discussed. Quiz #5 was on axial flow compressors, and I was pleased to see almost 82% of the class scoring a 70% or better.

*Recommendation:* Continue the current approach of bi-weekly assessment through quizzes.

*Implementation:* In every course offering.

***Performance Indicator A-3.6: Apply stability and control principles.***

*AE 168 – Prof. Kamran Turkoglu – Fall 2015*

*Assessment Summary:* The performance target is **not met** for Performance Indicator A-3.6.

*Course Activities*

- a. Develop perturbation equations for aerospace vehicle six degree-of-freedom motion
- b. Determine the natural frequencies and damping ratios of the short period and phugoid modes
- c. Derive transfer functions and plot vehicle time response
- d. Analyze aircraft robustness with respect to perturbations and disturbances
- e. Design closed-loop control systems for longitudinal and lateral/directional dynamics
- f. Derive the equations of a satellite using gravity-gradient passive control

- g. Design a satellite control law using a momentum wheels, thrusters and other actuation mechanisms

*Student Performance Results*

	Students who scored 70% or higher	
	Exam 1	Exam 2
N=60; Passed = 56 (93%)	29 (49%)	30 (50 %)

*Analysis*

Students struggle when presented with a slightly different conceptual question(s) w.r.t what they have seen, solved and discussed in class. In this class students are encouraged to collaborate and discuss in small groups questions related to stability and control concepts. Basic concepts are tested in class discussions, whereas students' ability to understand and implement stability and control is tested in exams. Students need more help one-on-one and mentoring on how to approach challenging problems in the field.

It is observed that solving more problems in class help students in their understanding of concepts, however, automatic control (AE157) is a prerequisite for AE168, and students seem to have difficulty with the material in AE157. Hand-holding students (unfortunately) creates a preference in memorizing problem setups rather than understanding the core concepts underneath. This is observed specifically when a concept is presented in a slightly different way/shape, requiring the same tools/skills presented.

*Recommendations*

To increase the level of understanding in class material, more example problems will be solved, better mentoring will be provided, more problems will be solved in problem solving sessions outside of class and collaborative efforts will be encouraged to enhance students' analytical skills.

*Implementation:* Fall 2016

**Outcome Element A-4: Ability to identify, formulate and solve AE problems**

***Assessment Summary***

The performance target is **met** for Outcome Element A-4.

***Performance Indicators***

*A-4.1: Engage in the solution of problems (spend adequate time on task, ask questions, etc.).*

*A-4.2: Define (open-ended) problems in appropriate engineering terms.*

*A-4.3: Explore problems (examine various issues, make appropriate assumptions, etc.).*

- A-4.4: Develop a plan for the solution (select appropriate theories, principles, approaches).*
- A-4.5: Implement their solution plan and check the accuracy of their calculations.*
- A-4.6: Reflect on the results as well as on their strengths and weaknesses in their problem solving process.*

*Assessment Summary:* The performance target is...

**Met** for Performance Indicator A-4.1.

**Met** for Performance Indicator A-4.2.

**Not met** for Performance Indicator A-4.3.

**Met** for Performance Indicator A-4.4.

**Met** for Performance Criterion A-4.5

**Met** for Performance Criterion A-4.6.

*AE162 – Dr. Nikos J. Mourtos – Spring 2016*

*Course Design to Address Outcome Element A-4*

Several core BSAE courses have been re-designed in an effort to help students develop problem-solving skills. This re-design includes:

- a. Explicit definition of skills and attributes that students need to develop to become capable problem-solvers.
- b. Inclusion of open-ended problems (OEP) in each of several key, junior-level, core courses.
- c. Coaching students in the use of Wood’s Problem-Solving Methodology (PSM). This process includes seven steps (Woods, 1994):

Step 1: Engage

Step 2: Define

Students try to understand the problem and re-state it in their own terms. They make a comprehensive list of what is given but also what may be known from other sources, and determine any applicable constraints. This step requires some research on the background of the problem. This may include reading various sections of the textbook, a visit to the library or searching online (students’ favorite method). Students are expected to draw a sketch of how they visualize the problem including any parameters they think relevant. The most important outcome of this step is the criterion to be used in answering the question in the problem.

*Assessment Tool*

Rubric for measuring student performance on Step 2 of the PSM

Score	Performance Indicator: Define one or more criteria (measures) for answering the question.
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10	Identifies a proper “measure”. Includes appropriate sketches illustrating all relevant parameters.
7 - 9	Identifies a “measure” that can indirectly lead to a more appropriate one. Sketches illustrate some of the relevant parameters.
5 - 6	Identifies what may at first appear as a reasonable “measure” but which may later be shown to be inappropriate. Sketches illustrate some of the relevant parameters.
1 - 4	Does not specify a useful “measure” for the comparison. No sketches included.
0	Does not attempt.

### Step 3: Explore

Students explore relevant questions and brainstorm possible ways to model the physical situation described in the problem by making appropriate assumptions. To develop intuition, students attempt to predict the answer to the problem.

### *Assessment Tool*

Rubric for measuring student performance on Step 3 of the PSM

Score	Performance Indicator: Generate appropriate questions related to the “measures” you defined in Step 2, identify possible approaches (models) for solving the problem, and make reasonable assumptions.
10	Generates at least two relevant questions, identifies at least two different approaches, and makes all necessary assumptions for each approach.
7 - 9	Generates at least one relevant question, identifies at least two different approaches, and makes most of the necessary assumptions for each approach.
5 - 6	Generates at least one relevant question, identifies at least one approach, and makes most of the necessary assumptions for this approach.
1 - 4	Generates one or two relevant questions, does not identify an approach, does not make some or all of the necessary assumptions.
0	Does not attempt.

### Step 4: Plan

Students select an appropriate model (usually the simplest available) for developing a solution. They break down the problem into smaller sub-problems, each involving the calculation of various parameters, which serve as stepping-stones towards the final answer. It is important that students develop an algorithm (flow chart) for the solution of the problem and not substitute any numerical values. This algorithm may involve, for

example, identifying appropriate equations or graphs for calculating various parameters in each sub-problem.

*Assessment Tool*

Rubric for measuring student performance on Step 4 of the PSM

Score	Performance Indicator:
	Select an appropriate model for developing a solution, break down the problem into sub-problems, and determine what needs to be found in each sub-problem.
10	Selects the most appropriate model for developing a solution, breaks down the problem into appropriate sub-problems; provides complete list of what needs to be found in each sub-problem.
7 - 9	Selects an appropriate model for developing a solution, breaks down the problem into appropriate sub-problems; incomplete list of what needs to be found in each sub-problem.
5 - 6	Selected model for developing a solution is not described adequately; breakdown of problem into sub-problems is not appropriate or helpful; list of what needs to be found is incomplete.
1 - 4	Does not identify a model for developing a solution or does not break down the problem into sub-problems and / or does not list what needs to be found.
0	Does not attempt.

**Step 5: Implement & Check**

This is the most straightforward step of the PSM. Students substitute the values of known and assumed quantities into their model (equations) and develop the solution, checking for accuracy and consistency of units. The outcome of this step includes numerical answers for various parameters and usually includes additional sketches, figures or drawings. Students check their calculations for errors and make sure the units in all parameters are correct.

*Assessment Tool*

Rubric for measuring student performance on Step 5 of the PSM

Score	Performance Indicator:
	Substitute appropriate values of known and assumed quantities in the equations and carry out calculations correctly. Produce sketches, figures, and drawings as necessary.
10	All calculations are correct. Appropriate sketches, figures, and drawings included in the solution.
7 - 9	Most calculations are correct. Appropriate sketches, figures, and drawings included in the solution.
5 - 6	Some calculations are correct. Some sketches, figures, and drawings included in the solution.
1 - 4	Several of the calculations are incorrect. Important sketches, figures, and drawings are missing from the solution.

0	Does not attempt.
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**Step 6: Reflect.**

Making an unrealistic assumption in Step 3 or choosing an inappropriate model in Step 4 often results in numbers that do not make sense. This is a common occurrence in OEP solving even among experienced problem solvers. Students are expected to identify the cause of the problem and correct it or suggest a more sophisticated approach to solve the problem. Furthermore, they compare their answer to their guestimate from Step 3. If their guestimate was incorrect they provide an explanation as a way of developing intuition. In addition to discussing the solution of the problem itself students reflect on their own strengths and weaknesses in the problem solving process.

*Assessment Tool*

Rubric for measuring student performance on Step 6 of the PSM

Score	Performance Indicator: Discuss whether answer makes sense, evaluate appropriateness of models used and any assumptions made. Reflect on personal problem solving process.
10	A. Comments on whether the answer is reasonable and why. Evaluates the appropriateness of any models used and any assumptions made. B. Reflects in depth on his/her personal problem solving process; identifies several strengths and several areas for improvement.
7 – 9	A. Comments on whether the answer is reasonable but does not explain why. Evaluates the appropriateness of any models used and some of the assumptions made. B. Reflects on the personal problem solving process. Identifies at least one strength and one area for improvement.
5 – 6	A. Comments on whether the answer is reasonable but does not explain why. Does not evaluate the appropriateness of any models used and/or some of the assumptions made. B. Inadequate reflection on the personal problem solving process. One strength and/or one area for improvement identified.
1 – 4	A. No comment on whether the answer is reasonable. No evaluation of the appropriateness of any models used and/or any assumptions made, based on the answer received. B. No reflection on the personal problem solving process. No strengths or areas for improvement identified.
0	Does not attempt.

Step 6 is critical for self-assessment and self-improvement. A small number of students receive non-passing scores (0 – 4), indicating that they have difficulty with this final step.

- d. Development of rubrics (see above) to evaluate student performance for each step of this methodology (Mourtos, 2010)

## Course Activities

### Students:

- Are presented with an example of an OEP and its detailed solution following the PSM.
- Work in teams to solve two OEP, using the PSM.
- Work in teams to identify, research, formulate, and solve a current multi-disciplinary problem that involves applications from AE162 and AE165. A final report is due at the end of the semester. This project involves the following:
  - ✓ Selecting an airplane with a high AR wing.
  - ✓ Performing a potential flow simulation using the Potential Flow Theory Program to simulate the flow around the fuselage of their selected airplane. Plotting the streamlines around the fuselage and write the stream function and the velocity potential function.
  - ✓ Performing an airfoil study by:
    - Defining criteria for selecting an airfoil for their airplane.
    - Based on these criteria, identifying at least ten potential airfoils and comparing them using published data and software such as XFLR5.
    - Selecting the best airfoil for their airplane wing.
    - Using thin airfoil theory to estimate the aerodynamic characteristics of their selected airfoil and compare with actual data.
  - ✓ Performing a wing study by:
    - Performing a parametric study to determine the best combination of sweep angle, thickness ratio and taper ratio using the WingDesign software of Desktop Aeronautics or any other piece of software they see fit.
    - Using wing weight as a figure-of-merit to select the best wing design.
    - Calculating the lift and drag characteristics of their wing using the monoplane equation.
    - Estimating the maximum lift coefficient of their wing, using the WingDesign software of Desktop Aeronautics.
  - ✓ Calculating the drag polars of their airplane:
    - Calculate the low and high-speed (if appropriate) drag of their entire vehicle.
    - Derive and plot the drag polars for the cruise, takeoff, and landing configurations.

### AE165 Project Requirements

- Estimate the takeoff and the landing performance of their airplane; compare their results with actual performance data.  
Estimate the climb performance of their airplane; compare their results with actual performance data.  
Estimate the cruise performance of their airplane; compare their results with actual



performance data.

Estimate the range/endurance of their airplane; compare their results with actual performance data.

Estimate the glide performance of their airplane; compare their results with actual performance data.

From planform geometry and aerodynamic data, calculate the stability derivatives

$C_{M_\alpha}$  and  $C_{M_{\delta_e}}$  of their aircraft.

### *Student Performance Results*

Students who scored 70% or higher; N=78; passed=72 (92%)									
Potential Flow Modeling	Airfoil Comparison	Thin Airfoil Theory Analysis	Wing Parametric Study	Wing Weight	Wing Aerodynamic Characteristics	Airplane drag polars	Individual Reflection	Team Reflection	Total Project Score
63 (88%)	60 (83%)	64 (89%)	50 (69%)	51 (71%)	67 (93%)	24 (33%)	53 (74%)	55 (76%)	63 (88%)

### *Analysis*

A-4.1 (Engage) – As the student performance results show, the majority of the students (88%) did indeed engage with their open-ended project (spent adequate time on task, asked questions throughout the semester, etc.) and produced a high quality report.

A-4.2 (Define) – In their airfoil comparison, 65% defined selection criteria appropriate for their airplane; the rest used a generic list of criteria presented in class without regard to the specific requirements of their particular airplane. On a positive note, 83% of the students used XFLR5 effectively in comparing the various airfoils in their database.

A-4.3 (Explore) – Only 69% of the students were able to frame their wing parametric study appropriately, making proper assumptions and using the wing structural weight as a figure of merit in selecting the best possible wing design for their airplane.

A-4.4 (Plan) – Students were able to select appropriate theories, principles, and approaches in carrying out the various parts of their project (e.g. potential flow theory, thin airfoil theory, etc.) except for the calculation of their drag polars. This was surprising, as this topic was discussed in boundary layer theory in AE160, which is a prerequisite for AE162, and it was reviewed in AE162 on two separate occasions during class. While 11% (8) of the students did exceptional work on their drag polars with a level of detail above and beyond the call of this assignment and another 22% (16) performed a very good drag polar analysis, 67% of the students were lost; they did not seem to know what drag polars were or how to estimate them and they never asked for help or clarification with this part of their project.

A-4.5 (Implement & Check) – Overall, students did implement effective plans for the potential flow simulation of their airplane fuselage, the comparison of the various airfoils they selected, and the calculation of the aerodynamic characteristics of their wing. Furthermore, their results were fairly accurate.

A-4.6 (Reflect) – Most students reflected appropriately on the validity and accuracy of their results as well as on their strengths and weaknesses in the problem-solving process, while carrying out the various parts of this project. In fact, a large percentage of them (~ 25%) provided excellent insights regarding the lessons learned and the

limitations of their approach throughout the project as well as regarding their learning process.

### *Recommendations*

- Case studies will be presented and discussed in class to demonstrate the different requirements of airfoils designed for different airplanes.
- Several parametric studies will be presented in class involving wing parameters to illustrate how such studies can be used to optimize wing design.
- A step-by-step process will be added to the class notes to guide students in their estimation of drag polars for an airplane in cruise, takeoff, and landing configurations, allowing also for compressibility drag if the plane operates at high speeds.

*Implementation:* Spring 2017

*AE165 – Aerospace Flight Mechanics*

*Dr. Derek Lang*

The students were assigned a group research problem for which they needed to define a problem, develop a work plan, and report the results of their analysis. Often they chose real-world problems for which they had difficulty identifying where engineering judgments could be made to converge on a solution. They did well independently analyzing aerodynamic characteristics and then flight performance characteristics; but had difficulty connecting the former as inputs into the latter and identifying parameters to do meaningful sensitivity studies.

*Recommendation:* Although these skills will be revisited in senior design, spend some time in the aerodynamics and flight mechanics classes explaining how to set up sensitivity and trade studies.

## **OUTCOME B**

**Assessment Summary:** The performance target **is met** for Outcome B.

*AE160 – Aerodynamics I*

*Prof. Nikos J. Mourtos*

### *Course Design to Address Outcome B*

The laboratory experience in AE160 and AE162 has been re-designed to include:

- a. Instruction on how to design experiments.
- b. Modification of the original experiments from ‘cook-book’ to open-ended: students design their own experiments, given a general goal.
- c. Introduction of a Design-of-Experiment (DoE) process (Du, Furman, and Mourtos, 2005), which students are required to use:

Step 1 – Define specific and measurable objectives for the experiment.

Step 2 – Research the relevant theory and previously published data from similar

experiments. Perform computer simulations if appropriate software is available. The purpose of this step is to prepare students on what to expect from the experiment.

Step 3 – Select the dependent and independent variable(s) to be measured.

Step 4 – Select appropriate methods for measuring / calculating each variable.

Step 5 – Select the proper range for the independent variable(s).

Step 6 – Determine an appropriate number of data points needed for each type of measurement.

- d. Development of rubrics (see below) to evaluate student performance in each step of this process (Anagnos, Komives, Mourtos, and McMullin, 2007).
- e. In both courses, students write extensive lab reports for each lab experiment, in which they present their design, results, and discussion (interpretation) of their results. Their lab reports are graded using the rubric below.

#### *Course Activities (AE 160)*

- a. Design and perform a water tunnel experiment to study the effects of shape and angle of attack on the flow pattern around an airfoil, a forebody, and a delta-wing aircraft model and report the results. As part of the study students distinguish basic flow features, such as laminar or turbulent flow, attached or separated flow, etc.
- b. Design and perform a wind tunnel experiment to study the effects of shape and Reynolds number on the aerodynamic drag of 2-D and 3-D bodies and analyze the results.
- c. Design and perform a wind tunnel experiment to study the drag of an airfoil from wake measurements and analyze the results.
- d. Design and perform a wind tunnel experiment to study boundary layer characteristics on an aerodynamic surface and analyze the results from such experiments.

#### *Course Activities (AE 162)*

- a. Design and perform a wind tunnel experiment to study the effects of Reynolds number on the pressure distribution of a circular cylinder and compare with potential flow theory results (new experiment, implemented in Spring 2011).
- b. Design and perform a wind tunnel experiment to study the effect of angle-of-attack and Reynolds number on the pressure distribution of an airfoil and compare the results with published and computational data.
- c. Design and perform a wind tunnel experiment to study the effect of angle-of-attack and Reynolds number on the lift and drag characteristics of an airfoil and compare the results with theoretical, published and computational data.
- d. Design and perform a wind tunnel experiment to study the effect of high-lift devices on the lift and drag characteristics of an airfoil and compare the results with published and computational data (new experiment, implemented in Spring 2011).

#### *Assessment Tools*

- One lab report (water tunnel experiment) in AE160.
- One lab report (wind tunnel experiment) in AE162.

## Design-of-Experiments Rubric

1. Given the general goal of an experiment, define **specific and measurable objectives** for this experiment.

NOT PASS	0	No objectives defined for this experiment.
	1	Objectives identified but <ul style="list-style-type: none"> <li>• Not relevant to experiment OR</li> <li>• Contain technical or conceptual errors OR</li> <li>• Not measurable</li> </ul>
PASS	2	Objectives are conceptually correct and use correct technical terminology but may be incomplete in scope or have grammatical errors.
	3	Objectives are complete, conceptually correct, concise, and use correct technical terminology but may have grammatical errors.
	4	Objectives are complete, conceptually correct, concise, specific and clear, and use correct technical terminology and grammar

2. Research and summarize the **relevant theory** for this experiment.

NOT PASS	0	No theory section is included in the report.
	1	A theory section is included but it is not relevant to the experiment.
PASS	2	Theory section includes some of the relevant equations and some discussion relevant to the experiment. Theory is used to predict some of the experimental results.
	3	Theory section is well written, with equations and some discussion relevant to the experiment. Theory is used to predict experimental results.
	4	Theory section is well written, with equations and discussion relevant to the experiment. Theory is used to predict experimental results.

3. Research and summarize **previously published data** from similar experiments.

NOT PASS	0	Previously published data are not included in the report.
	1	Published experimental data, and computer simulations included but not relevant to the experiment.
PASS	2	Theory section includes some of the relevant equations and some discussion relevant to the experiment. Published experimental data or computer simulations relevant to the experiment are included but not used to predict experimental results.
	3	Theory section is well written, with equations and some discussion relevant to the experiment. Published experimental data and / or computer simulations relevant to the experiment are included but not used to predict experimental results.
	4	Theory section is well written, with equations and discussion relevant to the experiment. Published experimental data are included as well as computer simulations relevant to the experiment. Theory, published data, and simulations are used to predict experimental results.

4. Perform appropriate **computer simulations** relevant to this experiment.

NOT PASS	0	Computer simulations are not included in the report.
PASS	1	Computer simulations are included but are not relevant to the experiment.
PASS	2	Computer simulations relevant to the experiment are included but not used to predict experimental results.
	3	Theory section is well written, with equations and some discussion relevant to the experiment. Published experimental data and / or computer simulations relevant to the experiment are included but not used to predict experimental results.
	4	Theory section is well written, with equations and discussion relevant to the experiment. Published experimental data are included as well as computer simulations relevant to the experiment. Theory, published data, and simulations are used to predict experimental results.

5. Select **dependent and independent variables** to be measured (or controlled)

NOT PASS	0	Did not identify variables.
PASS	1	Identified variables but did not distinguish dependent and independent.
PASS	2	Identified dependent and independent variables and relationship between them.
	3	Identified dependent and independent variables and relationship between them.
	4	Identified dependent and independent variables and relationship between them.

6. Select appropriate **methods for measuring / controlling each variable**

NOT PASS	0	Did not identified methods for measuring/controlling variables
PASS	1	Identified inappropriate method(s)
PASS	2	Method(s) listed with no description or incomplete description OR Complete description of method(s) presented, but list is not comprehensive
	3	Comprehensive list of possible methods of measurement and instrumentation with complete descriptions but no discussion of limitations and dynamic range
	4	Comprehensive list of possible methods of measurement and testing instrumentation and equipment based on available resources with complete descriptions including a discussion of limitations and dynamic range

7. Select appropriate **equipment and instrumentation**

NOT PASS	0	Did not identify instrumentation and equipment for measuring/controlling variables.
PASS	1	Identified inappropriate instrumentation and equipment.
	2	Selected appropriate instrumentation and equipment with no justification OR

		Incomplete list of instrumentation.
	3	Selected appropriate instrumentation and equipment with incomplete justification.
	4	Selected appropriate instrumentation and equipment with complete justification (e.g. based on accuracy, sensitivity, reliability, and available resources ).

8. Select a proper **range for the independent variables**

NOT	0	Ranges not identified
PASS	1	Ranges grossly unreasonable*** OR Ranges provided with no justification
PASS	2	Range is reasonable* but not adequately justified OR Range is unreasonable but based on correct theory with mathematical errors
	3	Reasonable* range for all independent variables that are justified based on appropriate but possibly incomplete use of literature, correct theoretical calculations, and equipment/instrumentation limitations.
	4	Optimal** range for all independent variables that are justified based on appropriate use of literature, theoretical calculations, and equipment/instrumentation limitations.

\* reasonable – pushing the limits of equipment, instrumentation or specimens, or captures some aspects of system behavior but is inadequate for complete analysis

\*\* optimal – range will capture full response of system, is within limitations of equipment, instrumentation, and specimens, and will provide sufficient data for a statistically valid and complete analysis

\*\*\* unreasonable – theoretically impossible, or significantly outside the limits of the equipment, instrumentation, or specimens

9. Determine an appropriate number of data points needed for each type of measurement.

NOT	0	Number of data points not identified
PASS	1	Number of points grossly unreasonable OR Number of points provided with no justification
PASS	2	Number of points is sufficient to capture mathematical properties in an ideal world, but insufficient in the presence of experimental error or other confounding factors
	3	Reasonable* number of points for measurements, justified based on some but not all of the following: theory, equipment limitations, and potential error
	4	Reasonable* number of points for all measurements, justified based on consideration of theory, equipment limitations, and potential error

\* reasonable – a sufficient number of points to capture the mathematical properties of the relationship (e.g. linear versus logarithmic) and account for possible measurement error.

\*\*\* unreasonable – insufficient number of points to capture the mathematical properties of the relationship

Lab Report Grading Rubric

Total Score	<b>106</b>
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1. Abstract		<b>10</b>
2. Experimental Design		<b>36</b>
• (1) Define specific and measurable objectives for the experiment		4
• (2) Research / summarize relevant theory		4
• (3) Research / summarize previous data		4
• (4) Computer simulations (if available)		4
• (5) Select dependent and independent variables		4
• (6) Select appropriate methods to measure these variables		4
• (7) Select appropriate equipment and instrumentation to measure these variables		4
• (8) Select proper range for independent variables		4
• (9) Determine appropriate number of data points for each type of measurement.		4
3. Experimental results		<b>20</b>
4. Discussion		<b>20</b>
• Interpretation of results		
• Explanation of any discrepancies with theory and / or published data and / or computer simulations		
5. References		<b>10</b>
6. Appendices		<b>10</b>
• Raw data		
• Data Analysis - Calculations		
• Published data		
• Other		

### **Outcome Element B-1: Ability to design water tunnel and wind tunnel experiments**

*Assessment Summary:* The performance target **is met** for Outcome Element B-1.

#### ***Performance Indicators B-1***

*B-1.1: Given the general goal of an experiment, define specific and measurable objectives for this experiment.*

*B-1.2: Research and summarize the relevant theory for this experiment.*

*B-1.3: Research and summarize previously published data from similar experiments.*

*B-1.4: Perform appropriate computer simulations relevant to this experiment.*

*B-1.5: Select dependent and independent variables to be measured (or controlled).*

*B-1.6: Select appropriate methods for measuring / controlling each variable.*

*B-1.7: Select appropriate equipment and instrumentation.*

*B-1.8: Select a proper range for the independent variables.*

*B-1.9: Determine an appropriate number of data points needed for each type of measurement.*

#### *Student Performance Results*

Enrolled = 95	Passed (C- or better) = 92 (97%)								
	Students who scored 2, 3 or 4 on the Design-of-Experiments Rubric								
	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8	Step 9
AE 160 – Fall 2016	75%	50%	92%	N/A	83%	96%	96%	100%	92%

### *Analysis*

The performance target was met for all the steps in the design-of-experiment process except for Step 2, which calls for a summary of the relevant theory of the particular experiment. The reason for this is that the experiment assessed involved flow visualization in the water tunnel and the theory pertaining to the flow around some of the models is not explicitly discussed in AE160 (e.g. separated flows around airplanes and conical bodies at high angles of attack). Although references were provided, some students were not able to identify key points and summarize them in their discussion of relevant theory.

### *Recommendations*

A summary of the relevant theory for separated flows around delta-winged aircraft and bodies of revolution at high angles of attack will be provided to students during lecture as well as in notes, along with references for further study.

*Implementation:* Fall 2017

### **Outcome Element B-2:**

#### **Ability to conduct water tunnel and wind tunnel experiments**

**Assessment Summary:** The performance target is met for Outcome Element B-2.

### **Performance Indicator B-2:**

*Given an experimental setup, become familiar with the equipment, calibrate the instruments to be used, and follow the proper procedure to collect the data.*

### **Laboratory Activities**

- Students prepare for their experiments beforehand. The equipment manuals as well as questions pertaining to each experiment are posted on the courses' website.
- Students turn in written answers to these questions and must score a minimum of 70% before they are allowed to perform their experiment.
- Students turn in their design-of-experiment for approval before they are allowed to use the equipment in the Aerodynamics Lab.
- For safety reasons students conduct their experiments under the supervision of a lab assistant, who is usually an MSAE student familiar with the equipment. He/she (a) demonstrates all the equipment and instrumentation in the Aerodynamics Lab, (b) ensures that students are indeed familiar with the equipment before allowed to operate the wind and the water tunnel, and (c) supervises all experiments to ensure students follow proper procedures.



*Assessment Process:* Following each experiment, the Lab Assistant certifies that each student is capable of conducting the experiment.

*Recommendation:* None.

*Implementation:* N/A

**Outcome Element B-3:**

**Ability to analyze data from water tunnel and wind tunnel experiments**

***Performance Indicator B-3***

*Given a set of experimental data, carry out the necessary calculations and tabulate / plot the results using appropriate choice of variables and software.*

*Student Performance Results*

Enrolled = 95	Passed (C- or better) = 92 (97%)
	Students who scored 70% or higher in the results section of their lab report
AE 160 – Fall 2016	87 (95%)

*Analysis*

The results section of the flow visualization experiment involved photographs and sketches of the various types of flows observed in the water tunnel. The photographs and sketches presented by most students captured the essential flow features observed in the water tunnel experiments.

*Recommendation:* None

*Implementation:* N/A

**Outcome Element B-4:**

**Ability to interpret data from water tunnel and wind tunnel experiments**

***Performance Indicators B-4***

*B-4.1: Given a set of results in tabular or graphical form, make observations and draw conclusions regarding the variation of the parameters involved.*

*B-4.2: Given a set of results in tabular or graphical form, compare with theoretical predictions and/or other published data and explain any discrepancies.*

*Student Performance Results*

Enrolled = 92	Passed (C- or better) = 92 (97%)
	Students who scored 70% or higher in the discussion section of their lab report
AE 160 – Fall 2017	79 (86%)

### *Analysis*

Some students had difficulty interpreting the flow visualization patterns of the three-dimensional bodies tested in the wind tunnel (conical body and delta-wing aircraft). This difficulty was the result of: (a) students' unfamiliarity with these types of flows, (b) the fact that these flows are discussed in more detail later on in the course, and (c) the fact that students did not take the time to read the references provided, including the course textbook. As a result, some students performed poorly in the design of their experiment, as discussed above in relationship with Outcome Element B-1 and in particular with Outcome Performance Indicator B-1.2, but also in their interpretation of the flow patterns observed.

### *Recommendation*

Some discussion will be provided in class to guide students on how to interpret the flow patterns observed in their water tunnel experiment.

## **OUTCOME C**

**Assessment Summary:** Overall, Outcome C is satisfied in the BSAE Program.

### **AY 2013 – 2014 Assessment, Evaluation, and Recommendations**

*AE171A – Aircraft Design I*

*Prof. Gonzalo E. Mendoza*

*AE172A – Spacecraft Design I*

*Prof. Periklis Papadopoulos*

*AE171B – Aircraft Design II*

*Prof. Gonzalo E. Mendoza*

*AE172B – Spacecraft Design I*

*Prof. Periklis Papadopoulos*

### **Courses Statistics**

<i>Courses</i>	<i>Enrollment</i>	<i># of students who passed</i>	<i>% of students who passed</i>
AE 171A&B	24	23	96%

### **Performance Indicator C-1:**

*Research, evaluate, and compare vehicles designed for similar missions.*

### **Assessment Summary:**

The performance target is **met** for Performance Indicator C-1.

### *Course Activities*

AE 171 A – Students present a comparative study of airplanes with a mission similar to theirs. The objective is to become familiar with the competition and work done by others. They use encyclopedias, the internet, and intelligence gathered from previous projects to collect data on various airplanes. Students compare and discuss important design parameters for the airplanes selected, such as takeoff and payload weight,

available thrust, cruise speed and altitude, range, wing area, wingspan, wing aspect ratio, fuselage length, type of payload, etc.

#### AE 172 A

- a. Research various spacecraft projects which are existing and see how they have met their design and mission requirements.
- b. Develop a design space flow chart for your senior project.
- c. In the interim report reflect on historical spacecraft and describe and compare your final design to previous spacecraft of similar missions.

#### *Assessment Tools*

AE171A – Section 3 of Design Report 1: Mission specification and comparative study  
AE172 – Subsystem requirements assignment, MEDLI assignment, Interim report (historical study)

#### *Student Performance Results*

##### AE171A – Fall 2013

Students who scored 70% or higher
19 (76%)

##### AE172A – Fall 2016

Subsystem Requirements Assignment: 96.8% of students scored at or above 70%.
SEEME /TRL / Confidence Levels Assignment: 31.3% of students scored at or above 70%.
MEDLI Assignment: 78.1% of students scored at or above 70%.
Interim Report (Historical Study): 59.4% of students scored at or above 70%.

#### *Analysis*

AE171A – Students typically do well on this assignment; no improvements are needed. Statistics were skewed by a team, which did not meet the requirements of the assignment. Part of the course involves the preparation of a final design report, which must contain information from all previous reports in one place. Deficiencies found in the specific reports must be corrected on the final design report for a satisfactory grade.

##### AE172A

This performance criteria was further broken up into course learning objectives (CLOs) C.2 and C.3 inside of AE172A. The data shows that not all students were capable of meeting the target criteria of a 70% or higher on the assignment. While many students were able to develop mission requirements and design requirements for their spacecraft, most did not attempt to do an in-depth historical study. Students were given multiple opportunities to show their research, however neglected to do so in all of the

assignments. In the MEDLI and SEEME assignments, students did show their ability to connect a single mission design to their project, however they did not focus in their historical study to spacecraft which were in similar missions overall.

*Recommendations:*

AE171A – None

AE172A – (a) Make the historical study into a separate assignment at the beginning of the semester and increase its grade weight. (b) Put more emphasis on design space exploration and historical incremental approaches.

*Implementation:* Fall 2017

**Performance Indicator C-2:** *Follow a prescribed process to develop the conceptual / preliminary design of an aerospace vehicle.*

**Assessment Summary:**

The performance target is met for Performance Indicator C-2.

*Course Activities*

AE171A&B – Students follow an iterative process (Roskam, 1985; Raymer, 2006) to design their airplanes. This process involves mission specification, configuration selection, weight sizing, performance sizing, fuselage design, wing design, empennage design, landing gear design, weight and balance, stability and control analysis, drag polar estimation, and final specification. The open-ended nature of design requires students to iterate through their design process in order to meet their mission requirements.

AE172A&B – Students apply the complete product development lifecycle to their project. They create the baseline design of a spacecraft and establish the final design of a spacecraft.

*Assessment Tool*

AE171A&B – 4 group (two in AE171A, two in AE171B) design briefings and 2 written examinations with concepts from all aspects of design (one on each class). The briefings include directed Q&A sessions.

AE172A&B – Interim Report

*Student Performance Results*

AE171A&B

Written Examination Students who scored 70% or higher		Team Design Reviews (DR) Students scoring 70% or higher			
1 <sup>st</sup> Exam	2 <sup>nd</sup> Exam	Prelim. DR	Interm. DR	Critical DR	Final DR

(F13)	(S14)	(F13)	(F13)	(S14)	(S14)
6 (25%)	11 (46%)	24 (100%)	24 (100%)	24 (100%)	24 (100%)

AE172A&B – Fall 2016: 100% of the students scored 70% or above in their Interim Report.

### *Analysis*

AE171A&B – Student performance was mixed in AY 13-14, despite the fact that student teams produced reasonably good designs. Students divide the tasks among Team members and thus do not get detailed exposure to the various aspects of the design. Rather, they tend to specialize in particular areas of the design, for which they take responsibility. To ensure that all students are adequately knowledgeable in the entire design process, students are challenged with random questions on various aspects of the design individually during each of their design briefings in class. On this, they do relatively well, as evidenced by the design review scores. More detailed questions, as included in the written examinations, posed greater difficulty for the students. This is reflected in the far less positive exam scores. The exams are conceptual in nature, with a design issue posed and a series of questions regarding potential treatments to improve mission suitability of the design, followed by more general questions regarding design procedures and aerodynamic, systems, and stability and control concepts.

AE172A&B – Students developed their ideas for a spacecraft system and began to create and evaluate conceptual design plans. By the end of the semester the first full design iteration of the system requirement was met and 100% of the students passed. As such were able to meet the performance criteria by having a preliminary design, which was close to completion for the building phase during the spring semester.

### *Recommendations*

AE171A – Conceptual design questions used in the written exams form the basis for excellent discussions following the actual test. Similar exercises should be posed to the students during class to facilitate these discussions before the test and thus potentially improve the results.

AE172A – Continue having a two part class where the design and prototyping is done in the first semester.

*Implementation: AY 14-15*

***Performance Indicator C-3: Develop economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability constraints and design a vehicle that meets these constraints.***

### ***Assessment Summary:***

The performance target is met for Performance Indicator C-3.

## Course Activities

### AE171A&B

- Develop economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability constraints as appropriate for their airplane.
- Take into consideration these constraints in the design of their airplane and discuss how well their particular design meets these constraints.

### AE172A&B

- Develop system requirements and subsystem requirements for your project.

### Assessment Tools:

AE171 – Sections in two design reports (Mission Specification and Final Design Reports) and participation in online and class discussions on this topic.

AE172 – Subsystem requirements assignment.

### Student Performance Results

#### AE171

	Students who scored 70% or higher		
	Mission Spec. Report (F13)	Final Design Report (S14)	Participation (S14)
AE171A&B – F13/S14	19 (100%)	24 (100%)	24 (100%)

AE172A – Fall 2016: 96.8% of students scored at or above 70%.

### Analysis

AE171 – Student performance is generally good in this area. Sometimes students need help identifying realistic constraints, especially for airplanes designed for the SAE Aero-Design or the AIAA Design-Build-Fly competitions. Students may also need help analyzing how well their airplane meets certain constraints. Nevertheless, they seem to grasp the importance of specific constraints in airplane design and do a fairly good job meeting those constraints in their designs. Their assignments for outcomes 3F and 3G helpful in this area, as they broaden their horizons beyond the technical aspects of airplane design. As a result of these assignments students have a much better understanding of how to deal with their specific constraints. The class incorporates a fair number of examples of real life designs which test safety, ethical, environmental, economic, and other societal concerns. Participation in online discussion threads on these topics are part of the evaluation plan. In addition, individual and group assignments related to outcome F and G are tied to specific design examples during class discussion. Early deficiencies during the Mission Specification Report are required to be addressed in the Final Design Report for a satisfactory score.

AE172 – Each group was required to create a set of overall and subsystem requirements while meeting system level constraints. These were based on the SMART criteria which is a set of specific, measurable, achievable, relevant and time constrained requirements. These criteria were then measured against the mission criteria to determine the relevancy and impact on both performance, safety, economic, and other feasibility constraints.

*Recommendations:*

AE171 – None

AE172 – Expand the system requirements assignment to incorporate non-performance criteria to develop specific environmental, social, ethical and political constraints.

*Implementation:* Fall 2017

**Performance Indicator C-4:**

*Select an appropriate configuration for an aerospace vehicle with a specified mission.*

**Assessment Summary:**

The performance target is met for Performance Indicator C-4.

*Course Activities*

AE171A

- Study the configurations of aircraft with a mission specification similar to the proposed airplane; discuss the reasons for the selection of the particular configuration in each of these aircraft.
- Select and sketch a few overall configurations for the proposed airplane; discuss the pros and cons of each configuration. Select one of these configurations for preliminary design purposes and justify the choice.
- Select the specific wing, empennage, landing gear, and propulsion system configuration, discuss the pros and cons of each configuration and justify the choice.

AE172A

- Establish the final design of a spacecraft.

*Assessment Tools:*

AE171 – Configuration Design Report and Schematics, Final Design Report

AE172 – Interim Report

*Student Performance Results*

	Students who scored 70% or higher	
	Conf. Design Report	Final Design Report
AE171A&B – F13/S14	20 (83%)	24 (100%)

AE172A – Fall 2016: 100% of students scored at or above 70%.

## *Analysis*

AE171 – Students typically do well on this assignment; no improvements are needed.

AE172 – The design of the spacecraft was an iterative process which was based on feedback from both the instructor and in class discussions of historical data. This enabled students to down select an appropriate system architecture that met system level objectives and missions requirements.

## *Recommendations:*

AE171 – None

AE172 – It is recognized that more time should be spent reviewing and discussing in class the historical data in-depth and in detail to leverage past spacecraft system designs.

*Implementation:* Fall 2017

***Performance Indicator C-5:*** *Apply AE principles (e.g. aerodynamics, structures, flight mechanics, propulsion, stability and control) to design various vehicle subsystems.*

## ***Assessment Summary:***

The performance target is met for Performance Indicator C-5.

## *Course Activities*

AE171A&B

- Students apply AE principles throughout their conceptual and preliminary design of their airplane.

AE172A&B

- Perform in-depth analysis of four separate subsystems and relate their sizing/governing equations to the performance requirements of your system.
- Using trade studies, historical data and high fidelity analysis analyze your subsystems in order to develop an optimal solution which feasibly meets your performance criteria.

## *Assessment Tools*

AE171 – The following design reports: Weight and Performance Sizing (AE171A), Weight and Balance (AE171A), Stability and Control (AE171A, report includes aerodynamic data estimation, as well as empennage and control surface sizing), and iterations of the Final Design Reports (AE171B).

AE172 – Subsystem report.



## *Student Performance Results*

### *AE171*

Students who performed at 70% or higher				
Sizing Report (F13)	W&B Report (F13)	S&C Report (F13)	Draft Design Report (S14)	Final Design Report (S14)
17 (71%)	16 (67%)	15 (63%)	19 (79%)	24 (100%)

AE172 – Fall2016 / Spring 2017: 100% of students scored at or above 70%.

### *Analysis*

This Criterion is very broad. Student performance in the various reports varies from team to team and from year to year. It is not uncommon for a team to receive a low score in one of their reports and a number scored grades just below the 70% threshold. Detailed written and oral feedback is provided to each team, and opportunities for resubmitting the assignment are given. The offer for re-submitting reports is often declined early in the semester, as students place their efforts in either hardware research or other priorities. In the end, a satisfactory evaluation of the analyses employed in the design of their aircraft is required to approve the course. Thus, performance improves as the students dedicate additional time to their assignments toward the final design report.

### *Recommendation*

AE171 – The development of appropriate aerodynamic and mass models, as well as the completion of meaningful stability and control analyses, represent the areas which require additional attention. Re-introduction of the joint stability and control project tested out in prior years would add emphasis in these areas. This joint assignment increased the stakes for students to develop good quality weight estimation and aerodynamic models for analysis. The assignment was carried out in conjunction with the AE 168 course, a co-requisite for the aircraft design course.

AE172 – None

*Implementation:* AY 14-15

**Performance Indicator C-6:** *Develop and compare alternative configurations for an aerospace vehicle, considering trade-offs and appropriate figures of merit.*

### **Assessment Summary:**

The performance target is met for Performance Indicator C-6.

### *Course Activities*

AE 171 A&B – Extensive class discussion related to aircraft designs of varying configurations, missions, and degrees of success. Selection of configuration and design

concepts for application in student design projects. Comparative analysis of projects with similar performance goals.

AE172A – Perform design trade studies in your design reports in order to evaluate the optimal system configuration for your spacecraft requirements.

### *Assessment Tools*

AE171 – The following design reports: Configuration Design and Schematics Report (AE171A) and Final Design Report (AE171B). Both documents require the students to compare and select between various configurations for major components or overall design concepts. The selection must be based on objective or practical evaluation of a reasonable number of alternatives and how they are tied to mission requirements for their design.

AE172 – Subsystem report and conceptual design report.

### *Student Performance Results*

AE171

Students who scored 70% or higher	
Configuration Design Report	Final Design Report
20 (83%)	24 (100%)

AE172

Subsystem Report: 100% of students scored at or above 70%.

Conceptual Design: 81.3% of students scored at or above 70%.

### *Analysis*

AE171 – Students enjoy and perform well in these areas. Re-directive feedback typically results from the student’s inclusion of clearly impractical design choices for the sake of providing what is felt is an appropriately large selection. In addition, design concepts are sometimes qualitatively selected or dismissed based on design myths which are common among popular enthusiast groups. These are relatively minor issues which are improved upon throughout the class experience.

AE172 – Students performed in-depth trade studies and developed several conceptual system design architectures. Then a down selection process was implemented within each subsystem. These configuration studies were evaluated with design matrices and the pros and cons related to the system requirements.

### *Recommendations:*

AE171 – None

AE172 – Assign a stand-alone trade study report that elaborates on design space exploration instead of incorporating it into other assignments. This will enable the

students to develop a better understanding of design space exploration techniques and methods.

*Implementation:* Fall 2017

***Performance Indicator C-7:*** *Develop final specifications for an aerospace vehicle.*

***Assessment Summary:***

The performance target is met for Performance Criterion C-7.

*Course Activities*

AE171A&B – Students are required to develop specifications for their designs such that the mission goals from the Mission Analysis exercise are met. Students either test proof of concept aircraft or, if impractical, provide design validation analyses for their designs and are asked to compare the actual or estimated performance of their airplane against their design specifications.

AE172A&B – Establish the final design specifications of a spacecraft.

*Assessment Tools*

AE171 – Outcome C-7 is specifically assessed through the Critical Design Review, where suitability of design specifications is evaluated, and the Final Design Report, which contains the final set of specifications for the design and relevant mission scorecard.

AE172 – Interim report.

*Student Performance Results*

AE171

	Students who scored 70% or higher	
	Critical Design Review	Final Design Report
AE171A&B – F13/S14	24 (100%)	24 (100%)

AE172A – Fall 2016: 100% of the students scored 70% or higher.

*Analysis*

AE171 – Students typically participate in design competitions such as AIAA Design Build Fly or SAE Aero Design. These competitions provide an interesting exercise in that the specifications are the product of mission score analyses, rather than suitability to a particular mission. Thus, aircraft with rather poor performance characteristics may very well achieve high scores based on one or more design attributes (low weight, short wingspan, etc). Students at San José State have done very well in these types of contests through careful analysis and definition of design specifications which result in high scoring aircraft. Three teams chose to design AIAA DBF aircraft this year. Other

projects also showed reasonable judgment in the selection and analysis of final design specifications. One team struggled with the idea of having mission requirements dictate the specifications of their design. Corrective feedback resulted in a satisfactory outcome, but significant time for other activities was lost.

AE172 – Performance criteria was evaluated in CLOs C.7 and C.8. from AE172A. The final design specifications of the spacecraft were based on feedback from both the instructor and in class discussions during critical design review (CDR) presentations that were captured in the interim presentations and reports. Previous assignments all contributed to enable the students to capture the final specifications properly that meet system level objectives and mission requirements.

*Recommendations:* None

*Implementation:* N/A

## OUTCOME D

**Assessment Summary:** Overall, Outcome D is satisfied in the BSAE Program.

*AE171A – Aircraft Design I*

*Prof. Gonzalo E. Mendoza*

*AE172A – Spacecraft Design I*

*Prof. Periklis Papadopoulos*

*AE171B – Aircraft Design II*

*Prof. Gonzalo E. Mendoza*

*AE172B – Spacecraft Design I*

*Prof. Periklis Papadopoulos*

### *Course Activities*

- Engage in team building activities.
- Work in teams (typically 4–6 students) to design an aircraft. For some projects students also work in teams to build and test fly their aircraft. The multicultural aspect of teamwork is inherent in all teams in our capstone, senior design experience, simply by virtue of our multicultural student population<sup>5</sup>. Nevertheless, an additional effort is made to create teams that are as diverse as possible in terms of cultural background as well as abilities.
- Individuals and teams are coached throughout the year on how to improve their team skills.
- Evaluate the performance of teammates at the end of each semester based on 7 specific criteria. Peer reviews are taken into consideration when individual grades are assigned.

### **Performance Indicators**

**D-1:** *Committed to the team and the project, dependable, faithful, reliable. Attends all meetings; arrives on time or early. Comes to the meetings prepared and ready to work.*

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<sup>5</sup> For example, an aircraft design team in a recent year included members with cultural backgrounds from Singapore, El Salvador, Philippines, Mexico, and Tibet.

**D-2: Leadership:** takes initiative, makes suggestions, provides focus. Creative, brings energy and excitement to the team. Has a “can do” attitude. Sparks creativity in others.

**D-3:** Gladly accepts responsibility for work and gets it done; spirit of excellence.

**D-4:** Has abilities the team needs. Makes the most of these abilities. Gives fully, doesn’t hold back.

**D-5:** Communicates clearly when speaking and writing. Understands the direction of the team.

**D-6: Personality:** positive attitudes, encourages others, seeks consensus, brings out the best in others.

### Assessment Tool

Students use the following rubric to evaluate the performance of their teammates as well as their own at the end of each semester.

### Team Member Report Card

Project Title:					
Criteria		Filled out by:			
		Member	Member	Member	Self
1	<i>Quality of Technical Work:</i> Work is correct, clear, complete, and relevant to the problem. Equations, graphs, and notes are clear and intelligible.				
2	<i>Commitment to Team / Project:</i> Attends all meetings. Arrives on time or early. Prepared. Ready to work. Dependable, faithful, reliable.				
3	<i>Leadership:</i> Takes initiative, makes suggestions, provides focus. Creative. Brings energy and excitement to the team. Has a “can do” attitude. Sparks creativity in others.				
4	<i>Responsibility:</i> Gladly accepts work and gets it done. Spirit of excellence.				
5	Has abilities the team needs. Makes the most of these abilities. Gives fully, doesn’t hold back.				
6	<i>Communication:</i> Communicates clearly when he/she speaks and when she/he writes. Understands the team’s direction.				
7	<i>Personality:</i> Positive attitude, encourages others, seeks consensus. Brings out the best in others.				
	<i>Average score</i>				
Grading scale:					

5 – Always, 4 – Most of the time, 3 – Sometimes, 2 – Rarely, 1 – Never  
 Keep in mind that if you award high scores to everyone, regardless of their contribution, team members who have worked unduly hard or provided extraordinary leadership will go unrecognized, as will those at the other end of the scale who need your corrective feedback.  
 Please write below and on the back of this form one (**minimum**) or more paragraphs about the work of **each member** of your team, including your own. These narratives should amplify the ratings you gave in the table, by (a) identifying the strengths and weaknesses of each individual and (b) suggesting ways in which his / her work can be more effective. Also, evaluate the team as a whole. Feel free to attach additional pages.

*Student Performance Results*

	% of students who averaged 4 (most of the time) or higher	
	AE171	AE172
Item # 1	85%	91%
Item # 2	85%	100%
Item # 3	70%	75%
Item # 4	85%	90%
Item # 5	100%	100%
Item # 6	80%	87%
Item # 7	90%	100%

*Analysis*

In general, student teams worked well both semesters and this reflected in their peer evaluation scores as well as on the quality of their project reports.

*Recommendation*

There is always room for improvement in team skills. To help each and every student develop leadership skills, students will randomly be appointed team leaders for their team at the beginning of the semester and rotate leadership in all teams periodically, so all students will have an opportunity to practice and develop leadership skills. Team leaders will be given specific tasks, will meet with the course instructors weekly, supported as best as possible, and hold them accountable to perform these tasks.

*Implement: AY 2015-2016*

**OUTCOME E**

**Assessment Summary:** Overall, Outcome E is satisfied in the BSAE Program.

**AY 2015 – 2016 Assessment, Evaluation, and Recommendations**

**Outcome Element E-1: Ability to communicate in writing**

*Engr.100W – Engineering Reports*

*Engr.195A – Global and Social Issues in Engineering Practice A*

*Engr.195B – Global and Social Issues in Engineering Practice B*

*AE171A – Aircraft Design I*

*Prof. Gonzalo E. Mendoza*

*AE172A – Spacecraft Design I*

*Prof. Marcus S. Murbach*

*AE171B – Aircraft Design II*

*Prof. Gonzalo E. Mendoza*

*AE172B – Spacecraft Design I*

*Prof. Marcus S. Murbach*

### **Outcome Performance Indicators**

**E-1.1:** Produce well-organized reports, following guidelines.

**E-1.2:** Use clear, correct language and terminology while describing experiments, projects or solutions to engineering problems.

**E-1.3:** Describe accurately in a few paragraphs a project / experiment performed, the procedure used, and the most important results (abstracts, summaries).

**E-1.4:** Use appropriate graphs and tables following published engineering standards to present results.

### **Assessment Summary**

The performance target is met for Performance Indicators E-1.1, E-1.2, E-1.3, and E-1.4.

### *Course Activities*

Engr.100W – This course is required for all engineering majors, and covers technical writing and the general education area encompassing earth and the environment.

Engr.195A

This course is required for the major and covers GE topics in Self and Society. It provides the broad education described in this outcome through a series of writing assignments:

- Describe how identities are shaped by cultural and societal influences
- Describe historical, social, political, and economic processes producing diversity, equality, and structured inequalities
- Describe social actions which have led to greater equality and social justice in the US
- Recognize and appreciate constructive interactions between people from different cultural, racial, and ethnic groups.

Engr.195B

This course is required for the major and covers GE topics in Culture, Civilization and Global Understanding. It provides the broad education described in this outcome through a series of writing assignments:

- Compare systematically the ideas, values, images, cultural artifacts, etc. of people from more than one culture outside of the US
- Identify the historical context of ideas and cultural traditions outside of the US
- Explain how a culture outside the US has changed in response to pressures.

#### AE171A

- a. Develop and document mission requirements and comparative studies for design of an atmospheric flight vehicle. Research and testing of said vehicle and/or associated components forms the basis for students' Senior Design Project.
- b. Develop and document preliminary performance and weight sizing studies
- c. Develop and document the rationale for vehicle configuration selection and preliminary design sketches and drawings
- d. Estimate and document, using a variety of analytical and test methods, the mass properties of the proposed vehicle
- e. Develop and document, following standard methodologies for aerodynamic performance estimation, the stability and control characteristics of the vehicle
- f. Develop a detailed Project Proposal outlining objectives, resources, design highlights, and expected performance following AIAA student competition requirements

#### AE 172 A

- a. Develop and document mission requirements and comparative studies for design of a spaceflight mission. Research and testing of said vehicle and/or associated components forms the basis for the students' Senior Design Project.
- b. Develop and document preliminary performance and weight sizing studies
- c. Develop and document the rationale for vehicle configuration selection and preliminary design sketches and drawings
- d. Estimate and document, using a variety of analytical and test methods, the mass properties of the proposed vehicle
- e. Develop and document, following standard methodologies for aerodynamic performance estimation, the stability and control characteristics of the vehicle
- f. Develop a detailed Project Proposal outlining objectives, resources, design highlights, and expected performance following AIAA student competition requirements

#### AE 171 B

- a. Prepare a draft technical report highlighting all relevant aspects of design covered in AE171A, expanded to incorporate preliminary systems testing and performance assessments resulting from an initial test article demonstration. Guidelines based on AIAA student competition requirements are enforced.
- b. Write a final design report, including revised content from the draft report, as well as a technical section related to test plans, test results, and recommendations for future work. Guidelines based on AIAA student competition requirements are enforced.
- c. Write an individual paper addressing a topic related to aerospace ethics, safety, and/or liability. Paper must include a minimum of three valid references appropriate for academic use.
- d. Document test plans, flight test cards, and incident reports as outlined by the class aircraft design and operations manual.

#### AE 172 B



- a. Prepare a draft technical report highlighting all relevant aspects of design covered in AE172A, expanded to incorporate preliminary systems testing and performance assessments resulting from an initial test article demonstration. Guidelines based on AIAA student competition requirements are enforced.
- b. Write a final design report, including revised content from the draft report, as well as a technical section related to test plans, test results, and recommendations for future work.
- c. Write an individual paper addressing a topic related to aerospace ethics, safety, and/or liability. Paper must include a minimum of three valid references appropriate for academic use.
- d. Document test plans, and developmental notes throughout the project evolution process.

### ***Assessment Tools***

#### Engr.100W

- a. Exit Exam: Administered at the conclusion of the course to assess whether students can explain, analyze, develop, and criticize ideas effectively. The exam asks students to respond to a prompt during a proctored, and timed test in the computer labs.
- b. Assessment: The exams are sent to an outside evaluator for blind scoring (no student or faculty identities are evident). A score in the range 7-8 is considered meeting the standard for this ABET outcome, as well as the university's Graduation Writing Assessment Requirement (GWAR).

Engr195A&B – Written reflections described above are graded using rubrics specific for each CLO. An example of such a rubric is shown below:

<i>Criteria/ Score</i>	<b>Thesis Statement</b>	<b>Organization &amp; Paragraph Construction</b>	<b>Mechanics</b>	<b>Content Criteria</b>
5	Clearly stated and appropriately focused	Information logically organized. All paragraphs include Introductory sentence, explanation or details, concluding sentence w. a transition	No grammatical errors, spelling or punctuation observed	Information clearly related to the main topic. Included consistent supporting details and two examples
4	Clearly stated but focus needed to be sharper	Information adequately organized. Most paragraphs include introductory sentence, explanation or details, concluding sentence w. a transition.	Almost no grammatical errors, spelling or punctuation observed	Information clearly related to the main topic. Included consistent supporting details and one examples.
3	Stated but not appropriately focused	Information is somewhat organized. Paragraphs include related information But are typically not constructed well.	A few grammatical errors, spelling or punctuation observed	Information clearly related to the main topic. Included adequate supporting details and

				examples.
2	Inferred but not stated	Obvious lack of organization. Paragraph structure is not clear. Sentences are not related with paragraphs.	Many grammatical errors, spelling or punctuation observed	Essay relates to the topic but is too general. Does not give any specific examples or there are few details or specifics in the response.
1				Information related to the topic but no examples or details given.
0	No statement of thesis or objective	No observable organization.	No observable effort in the area of mechanics	Essay does not address the topic directly.

AE171 & AE172 – Technical reports, test article documentation, and individual papers.

All courses in the curriculum that meet GE requirements for the university are required to submit annual assessment reports in the fall semesters, in which at least one GE student outcome for that area is assessed. Implementation of changes and improvements are typically implemented in spring semesters. The courses that undergo this assessment pattern and also meet ABET outcomes are: ENGR 100W Technical Writing (F. Ethics, E. Communication); ENGR 195A Global and Social Issues in Engineering Practice A (F. Ethics, G. Broad Education); and ENGR 195B Global and Social Issues in Engineering Practice B (F. Ethics, G. Broad Education).

### ***Student Performance Results***

Engr. 100W

Exit exam scores since Fall 2014 are summarized in the following table:

Exit Exam Score	Fall-2014	Spring-2015	Summer-2015	Fall-2015	Spring-2016	Summer-2016
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	1	2	0	4	0	0
6	13	27	14	40	13	2
7	26	81	21	71	45	10
8	87	178	40	212	110	15
9	36	103	13	94	157	16
10	18	42	7	32	121	20
11	7	12	1	9	57	6
12	0	1	0	2	15	9
<b>Students Assessed</b>	188	446	96	464	518	78
<b>Average Score</b>	8.2	8.19	7.80	8.06	9.08	9.23
<b>Sections Assessed</b>	8 (out of 18)	19 Sections	4 Sections	20 Sections	22 Sections	3 Sections
<b>Outcome met (%)</b>	92.6%	93.5%	85.4%	90.5%	97.5%	97.4%
<b>Outcome not met (%)</b>	7.4%	6.5%	14.6%	9.5%	2.5%	2.6%

Engr.195A

Assessment of Reflection Paper #3 in Fall 2015 and Spring 2016 resulted in the following statistics:

	Engr 195A Reflection paper (social media)		
<b>Number of students</b>	<b>Fall 2015</b>	<b>Spring 2016</b>	<b>Total</b>
Students who did not meet the criterion	11	0	11 (3.3%)
Students who met the criterion	141	38	179 (53.6%)
Students who exceeded the criterion	122	18	140 (41.9%)
Students who did not submit assignment	3	1	4 (1.2%)
<b>Total Students</b>	<b>277</b>	<b>57</b>	<b>334</b>

Engr.195B

Assessment of the GMO Social Impact paper in Fall 2015 and Spring 2016 resulted in the following statistics:

<b>Number of students</b>	Fall 2015	Spring 2016	Total
Students who did not meet the criterion	4	1	5 (1.5%)
Students who met the criterion	17	89	106 (32.4%)
Students who exceeded the criterion	32	177	209 (63.9%)
Students who did not submit assignment	2	5	7 (2.1%)
<b>Total Students</b>	<b>55</b>	<b>272</b>	<b>327</b>

Based on these results, it appears that over 95% of students are meeting or exceeding expectations for this outcome on all three assignments.

AE171A&B

	Students who scored 70% or higher <i>NB: Only students who passed each course are included in the statistics below</i>					
	Report 1	Report 2	Report 3	Report 4	Report 5	Report 6
AE171A – Fall 2015	21 (78%)	22 (81%)	17 (63%)	22 (81%)	27 (100%)	27 (100%)
AE172A – FALL 2015	36 (100%)	36 (100%)	36 (100%)	N/A	N/A	35 (100%)
AE171B – Spring	22 (81%)	27 (100%)	25 (93%)*	N/A	N/A	N/A

2016						
AE172B – Spring 2016	N/A	N/A	N/A	34 (100%)	34 (100%)	34 (100%)

*\*Individual ethics assignment.*

### **Analysis**

Engr.100W – As shown in the table above, between 85% - 97% of the students enrolled in the course typically meet or exceed the performance criterion of a score of 7 or above on the exit exam. Students who do not meet this performance criterion are encouraged to take Engr90W, which provides targeted writing instruction in smaller groups, before retaking Engr100W.

After AY 2014-15 the Engr100W instructors met to discuss ways to further support students in meeting the outcome. A consensus formed to introduce learner-centered activities, including: use of Criterion software to automatically check grammar and writing mechanics prior to submission of assignments; introduction of peer review of essays; and incorporation of structured critique exercises. As a result, the data shows modest gains in the percentage of students who met the outcome starting in Spring 2016. It is possible that the delay in seeing results is due to the instructors gaining experience and effectiveness with the new activities.

AE 171 A – 50% of the total grade of the course is based on development of 5 formal technical papers to be prepared by Teams of 5-6 students. An additional 3% of the grade was assigned to a project proposal paper summarizing the student’s design concept and performance.

AE 171 B – 20% of the total grade of the course is based on development of two formal technical papers outlining all aspects of the student projects, with emphasis on test plans and results. An additional 4% of the grade was assigned to an individual paper addressing ethics, safety, and/or liability in Aerospace Engineering. Finally, 10% of the test article delivery grade was assigned to associated paperwork including flight test cards, plans, and incident reports.

Each of the reports for both courses must follow a clear instructor provided rubric and conform to technical guidelines as provided by the AIAA and SAE student competition committees.

Early design report drafts were inconsistent with the standards set for the class. Students were given the opportunity to submit updated drafts throughout the semester, which generally resulted in better results. Overall, student performance was satisfactory in area E-1.1, with good adherence to report guidelines being the norm. Performance in E-1.2 was adequate, with inconsistency in technical language use being the primary area for corrective feedback. Area E-1.3 was met satisfactorily with the caveat that students struggle with the idea of presenting a full summary, including results and conclusions, as part of the introductory sections of a document. Performance in area E-1.4 was mixed, with students having difficulty manipulating graphs to ensure appropriate presentation with complete and readable labels, legends, and titles. In repeated occasions the students showed difficulty in changing chart types, axis limits, and other

default settings on their data manipulation programs to ensure proper depiction of said data.

Observations noted during evaluation of reports indicate that performance is hampered by:

- Fundamental difficulty using formal technical language: It is noted that, with few exceptions, students perform adequately in individual writing assignments not requiring rigorous technical language and formatting. Students, however, struggle to retain a consistent technical voice throughout their formal design reports.
- Inadequate task planning and time-on-task: Students typically turned in papers in the early hours of the morning (1-3 am) on the day following the deadline. All but the top scoring Teams acknowledged they had done little to prepare for the reports until the day before they were due. Given the amount of complex calculations, background research, and general analysis required for each report, students' typically allowed the important task of checking language, grammar, formatting, quality of graphs, etc, to take a back seat. Students' performance improved markedly when given additional time to work on their documents after resolving issues with calculations, experiments, and analysis. Few students presented adequate paperwork (flight cards, incident reports, build records) for their test articles following long nights of construction activity. Not surprisingly, students working ahead of deadlines had markedly superior reports and documentation

AE 172 A – 60% of the total grade of the course is based on development of the formal reports/presentations during the 3 formal technical papers to be prepared by Teams of 5-6 students. This includes the weekly QUAD chart development (and oral presentation, per below) – which summarizes status, problems, schedule, budget, technical progress. 20% of the total grade is based on realization of the HW/SW as related to sub-systems and systems. Lastly, 20% of the grade is on a summary final – in which the project management techniques, examples and self-assessment are asked.

AE 172 B – 60% of the total grade of the course is based on development of the formal technical reports/presentations outlining all aspects of the student projects and related management/execution. 20% of the grade is based on test plans, rapid-prototyping, supporting analysis. Finally, 20% of the grade is the summary final exam – as an extension of topics introduced in the previous semester.

Early in the first semester (and reinforced in the second), the NASA Project Engineering Handbook, as well as NPR 7120.5 processes were introduced. Such topics as general content, entrance/exit criteria, management of sponsor expectations was covered. The origins of complex project management was introduced – as well as key examples from the origins of architectures/topologies that led to the Apollo and Shuttle Programs. Also, small project management techniques – using the Wright brothers as an example, were also developed (counterpoint- WHY did S. Langley fail to produce the first aircraft – when he had ALL of the necessary resources).

Also – over the course of both semesters, the students were introduced to 'real-time' projects which included the SOAREX-9 flight (March 7, 2016), the execution/delivery of the TechEdSat-5 nano-satellite, as well as the flight test of the Super-Strypi (watched on live feed in class). These real-time project examples – which include some of the SJSU students – were used to reinforce some of the concepts.

### ***Recommendations***

AE171 – Implement an enhanced review of documentation standards. Minimum requirements are spelled out in the provided guidelines; however, additional discussion, with pertinent examples, should improve initial report outcomes. Review should focus on use of technical language and introductory to charting data in Microsoft Excel and Matlab, both commonly used by students.

AE172 – Continued use of the NASA Project Management Handbook (NASA/SP-2007-6105) is suggested – with clear uses delineated for small vs. large projects. Rapid prototyping is highly encouraged – such that all students are able to produce a 3-d printed part related to the overall system/project. The use of the weekly QUAD charts and ensuing discussion helped to keep the teams focused – which is also highly recommended. Lastly, various movies and videos describing the evolution of the Apollo and Shuttle programs (video from experts involved in their development) – was also very positive.

### ***Implementation***

AE171 – AY 2016 – 2017

### **Outcome Element E-2: Ability to communicate orally**

#### ***Outcome Performance Indicators:***

**E-2.1:** Give well-organized presentations, following guidelines.

**E-2.2:** Make effective use of visuals.

**E-2.3:** Present the most important information about a project / experiment, while staying within allotted time.

**E-2.4:** In small group settings, listen carefully, ask clarifying questions when others speak, and respect the opinion of others when disagreeing.

#### ***Assessment Summary***

The performance target is met for Performance Indicators E-2.1, E-2.2, E-2.3, and E-2.4.

#### ***Course Activities***

AE171A

- a. Prepare a critical design review outlining mission, system architecture, and planned testing in support of project completion. Successful completion is required to obtain authorization to begin hardware integration and/or detailed design tasks.
- b. Participate, with the perspective of regulator, safety advocate, operator, or manufacturer, in a debate centered on the initial entry of service and subsequent grounding of McDonnell Douglas DC-10 airplanes.

AE172A

- a. Preparation of the three critical reviews, as indicated.

- b. Participate, in the discussion and analysis related to the Breakthrough Star-shot project announced in Spring 2016, as a large, complex project with significant risk but high potential scientific reward (analog to the first large observatory on Mt. Hamilton was discussed).

**AE171B**

- a. Prepare a pre-competition/demonstration design review outlining modifications, future test plans, and initial test results of the student projects. Objective is to receive authorization to move forward to the final testing and development phase.
- b. Prepare a final design review outlining the entire project development journey, including final performance results and recommendations for future projects.
- c. Prepare and take part on an individual discussion regarding an aerospace engineering ethics, safety, and/or liability topic of the student's choosing.

**AE172B**

- a. Prepare for the Delta-CDR based on progress and comments from the end of the first semester. This is followed with the weekly QUAD chart style of reporting.
- b. Present the final project hardware/software as a functional system (as appropriate).
- c. Prepare and take part on an individual discussion regarding an Aerospace Engineering ethics and societal implications.
- d. Present a space system sub-topic in technical detail from the NASA-Ames State-of-the-Art paper, as well as the SMAD (Space Mission Analysis and Design) by J. Wertz, et al.

**Assessment Tools**

Formal design reviews with Q&A, debates and class discussions on assigned topics.

**Student Performance Results**

	Students who scored 70% or higher <i>NB: Only students who passed each course are included in the statistics below</i>		
	Formal Design Review 1	Formal Design Review 2	Graded Discussion
AE171A – Fall 2015	27 (100%)	N/A	26 (96%)
AE172A – FALL 2015	35 (100%)	N/A	34 (100%)
AE171B – Spring 2016	27 (100%)	27 (100%)	27 (100%)
AE172B – Spring 2016	34 (100%)	34 (100%)	34 (100%)

AE 171 A – 5% of the grade of the course is associated with successful completion of a critical design review. Students must successfully complete the design review prior to

authorization for hardware integration and/or detailed design activities, as appropriate to each project. An additional 4% of the grade is assigned to a graded discussion regarding the grounding of DC-10 airplanes following a string of accidents.

AE 171 B – 10% of the grade of the course is based on two formal design reviews. The first review is scheduled ahead of test article testing and competition activities, while the second review summarizes the entire journey at the end of the course. An additional 2% of the course grade is assigned to individual discussion and technical debate on student selected ethics, safety, and/or liability topics in Aerospace Engineering.

Students generally did well in oral presentations and debates, particularly in regards to performance indicators E-2.1 and E-2.4. Students stayed fairly close to the provided guidelines with minimal prompting. During debates, while addressing controversial topics, students remained appropriately composed while vigorously presenting their points. Minimal moderation was required during these discussions. Area E-2.2 performance was adequate, with slides and visuals generally adding value to the presentations. Typical formatting problems, such as use of excessive text, inadequate text font size, and distracting colors and backgrounds, were evident in a number of presentations, but decreased significantly with each subsequent presentation. Area E-2.3 presented the most significant challenge, with students at times struggling to identify appropriate material to cut or reduce in order to stay within the time allotment.

AE 172 A – 60% of the grade of the course is associated with successful completion of the semester reviews and associated oral presentations. In addition, lectures from the professor and carefully selected on-line videos are used to further reinforce the particular learning objectives. This is also reinforced in the summary final examination at the end of each semester.

AE 172 B – 60% of the grade of the course is based on the associated reviews, as in the first semester. All students participate in the oral presentations. Weekly, different team members present the QUAD chart and any backup material. Also, there is lively discussion with the set of reflection papers.

Students generally did well in oral presentations and debates. Again, the weekly QUAD chart and reporting system, with alternating team members – seemed to work well. In most cases the visual presentations were well done, and captured the current state of the project technical progress. In addition, it was requested that the team presented a ‘risk’ chart – so that the risk reduction posture was well noted. Many times, the emphasis was placed on concise technical content – and that such a lucid presentation would be as desirable to a technical review team or – venture capitalist.

### ***Recommendations***

AE171 – Current mechanisms for differentiating individual contributions to team presentations do not sufficiently capture differences in student performance. It is expected that increasing the proportion of the presentation grade allotted to individual performance will drive additional preparation.

AE172 – Rotating the oral team presentation went very well. Particularly for the shy students, an atmosphere of friendship was created so that they would have a chance to



perform some public speaking. The weekly QUAD chart style of reporting permitted rapid feedback, so that when the critical design review material was presented – it would tend to be more crisp and concise.

**Implementation:** AY 2016 – 2017

## **OUTCOME F**

**Assessment Summary:** Overall, Outcome F is satisfied in the BSAE Program.

### **AY 2011 – 2012 Assessment, Evaluation, and Recommendations**

*Engr.100W – Engineering Reports*

*Engr.195A – Global and Social Issues in Engineering Practice A*

*Engr.195B – Global and Social Issues in Engineering Practice B*

*AE171A&B – Aircraft Design I&II*

*Prof. Gonzalo E. Mendoza*

*AE172A&B – Spacecraft Design I&II*

*Dr. Periklis Papadopoulos*

#### **Outcome Element F-1: Understanding of professional responsibility**

##### ***Outcome Performance Indicator***

**F-1** – Properly acknowledge the work of others by citing all sources when writing reports.

#### **Outcome Element F-2: Understanding of ethical responsibility**

##### ***Outcome Performance Indicator***

**F-2** – Given a job-related scenario that requires a decision with ethical implications, students can (a) identify any ethical issues raised by reference to professional codes of ethics (e.g. NSPE, ASME), (b) identify possible courses of action, (c) discuss the pros and cons of each course of action, (d) decide what is the best course of action, and (e) justify their decision<sup>6</sup>.

##### ***Course Activities***

Engr. 100 W

Prior to 2014, a writing assignments on a contemporary ethics case study was assigned. In 2014, the course coordinator changed. Under the new coordination, a new ethics assignment was developed and its assessment (using CANVAS, our online course management system) was piloted in AY 2015-16.

AE 171 A&B

- The content that pertains to Performance Indicator F-2.1 is based on four (4) main case studies in ethics, safety, and liability issues, as well as on evaluation of several

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<sup>6</sup> As applicable, students also examine ethical constraints applicable to their particular vehicle design, as discussed in Outcome C

watershed accident investigations. Cases are discussed in the context of existing regulatory guidance and technical expertise. The main case studies for the AY 2011-2012 were:

- The McDonnell Douglas DC-10/MD-11 accident sequence: This case focuses in the operational and technical issues, as well as the engineering response, to real and perceived design philosophies that influenced a number of accidents. Ethics, safety, and liability issues are emphasized.
- The Sino-Swearingen SJ30-2 loss: This case focuses on the ethics and safety of flight test vehicles and the protocols associated with experimental tests. The influence of cost and schedule pressures is also discussed.
- General aviation fuels: This study focuses on the practical concerns and ethical questions raised by the continued use of leaded fuels for the piston airplane fleet. The study seeks to weigh in the practical impact of a phase-out against the potential environmental benefits of new fuel formulations.
- Civil supersonic flight: This study weighs in the advantages and drawbacks of expanded high speed flight. Increased fuel consumption, noise, and emissions are discussed, as are the potential benefits of increased speed. Key enabling technologies are also discussed.

Important accident investigation discussions included: The de Haviland DH.106 accident saga, lessons from the early jet transportation age, the Zodiac 601XL flutter incidents and response, among others.

- Aircraft design students participate jointly in the presentation and discussion of these case studies.
- Students study the background information on each of these cases and make a 15-minute presentation in class.
- Following the presentation of the background information on each case, students gather into small groups for 20 min, discuss ethical issues raised, and summarize their position and arguments for each issue. For some of the case studies students are asked to look into the issues from the perspective of the various parties, including engineers involved in design, operations, or regulatory review.
- Each group presents a summary of their position orally as well as in writing and the floor is opened for additional comments by the rest of the class.
- Students follow up with a written paper in which they answer individually key ethical questions on each case.

***Assessment Tools***

AE 171 A&B

- Presentation of the background of a case study.
- In class participation in group discussion and sharing.
- Individual written arguments in response to specific prompts in each of the four case studies.

***Student Performance Results***

Engr. 100 W

Assignment	Spring 2012	Spring 2013	Spring 2014
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Nuclear energy case study	89%		
Green manufacturing ethics dilemma		92%	
Silicon Valley ethics codes		94%	
Chevron oil refinery explosion			96%

#### Engr.195A

Assessment of Reflection Paper #3 in Fall 2015 and Spring 2016 resulted in the following statistics:

	Engr 195A Reflection paper (social media)		
Number of students	Fall 2015	Spring 2016	Total
Students who did not meet the criterion	11	0	11 (3.3%)
Students who met the criterion	141	38	179 (53.6%)
Students who exceeded the criterion	122	18	140 (41.9%)
Students who did not submit assignment	3	1	4 (1.2%)
Total Students	277	57	334

#### Engr.195B

Assessment of the GMO Social Impact paper in Fall 2015 and Spring 2016 resulted in the following statistics:

Number of students	Fall 2015	Spring 2016	Total
Students who did not meet the criterion	4	1	5 (1.5%)
Students who met the criterion	17	89	106 (32.4%)
Students who exceeded the criterion	32	177	209 (63.9%)
Students who did not submit assignment	2	5	7 (2.1%)
Total Students	55	272	327

Based on these results, it appears that over 95% of students are meeting or exceeding expectations for this outcome on all three assignments.

#### AE 171 A&B

Enrolled	Passed	Averaged 70% or higher on assignments
13	13	13 (100%)

	(100%)	
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## ***Analysis***

### *Engr100W*

Based on this data, students generally meet this outcome on this assignment in sufficiently high percentages.

### *AE 171 A&B*

Gateway assignments related to this outcome were added in AY 2011-2012: Students must average at least 70% on their presentations, in-class participation, and papers, in each course, to earn a passing grade in the course, regardless of their performance on other aspects of the course.

Students are usually very engaged and perform well in their ethics assignments. Their arguments in class as well as in their individual papers indicate that they begin to appreciate the complexities of the ethical issues encountered in engineering design and in particular, in aerospace vehicle design. Discussion was lively and included very strong and diverse opinions from various individuals. This served to highlight the difficulty of managing these issues by the parties involved in the case studies. The group presentations and written reports focused on background research of the case studies and were generally satisfactory. Performance in the individual written assignments was acceptable, but less satisfactory. It is clear that once a team researches a given issue together and extensive discussion takes place, a majority of the points and counter-points are already settled. The result is similar papers listing what are essentially similar points, though with perhaps differing conclusions.

## ***Recommendation***

### *AE 171 A&B*

For the individual written component of the case studies, additional emphasis should be placed on the individual perspective of the student. Background information should be left to the group component of the assignment. Papers focused on the individual position in light of the facts, rather than descriptive of the facts themselves, were far more compelling.

***Implementation:*** AY 12-13

## **OUTCOME G**

**Assessment Summary:** Overall, Outcome G is satisfied in the BSAE Program.

*Engr.195A – Global and Social Issues in Engineering Practice A*

*Engr.195B – Global and Social Issues in Engineering Practice B*

### **Performance Indicators**

- G-1:** Identify regional, national, or global contemporary problems that involve AE.
- G-2:** Discuss possible ways AE could contribute to the solution of these problems.
- G-3:** Describe accurately the environmental impact of aerospace vehicles, including those they have designed in course projects.
- G-4:** Describe accurately the health / safety impact of aerospace vehicles, including those they have designed in course projects.

### **Course Statistics**

<i>Course</i>	<i>Semester</i>	<i>Enrollment</i>	<i># of students who passed</i>	<i>% of students who passed</i>
AE 171 B	Spring 2013	24	23	96%

### **Course Activities**

AE 171 B

- Assignment 1: Each student identifies a **regional, national, or global contemporary problem** and discusses how aerospace engineering plays a role in it. For example, some of the topics selected in AE171B in AY 12-13 were:
  - Use of unmanned aerial vehicles as offensive weapons
  - Global influence of the F-35 program (impact of costs, foreign policy implications)
  - Implications of large investment in the aerospace defense complex.
  - Environmental impact of transports
  - Future of general aviation fuels
- Students find at least 3 references that discuss their particular topic. At least two of these references must be technical journal articles or conference papers or technical reports. For the rest they may use newspapers, magazines, Aviation Week & Space Technology, and the worldwide web.
- Students study these references and prepare a two-page (minimum) paper summarizing the key points of their research and prepare to debate the topic of their choice with the class. An open forum discussion, involving all student topics is then performed during class, with the author of each paper initiating discussion on his or her chosen topic.
- Assignment 2: Students select and research topics related to the environmental, health and safety impact of specific aerospace vehicles. These topics are debated in class for credit.

Engr.195A&B – The GE Assessment reports pertaining to Areas S&V can be found in Appendix K

### **Assessment Tools**

Engr.195A

The writing assignments that address the required content for our general education Area S, are also aligned with Outcome G.

- Testimony 1 (250-500 words): Discuss and provide examples of how your identities (i.e., religious, gender, ethnic, racial, class, sexual orientation, disability and/or age, among others) are shaped by cultural and societal influences within contexts of equality and inequality.
- Testimony 2 (250-500 words): How does language affect our identities? How do we use language and labels to authenticate our identities to others and ourselves?
- Reflection Paper 2 (250-500 words): “Secrets of Silicon Valley”
- Reflection Paper 1 (750-1250 words): Describe social actions within the borders of the United States that have led to greater equality and social justice in your life (i.e., religious, gender, ethnic, racial, class, sexual orientation, disability, and/or age). Discuss how your current or past projects have or will contribute to social justice in the United States.
- Reflection Paper 2 (250-500 words): In his essay, Dyson gives historical examples of technological innovations, which he claims have increased social justice. Consider the technological innovations in AE and describe another example, indicating how it has increased social justice in the U.S.
- Website Analysis (750 words): Organization Website Analysis Environmental and social justice issues are addressed at many different levels and in different ways by groups and organizations. This assignment addresses the broad GE learning objective of “recognizing and appreciating constructive interactions between people from different cultural, racial, and ethnic groups in the U.S.” and the specific course learning objective to “Identify, compare, and contrast how local community organizations, groups, and agencies address social issues relevant to the environment and quality of life in the Santa Clara Valley.

### Engr.195B

The General Education Assessment reports pertaining to Engr.195B (GE Area V) can be found in Appendix K

- Essay 1 (500 words): Choose one of the following technological developments that were discussed in the web tutorial: the mechanical clock, gunpowder, the Great or Jersey wheel, printing, or the compass. Write an essay that addresses the following topics. When you respond to these topics, you should be specific and cite specific details either from the web tutorial or your own research. You should cite specific events and/or cultures as you answer these questions.
  - Discuss the history of the technology from its early beginnings to the Renaissance. Please discuss at least three different events in the history of the mechanical clock.
  - Describe one force (e.g., historical, cultural, social, economic, political) that affected the development of the technology?
  - How did the development and use of the technology affect Europe in the Middle Ages?
  - Overall, how did the technology affect the United States?
- Essay 2 (1,000 words): Imagine you are part of a group of engineers to Guatemala at the request of Habitat for Humanity. You have been hired to come up with a plan

that will alleviate or at least mitigate the effects of Hurricane Stan on the Mayan communities in the Highlands. When thinking about your plan, you must consider all angles of the problem (for example, language barriers, culture, disease, landforms, seasonal weather, transportation, building materials, distrust and fear, etc.).

- Essay 3 (1,000 words): Write an essay that compares the ideas, values, attitudes, and technological developments of people from at least two different countries outside the US. Focus your essay on technological developments relating to aerospace engineering. One of the countries in your essay must be from your article.

#### AE171A, AE172A

The AE General Education Assessment reports pertaining to AE171A and AE172A (GE Area S) can be found in Appendix K

- Reflection Paper 1 (500 words): Based upon your response to Engr195A Testimony 1, consider your identity as a future aerospace engineer. How is your identity shaped by cultural and societal influences within contexts of equality and inequality?
- Reflection Paper 2 (500 words): Using the case studies provided in Engr195A, describe how airplanes/spacecraft in general and your project in particular, fit into the historical, social, political, and economic processes producing diversity, equality, and structured inequalities in the U.S.
- Reflection Paper 3 (500 words): Consider the technological innovations in aerospace engineering in general and aircraft design in particular, describe a historical example and indicate how it has increased social justice in the U.S. and the world.
- Reflection Paper 4 (500 words): Consider a negative side effect of aerospace technology: noise. Read the following articles (listed on the course syllabi) and research the procedures regarding airplane noise in your own town or region. What civic organizations promote the reduction of airplane noise in your community? Either visit one of these groups' websites or visit the group in person and describe the interactions between this group and the larger community. Your paper must cite your sources, including the ones listed.
- Students are allowed to re-write and re-submit their papers if they are not passing (score less than 70%).

#### AE171B, AE172B

The AE General Education Assessment reports pertaining to AE171B and AE172B (GE Area V) can be found in Appendix K

- Reflection Paper 1 (500 words): Assume that your airplane will go into production. Using the studies provided in Engr195A&B as a background, write about how you will take into account at least two aspects (e.g. ideas, values, images, cultural artifacts, economic structures, or technological developments) while evaluating your decision to manufacture your airplane in two other countries.
- Reflection Paper 2 (500 words). Consider an aerospace engineering technology invented outside of the U.S. (a) Describe the cultural and social factors that led to the invention of this technology. (b) Describe how this invention has evolved and influenced the culture in the U.S.

- Reflection Paper 3 (500 words): Using the social and cultural processes introduced in Engr195A&B, describe how non-US farmers have responded to the pressure from US farmers' enhanced ability in growing food using advances in aerospace engineering technology (UAVs, GPS).
- Reflection Paper 4 (500 words): Assume your airplane/spacecraft will go into production in the US. Describe how your product will put pressure on a culture outside the US. (choose a specific country). Use the social and cultural processes introduced in Engr195A&B to guide your answer.
- Students are allowed to re-write and re-submit their papers if they are not passing (score less than 70%).
- In-class presentation of the regional, national or global contemporary problem.
- Written analysis of the problem based on identified references.
- In-class presentation of examples of the impact of aerospace vehicle design in a global / societal context.

### **Student Performance Results**

AE171B

	Students who scored 70% or higher	
	Environmental, Health, and Safety Impact of Aerospace Vehicles	Impact of Aerospace Vehicle Design in a Global / Societal Context
AE171B – S13	24 (100%)	23 (96%)

### **AE171A & AE172A – GE Area S**

50 out of 52 (96%) of the students in AE171A & AE172A met the performance criteria for GE Area S and consequently for Outcome G.

<b>Number of students</b>	<i>AE171A – Fall 2014</i>	<i>AE172A – Fall 2014</i>
<i>Students who did not meet SLO-1 (reflection paper #1)</i>	<i>1</i>	<i>0</i>
<i>Students who met SLO-1</i>	<i>25</i>	<i>25</i>
<i>Students who did not submit assignment</i>	<i>0</i>	<i>1</i>
<i>Total Students</i>	<i>26</i>	<i>26</i>

*Overall, in their first attempt: 2 students (4%) did not meet SLO-1; 50 (96%) met SLO-1.*

<b>Number of students</b>	<i>AE171A – Fall 2014</i>	<i>AE172A – Fall 2014</i>
<i>Students who did not meet SLO-2 (reflection paper #2)</i>	<i>2</i>	<i>6</i>
<i>Students who met SLO-2</i>	<i>23</i>	<i>20</i>
<i>Students who did not submit assignment</i>	<i>1</i>	<i>0</i>
<i>Total Students</i>	<i>26</i>	<i>26</i>

*Overall, on their first attempt: 9 students (17%) did not meet SLO-2;*



43 (83%) met SLO-2.

<b>Number of students</b>	<i>AE171A – Fall 2014</i>	<i>AE172A – Fall 2014</i>
<i>Students who did not meet SLO-3</i>	20	0
<i>Students who met SLO-3</i>	6	25
<i>Students who did not submit assignment</i>	0	1
<b>Total Students</b>	26	26

Overall, on their first attempt: 21 students (40%) did not meet SLO-3; 31 (60%) met SLO-3.

<b>Number of students</b>	<i>AE171A – Fall 2014</i>	<i>AE172A – Fall 2014</i>
<i>Students who did not meet SLO-4</i>	19	0
<i>Students who met SLO-4</i>	7	24
<i>Students who did not submit assignment</i>	0	2
<b>Total Students</b>	26	26

Overall, on their first attempt: 21 students (40%) did not meet this SLO and 31 (60%) met this SLO.

#### **AE171A & AE172A – GE Area V**

All (100%) of the students in AE171B & AE172B met the SLOs for Area V and consequently for Outcome G.

<b>Number of students</b>	<i>AE171B – Spring 2015</i>	<i>AE172B – Spring 2015</i>
<i>Students who did not meet SLO-1</i>	4	0
<i>Students who met SLO-1</i>	19	25
<i>Students who did not submit assignment</i>	0	2
<b>Total Students</b>	23	27

Overall, on their first attempt: 6 students (12%) did not meet SLO-1; 44 (88%) met SLO-1.

<b>Number of students</b>	<i>AE171B – Spring 2015</i>	<i>AE172B – Spring 2015</i>
<i>Students who did not meet SLO-2</i>	0	0
<i>Students who met SLO-2</i>	22	26
<i>Students who did not submit assignment</i>	1	1
<b>Total Students</b>	23	27

Overall, on their first attempt: 2 students (4%) did not meet SLO-2; 48 (96%) met this SLO-2.

<b>Number of students</b>	<i>AE171B – Spring 2015</i>	<i>AE172B – Spring 2015</i>
<i>Students who did not meet</i>	0	1

<i>SLO-3</i>		
<i>Students who met SLO-3</i>	<i>23</i>	<i>24</i>
<i>Students who did not submit assignments</i>	<i>0</i>	<i>2</i>
<i>Total Students</i>	<i>23</i>	<i>27</i>

Overall, on their first attempt: 3 students (6%) did not meet SLO-3; 47 (94%) met SLO-3.

### ***Analysis***

AE171 – Students are usually engaged and perform well in this area, however, specific research assignments have so far been implemented only in AE171B (Aircraft Design II) for credit. For AY 12-13, pre-selected topics associated with the impact of aerospace vehicle design as well as current events related to aerospace engineering were discussed as part of required participation in online discussion threads in both AE171A and AE171B (Aircraft Design I & II).

#### ***AE171A & AE172A – GE Area S***

Reflection 1: One student did not meet SLO-1 because his paper was written in poor English.

Reflection 2: Two students did not meet SLO-2 because their papers were written in poor English. Six students did not meet SLO-2 because their paper did not respond to the prompt.

Reflection 3: Twenty students did not meet SLO-3 on their first attempt because their paper did not respond to the prompt. Students did not understand what social justice is and as a result, the examples they discussed in their reflections were not appropriate.

Reflection 4: Nineteen students did not meet SLO-4 on their first attempt because they did not follow the instructions regarding the references. Students provided a fairly good discussion based on their own references but ignored the references given for this assignment.

Students were allowed to resubmit their papers following the initial grading and the feedback given for each paper. As a result, 50 out of 52 (96%) of the students in AE171A and AE172A met the SLOs for Area S.

#### ***AE171B & AE172B – GE Area V***

Students performed much better in Area V assignments (reflection) because they were better able to make the connection between Area V concepts and aerospace engineering. Again, students were allowed to resubmit their papers following the initial grading and the feedback given for each paper. As a result, all students (100%) in AE171B and AE172B met the SLOs for Area V.

***Recommendations:*** None

***Implementation:*** N/A

### **OUTCOME H**

**Assessment Summary:** Overall, Outcome H is satisfied in the BSAE Program.

**Outcome Element H-1: Recognition of the need for lifelong learning**

***Performance Indicators:***

**H-1.1:** Are willing to learn new material on their own.

**H-1.2:** Participate in professional societies.

**H-1.3:** Read non-course related AE related articles / books, attend short courses, workshops, seminars, conferences and plan to attend graduate school.

H-1.1 is assessed indirectly together with H-2.3

H-1.2 85% of the juniors and seniors are members of at least one of our chapters of professional societies, such as AIAA, SEDS, Sigma Gamma Tau (by invitation only), and others, and participate regularly in chapter activities.

H-1.3 is encouraged but not assessed. A small percentage of students participates in conferences (student as well as professional) and present papers. The number of students who continues on to graduate school has been increasing over the years (currently at approximately 25%), as has the number of students who go on for a Ph.D. degree after earning their MSAE degree.

**Outcome Element H-2: Ability to engage in lifelong learning.**

***Performance Indicators***

**H-2.1:** Develop a systematic approach to studying a new topic, reflect regularly on their learning process and make any necessary adjustments to improve the efficiency of this process.

**H-2.2:** Access information effectively and efficiently from a variety of sources.

**H-2.3:** Research and learn new material on their own by reading articles, books, contacting experts, etc.)

AE160 – Aerodynamics I

Fall 2013

Dr. Nikos J. Mourtos

AE162 – Aerodynamics II

Spring 2014

Dr. Nikos J. Mourtos

*Course Statistics*

	<i>Enrollment</i>	<i># of students who passed</i>	<i>% of students who passed</i>
AE160	62	55	89%
AE162	65	58	89%

***Assessment Summary for Performance Indicator H-2.1:***

The performance target is met for Performance Criterion H-2.1

*Course Activities*

AE160

- Students reflect on their learning process during the semester, identify personal strengths and weaknesses, and develop strategies to improve their learning process. (H2.1)
- After each test, students reflect on why they did well/poorly and propose a strategy for improving their next test score. This reflection is required before students are allowed to re-take a test for grade improvement. (H2.1)
- Students perform a literature review on STEAM education (H2.2)
- Students perform a literature review on the particular technical topic, which relates to their Service Learning Project (H2.2)
- Students research material related to their Service Learning Project and learn it on their own at a sufficient level, so they can perform a simple analysis of their device. (H1.1, H2.3)

AE162

- Students are given a project that integrates aerodynamics and flight mechanics. They select an airplane and perform a series of open-ended assignments, which require application of aerodynamics concepts they learn in class. Some of the assignments also require the students to become sufficiently familiar with online tools.

**Assessment Tools:**

AE160

- Reflection journal (H2.1)
- Final SLP report (H2.2, H2.3)

AE162

- Wing parametric study assignment

**Student Performance Results**

	<i>Scored 70% or higher</i>			
	<i>Reflections</i>	<i>STEAM Literature Review</i>	<i>Technical Literature Review</i>	<i>Device Analysis</i>
<i>AE160</i>	<i>43 (78%)</i>	<i>47 (85%)</i>	<i>31 (44%)</i>	<i>25 (45%)</i>
<i>AE162</i>				<i>45 (78%)</i>

**Analysis**

Performance Indicator H2.1 is similar to A-4.6. As discussed earlier in the context of problem solving skills, students initially have difficulty reflecting effectively on their learning process. In class, they are shown examples of proper reflections and they respond fairly well in terms of identifying their strengths and weaknesses. On the other hand, they are not always able to identify effective strategies for correcting these weaknesses and/or they do not always take the necessary steps to improve their learning process. This performance criterion has become more problematic over the years, as students devote less and less time studying for their courses and furthermore, they are not always capable of processing when they read in the text or other references.

Students are given an opportunity to re-write their reflections one week after their scores are posted and many do take the opportunity to reflect better and improve their reflection scores.

Students did well in their literature reviews related to STEAM education. They found a variety of assignments, summarized key arguments and listed their references appropriately using AIAA or APA formatting. They did not, however, do as well in their technical literature review. First, the number of references they used was small. Then, many of their references were webpages. Although webpages are allowed to be used as references if properly documented, students are expected to include in their list journal articles, conference papers and technical reports.

Students also did not do very well in their analysis of their devices, either because they did not spend sufficient time on this task or because they did not seek help. Students who received high scores on this assignment interacted frequently with the instructor, asked many questions, and received frequent feedback on their analysis.

Students did much better on a similar assignment in AE162 in the following semester, as part of their open-ended, integrated project. They learned on their own and used the Wing Analysis program<sup>7</sup>, available online, to perform a parametric study of their wing and determine the best combination of geometric parameters (sweep, taper, thickness, etc.)

### **Recommendations**

- Additional class time and effort must be devoted to guiding students in their reflections and most importantly, to helping them develop and apply strategies for improving their learning process.
- Progress reports will be required in the AE160 project to ensure a timely student interaction with the instructor and better results in their analysis.

**Implementation:** Fall 2014

## **OUTCOME I**

**Assessment Summary:** Overall, Outcome I is satisfied in the BSAE Program.

### *Course Statistics*

<i>Course</i>	<i>Semester</i>	<i>Faculty Member</i>	<i>Enrollment</i>	<i># of students who passed</i>	<i>% of students who passed</i>
AE 160	Fall 2014	Dr. Nikos J. Mourtos	76	75	99%
AE 162	Spring 2015	Dr. Nikos J. Mourtos	77	73	95%
AE 169	Spring 2015	Dr. Periklis Papadopoulos			%

<sup>7</sup> < <http://www.desktop.aero/appliedaero/potential3d/wingcalc.html>>

Analytical, experimental, and design skills have been discussed extensively in Outcomes A, B, and C respectively. Hence, the emphasis in this outcome is on the use of modern software and laboratory equipment.

### **Performance Indicators**

**I-1:** Use modern software to conduct computer simulations, parametric studies, and ‘what if’ explorations.

**I-2:** Use modern equipment and instrumentation in AE laboratories. (see also Performance Indicator B-2).

### **Assessment Summary**

The performance target is met for Performance Criteria I-1 & I-2.

### **Course Activities**

#### AE160

- Use the AeroLab subsonic wind tunnel and instrumentation to perform 3 experiments and LabView to collect and process the data.
- Use the Rolling Hills Research Corporation model O710 water tunnel and instrumentation to perform a flow visualization experiment.

#### AE162

- Use Wing Analysis<sup>8</sup>, AVL,<sup>9</sup> XFOIL<sup>10</sup>, XFLR5<sup>11</sup>, QPROP<sup>12</sup> to perform computer simulations and parametric studies of airfoils, wings, and other aerodynamic bodies.
- Use the AeroLab subsonic wind tunnel and instrumentation to perform 4 experiments and LabView to collect and process the data.

#### AE169

- Use a meshing program to generate the computational mesh volume for a nozzle.
- Use a numerical solver to analyze the transient solution of a shock tube.

#### AE171A&B (not assessed)

- Use the AAA (Advanced Aircraft Analysis) Program to conduct parametric studies, process optimization, and ‘what if’ explorations in the design of their airplanes.
- Use AutoCad, ProE, CATIA, and other CAD programs to make the drawings of their airplanes.

**Assessment Tools:** Project reports, design reports

AE160 – In-lab demonstration of equipment use

AE162 – In-lab demonstration of equipment use; potential flow and wing parametric

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<sup>8</sup> < <http://www.desktop.aero/appliedaero/potential3d/wingcalc.html>>

<sup>9</sup> <<http://web.mit.edu/drela/Public/web/avl/>>

<sup>10</sup> < <http://web.mit.edu/drela/Public/web/xfoil/>>

<sup>11</sup> <<http://xflr5.sourceforge.net/xflr5.htm>>

<sup>12</sup> <<http://web.mit.edu/drela/Public/web/qprop/>>

study assignments (part of open-ended project)  
 AE169 – 2D/3D Meshing Assignment, ShockTube CFD Assignment (HW6)

***Student Performance Results***

	Students who scored 70% or higher	
	proficiency w. lab equipment	proficiency w. software
AE160 – Fall 2014	75 (100%)	N/A
AE162 – Spring 2015	73 (100%)	71 (97%) 69 (95%)
AE169 – Spring 2015	N/A	(91%) (92%)

***Analysis***

AE160 & AE162 – The laboratory reports constituter gateway assignments in AE160. Students must average at least 70% in their four lab reports to pass AE160. Demonstrating familiarity with the equipment in the laboratory is part of their assignment and most students do very well in this area, as they enjoy the hands-on part of their experiments. Students are very competent with hands-on laboratory work.

AE162 – Student application of the two software programs assessed for this outcome was effective and resulted in very good results in their reports. Students are very competent in the use of modern software. It should be noted that they learned how to use these pieces of software on their own, demonstrating good lifelong learning skills, related to software use and application.

AE169 – Performance Indicator I-1 was assessed with two homework assignments. The first is the use of a mesh generating program. 91% of students passed with scores above 70%. The second assignment was a shock tube transient analysis in this assignment a numerical solver (ESI) was used to setup and solve a shock tube problem. In this assignment 92% of students passed with scores higher than 70%.

***Recommendation*** – None

***Implementation*** – N/A

## B. Program Educational Objectives

B.SAE PEO are normally reviewed periodically every three years.

### B.1 Student Exit Surveys

Table 4.1 shows the number of graduating seniors surveyed from Spring 2012 through Spring 2017. The total number of responses summarized below is 111.

Table 4.1 – Number of graduating seniors interviewed

Spring 12	Spring 13	Spring 14	Spring 15	Spring 16	Spring 17
20	19	11	21	27	13

The questions along with a summary of student responses is shown in the tables below.

Question #1: *Which of the following skills you think are important for an AE to compete successfully for entry-level positions in industry?*

	Not Important	Somewhat Important	Extremely Important	Not Sure
Analytical Skills	7.69%	7.69%	76.92%	7.69%
Design Skills	0.00%	30.77%	61.54%	7.69%
Communication Skills	7.69%	7.69%	76.92%	7.69%
Problem Solving Skills	0.00%	7.69%	84.62%	7.69%
Team/Interpersonal Skills	0.00%	0.00%	92.31%	7.69%
Leadership Skills	0.00%	30.77%	61.54%	7.69%
Critical Thinking Skills	0.00%	15.38%	76.92%	7.69%
Lifelong Learning Skills	0.00%	15.38%	76.92%	7.69%
Reflecting/Self-Assessment Skills	0.00%	23.08%	69.23%	7.69%
Change Management Skills	0.00%	38.46%	53.85%	7.69%

Clearly, student responses indicate that they consider all the above process skills important for getting an entry-level position in industry.



Question #2: Which of the following skills you think are important for an AE to succeed in graduate school?

	Not Important	Somewhat Important	Extremely Important	Not Sure
Analytical Skills	7.69%	15.38%	53.85%	23.08%
Design Skills	0.00%	38.46%	46.15%	15.38%
Communication Skills	0.00%	23.08%	61.54%	15.38%
Problem Solving Skills	0.00%	0.00%	84.62%	15.38%
Team/Interpersonal Skills	0.00%	0.00%	84.62%	15.38%
Leadership Skills	0.00%	38.46%	46.15%	15.38%
Critical Thinking Skills	0.00%	7.69%	76.92%	15.38%
Lifelong Learning Skills	0.00%	7.69%	76.92%	15.38%
Reflecting/Self-Assessment Skills	0.00%	15.38%	69.23%	15.38%
Change Management Skills	0.00%	30.77%	53.85%	15.38%

Interestingly enough, students do not differentiate significantly between the skills they consider important for success in graduate school compared to those for success in the workplace.

Student responses to Questions #1 and #2 seem to validate PEO # 1, 2, and 3.

## B.2 Alumni Surveys

At the request of the AE Department, the SJSU Office of Institutional Effectiveness and Analytics set up our AE Alumni Survey online. In Spring 2017 the SJSU Alumni Association, again at the request of the AE Department, emailed an invitation to all AE alumni requesting their responses online. For some reason, the response rate was zero. To remedy the situation the AE Department has initiated a data collection process starting with the Spring 2017 graduates to create and maintain its own alumni database.

### B.3 Advisory Board Input

At our recent AEAB meeting, we asked the members of the Board (Appendix F) to define from their experience the “ideal engineer” in their company / organization, 3–5 years after graduation and in particular, to consider the following questions about this engineer:

1. What are his/her typical assignments, responsibilities and achievements?
2. What kinds of knowledge/skills does one need to be an "ideal engineer"?
3. How much of this knowledge/skill must come from the undergraduate experience?
4. How much of this knowledge/skill is typically acquired in the first few years as a practicing engineer?

A summary of their responses is given below.

Question 1. *What are his/her typical assignments, responsibilities and achievements?*

Engineers 3–5 years after graduation typically:

- Have a good understanding of how the company and the customers work.
- May interact directly with customers.
- At small company, they have more responsibility because there are not enough engineers to perform all the tasks. At a large company, there are many engineers and each is given a specific role (e.g. design, stress, systems, etc.).
- Perform the majority of the work at any company.
- Are given a fairly high level of responsibility and are expected to work independently with minimum supervision.
- They are able to “pick up a project/program and run with it”. Most work would follow established procedures, but critical thinking regarding the applicability of individual methods and appropriate deviations specific to the individual task are expected. Their work is reviewed for soundness of technical judgment and accuracy. For example:
  - Perform structural analysis of a major component and verifying results through hand or approximate calculations
  - Assist or direct the performance of complex tests, including planning
  - Perform sizing analysis for design
  - Go beyond following a specified procedure to get the requested answers
- Present and/or defend their work in front of an audience (technical meeting or exchange, presentation to supervisors, etc.).
- Have received at least one promotion.
- Specific responsibilities may include analysis (RF, thermal, structural, etc.), manufacturing / test (top level with spacecraft or “unit/box” level).
- Problem solving: Provide solutions to a variety of technical problems of moderate scope and complexity. May participate in, and contribute to, the resolution of problems of high complexity and visibility.
- Are considered “leads”. They have mastered the entry level position functions and are assigned tasks that are in addition to the everyday position functions, such as

providing training for new engineers and/or long-term projects aimed at increasing the efficiency of a process or a component.

- Have picked up a specialty role and are working toward becoming a subject matter expert (SME)
- Are able to mentor junior members on the team.

Question 2. *What kinds of knowledge / skills does one need to be an "ideal engineer"?*

- **Good practical sense of engineering**
  - There is a good place for theory, but for most of our work at this level, we are in need of application. Must know what can be manufactured and what cannot be manufactured.
  - A feel for numbers.
  - Knowing when to stop improving and freeze a design.
- **Lifelong learning skills** and willingness for continuous learning
  - Design, manufacturing, and testing are all different in Japan than those in Europe, sometimes even for the same application. The “ideal” engineer continues to learn and asks “why”, without considering his/her questions a show of weakness.
  - Ability to ask the right questions and quickly learn what you don't know.
- **Technical knowledge**
  - Solid foundation of fundamentals
    - Math
    - Physics
    - Materials
    - Dynamics
    - Aerodynamics
    - Controls
  - Comfortable in the correct application of engineering principles, theories, concepts and techniques.
  - Sufficient knowledge to understand technical documentation and high level descriptions of work to be performed
  - Problem solving / troubleshooting
  - Design skills
    - Iteration
    - Optimization
    - Systems engineering
      - ✓ Subsystems, purpose and interactivity.
      - ✓ Understanding where their work fits into a project, how it affects other areas.
      - ✓ Have a reasonable image of how the different disciplines are linked together in a project.
  - Programming; not important in what language.
    - ✓ Object-oriented language (e.g. Python)
    - ✓ Command line interface (e.g. Linux)
    - ✓ Shell scripts
    - ✓ Automatic execution of scripts (e.g. Cron Jobs)

- CAD skills:
  - ✓ Coming to work with CAD skills is important
  - ✓ Familiar with particular software (ProE, SolidWorks, etc.)
  - ✓ CAD knowledge is not assumed; the company takes responsibility to train engineers in CAD
- Communicate effectively with manufacturing
- Manufacturing skills (clean room, etc.)
- Testing skills
- Design experiments, perform error / statistical analysis
- Specialized knowledge is not expected; on-the-job training is provided for specific applications
- **Communication skills**
  - Able to convey ideas succinctly and clearly.
  - Able to give evidence for why their proposed way should be pursued.
  - Communicate with other engineers, with customers, and with government authorities.
  - Communicates openly if things are not going well.
  - Written communication skills (e.g. documentation, etc.)
  - Oral presentation skills
- **Self-directed.**
  - Motivated by their work. Have sufficient interest in the subject, so as to study different ways of doing things.
  - Able to perform their work with minimum supervision
  - Reach out across functional boundaries effectively
  - Understand the need to follow directions when required
  - Able to check their work independently and thoroughly; do so before delivering reports
- Able to contribute to the resolution of complex challenges with more experienced team members.
- **People skills**
  - Ability to work in a team
  - Knowing when to lead and when to follow
  - Ability to promote/facilitate teamwork; interpersonal skills
  - Personnel management
  - Have tact and diplomacy to deliver news and/or ask for help effectively.
- **Project development/management skills**
  - Sufficiently organized to manage a few simultaneous tasks of significant complexity.
  - Prioritize and keep a project on schedule.
  - Resource management
  - Understand very clearly the meaning of a deadline.

Question 3. *How much of this knowledge / skill must come from the undergraduate experience?*

- All the skills mentioned above

- All soft skills
- Theory
  - Mathematics
    - Linear algebra
  - Science
    - Physics
  - Engineering science
    - Materials
    - Loads
    - Dynamics
    - Aerodynamics
    - Flight mechanics
- Hands-on experience
  - Laboratory experience
    - Remote ground facilities
    - Telemetry / command / range
    - Clean room manufacturing
  - Summer coops / internships
  - Student club projects
    - AIAA Design/Build/Fly airplane projects
    - Design/Build/Launch rocket projects
- A broad feel for the subject (orders of magnitude, expected trends, etc.)
- Communication skills
  - Basic writing and presentation skills are expected from the first day of employment.
- Programming skills
  - Object-oriented language
  - Linux

Question 4. *How much of this knowledge/skill is typically acquired in the first few years as a practicing engineer?*

In the first few years as practicing engineers:

- Are expected to hit the ground running.
- There is a very steep learning curve. The amount of knowledge and skills acquired is tremendous.
- There is an expectation to produce results, but more importantly, to improve confidence, develop an increased feel for the subject, and be capable of continuous learning.
- Are expected to become experts with specific applications. Almost all specialized knowledge and expertise comes from on-the-job experience.
- Perspective is also something that takes shape during the early professional career, and is a skill that evolves throughout an engineer's entire career. Perspective (or lack thereof) is usually what keeps successful technical engineers away from leadership roles or confined to narrow areas of expertise.

- Latitude comes with comfort. It takes a little while for the engineer to realize what his sphere of influence is and how to adjust as needed to complete tasks and achieve career growth.
- Publishing internal documents, subsystems training, and personnel management can be learned within the first few years.

In summary, the AEAB members confirmed that new engineers (3-5 years after earning their BSAE degree) in their companies / organizations are expected to:

- a. Work independently with some supervision, undertake a high level of responsibility, participate in multiple projects, and make significant contributions to each project.
- b. Have solid fundamentals in their field, design skills, design-of-experiment skills, knowledge of modern tools, design-for-manufacturing experience, and ability to solve problems / troubleshoot.
- c. Bring a lifelong learning attitude and lifelong learning skills to allow for continuous learning on the job.
- d. Communicate well orally and in writing and have good interpersonal/team skills to work with engineers and customers from around the world.

These comments certainly validate all three of our PEO.

Advisory Board members were also asked to validate the language we use in the PEOs. While all of them considered all three of the PEO very important (5 on a scale from 1 to 5), they did disagree with the intent of PEO #2 that only through completion of a formal graduate degree can one enhance their professional skills. Based on their own experience in their organizations, they felt that in-house training is just as effective and many engineers do take this road for professional development and advancement. Hence, PEO #2 was modified to read:

*Have enhanced and continue to enhance their professional skills by pursuing / completing a graduate degree **or other post-graduate training.***

In summary, our constituents agree that the PEO defined are appropriate for our BSAE Program. Following our Advisory Board meeting in Spring 2017, one change was made to PEO #2 as described above.

## **C. Continuous Improvement**

The results of Outcomes assessment and evaluation are documented on the AE website and discussed in faculty meetings. Decisions, as to whether important changes must take place in the Program in order to improve Student Outcomes are taken collectively. The curriculum improvements discussed below in Section B.1 is an example of how assessment and evaluation is used to improve the quality of the BSAE Program.

### **C.1 BSAE Curriculum Improvements**

The Lower Division BSAE curriculum was strengthened by introducing:

### **AE20 – Computer-Aided Design for Aerospace Engineers (2 units)**

This is a one-hour lecture plus three-hour lab course per week, which provides an introduction to the fundamentals of drafting and computer-aided design with applications in aircraft and spacecraft design.

### **AE30 – Computer Programming for Aerospace Engineers (2 units)**

This is a one-hour lecture plus three-hour lab course per week, which provides an introduction to MATLAB/Simulink and C with applications in aerospace engineering.

Introducing AE-specific CAD and programming courses has strengthened our **AE Learning Community** (AELC) Initiative (see section C.2 below).

The Upper Division BSAE curriculum was strengthened by introducing:

### **AE112 – Aerospace Structural Analysis I<sup>13</sup> (4 units)**

The course was introduced to teach the fundamental principles of aerospace vehicle structural analysis using actual aerospace geometries, flight trajectories, materials and hardware. Using vector algebra and case studies, students learn the principles of statics, strength of aerospace materials and elementary structural analysis using aircraft and spacecraft examples. Integrating statics with aerospace structural analysis also solves the problem of excessive lower division units in the reduced BSAE curriculum.

An added benefit of the proposed change is that one unit was saved from the replacement of CE99/CE112 with AE112, which allowed the introduction of heat transfer content into the BSAE curriculum (please see discussion in AE164 below).

### **AE157 – Aerospace Automatic Control System Design (3 units)**

This is a new course in support of the Dynamics & Control stem in the BSAE curriculum, which supports both aircraft and spacecraft design. Prior to AY13-14 AEs did not take any courses in control theory, yet in AE168 (required course in the first senior semester) were introduced to aerospace vehicle stability and control. AE157 introduces students to classical and modern control theory with AE applications, so they can design aircraft and spacecraft control systems in AE168.

### **AE164 – Aerothermodynamics (5 units)**

The original course title was Compressible Flow and it was a 3-unit course. The title was changed to aerothermodynamics and the number of units was increased to 5 to include thermodynamics and heat transfer. The new course starts with thermodynamics, continues with compressible flow, and finishes with heat transfer, which AEs need for aerospace vehicle design, especially for re-entry vehicles.

**GE areas S and V** have been **integrated** into the **AE senior design** project courses (**AE171A&B, AE172A&B**). As a result, AE171A&B and AE172A&B have been certified as GE courses. GE assignments in areas S and V in AE171 and AE172 are aligned with,

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<sup>13</sup> The course title for AE114 was changed appropriately to “Aerospace Structural Analysis II”.

and build upon the discussion and assignments in Engr195A&B. As mentioned earlier the greatest advantage of this integration is the strengthening of BSAE Outcomes C (realistic constraints), E (writing skills), F (ethics), G (impact of engineering solutions in a global and societal context and knowledge of contemporary issues), and of course I (lifelong learning).

## **C.2 AE Learning Community Initiative**

The idea of the AELC was initiated by Dr. Mourtos in Fall 2013 after reviewing the literature on student retention. The initiative involves pairing AE student teams in AE20 and AE30 with students in AE171A&B (Aircraft Design) and AE172A&B (Spacecraft Design), so that freshmen and sophomores can shadow seniors in their design projects. The seniors provide simple CAD and programming assignments to AE20 and AE30 students and meet with them bi-weekly to clarify tasks, check on progress, and provide assistance, as necessary. This activity provides an opportunity for lowerclassmen to participate in advanced aerospace design work and contribute according to their capabilities. The AELC provides a venue for freshmen and sophomores to connect with AE seniors, whom they look up to as role models and mentors.

An effort is made to formalize and expand these activities, so that freshmen and sophomores (a) work alongside juniors and seniors in a variety of projects, (b) participate in AE professional societies, (c) receive tutoring in math and physics from juniors and seniors, (d) are assigned a mentor with whom they can meet on a regular basis throughout the year. Ms. Hunter, as the Director of the AELC, has been responsible for implementing and coordinating all these activities with great success.

## **D. Additional Information**

### **D.1 Facilities and Safety**

SJSU is audited periodically by Cal/OSHA and the Fire Marshal for safety compliance of our facilities. In 2011, the university received 192 infractions campus-wide, with 38 of them belonging to the College of Engineering. Recommendations made to the Colleges of Engineering and Science included a twice-yearly internal inspection of all facilities with hazards, implementation of a chemical procurement and inventory system, and the addition of two student assistants to assist with safety compliance tasks.

In response to the 2011 audit, we had assigned one of the department chairs to oversee safety in the building, and had hired two student assistants. In 2013, the College of Engineering received 10 safety infractions during the Cal/OSHA audit. Although the new system resulted in fewer infractions, it became apparent that assigning a department chair to the task was unsustainable in the long term due to limited time, less familiarity with safety issues typical in other departments, as well as limited influence in departments outside of his own.



In 2014, the college had hired a full-time staff member whose duties included oversight of building safety. In addition, we developed an Injury and Illness Prevention Plan, which is posted prominently on our website and enforced by the safety staff (<http://engineering.sjsu.edu/facilities/health-and-safety>). In 2015, the College of Engineering received 12 infractions, all which were minor and easily corrected. The campus received 29 infractions total. Cal/OSHA was sufficiently impressed with our progress that they decided to move to a three-year audit cycle, instead of two. The current safety infrastructure has been shown to be effective at maintaining safety compliance while also being sustainable in the long term. The 2015 SJSU Report on Environmental Health and Safety can be made available upon request.

## D.2 Student Success / Graduation Rates

In 2013, the Chancellor’s Office of the California State University system examined the graduation rates for all 23 campuses. They determined that while the CSU campuses were generally above the average six-year graduation rates of US public universities with similar incoming student characteristics (i.e. SAT math scores), our four-year rates were below the national average. There was a directive to improve the graduation rates for all undergraduates, with a special emphasis on four-year graduation rates for freshmen.

Two factors identified as hindering students from graduating in a timely manner included the large number of units in our programs, and the lack of college readiness of entering students.

The recent graduation rate history for Aerospace Engineering is shown below (with Cohort indicating the first semester) and compared with the College average.

Cohort	<b>4-Year 1<sup>st</sup>-Time Freshmen Graduation Rate</b>	
	AE	College Average
Fall 2009	3.30%	2.30%
Fall 2010	9.70%	3.30%
Fall 2011	13.30%	4.70%
<b>Fall 2012</b>	<b>16.30%</b>	<b>6.40%</b>

The AE Program enjoys *one of the two* (by far) *highest rates* in the College, *2<sup>nd</sup>* only to BME, which has a 4-Year rate of 16.7%.

Cohort	<b>6-Year 1<sup>st</sup>-Time Freshmen Graduation Rate</b>	
	AE	College Average
Fall 2007	33.30%	40.10%
Fall 2008	44.10%	42.40%
Fall 2009	60.00%	46.30%
<b>Fall 2010</b>	<b>51.6%</b>	<b>48.10%</b>

Again, the AE Program currently enjoys *one of the two highest rates* in the College, *2<sup>nd</sup>* only to CEE, which has a 6-Year rate of 71.7%. The 60.0% rate for the Fall 2009 cohort was the highest in the College.

Cohort	<b>2-Year Transfer Graduation Rate</b>	
	AE	College Average
Fall 2011	15.80%	5.30%
Fall 2012	14.30%	3.70%
Fall 2013	21.60%	4.70%
<b>Fall 2014</b>	<b>31.40%</b>	<b>7.80%</b>

Cohort	<b>4-Year Transfer Graduation Rate</b>	
	AE	College Average
Fall 2009	42.90%	56.30%
Fall 2010	75.00%	66.70%
Fall 2011	73.70%	65.30%
<b>Fall 2012</b>	<b>57.10%</b>	<b>52.70%</b>

The AE Program enjoys (by far) the *highest graduation rate* in the College *for two-year transfers*. The 4-Year graduation rate for transfers, although above the College average is the 5<sup>th</sup> highest in the College.

One of the reasons for the increasing trend in the graduation rates of the College is the mandatory unit reduction to 120 units (see discussion below). In AE, however, the main reason is consistent one-on-one advising, which became possible after the Program became independent in Fall 2013.

### **D.3 Unit Reduction to 120 Units**

In Fall 2014, all of the degree programs in the College reduced the number of required units from 132+ to 120. The reduction was largely accomplished by consolidating general education and major courses, and by reducing the number of units of electives and the engineering core. All students who graduated in Fall 2014 or later were eligible to switch to the 120-unit plan. There appear to be slight gains to some of the graduation rates that could be affected (please see 4-year graduation rate for Fall 2011 freshmen, 6-year grad rate for Fall 2009 freshmen, and 2-year grad rate for fall transfer students).

In the BSAE Program the unit reduction resulted in course consolidation (statics and strength of materials in AE112), elimination of obsolete topics (e.g. steam tables in thermodynamics), and most importantly, introduction of new important topics (e.g. heat transfer) and new courses (e.g. AE157). Hence, our reduced unit plan is much stronger in terms of successfully meeting our Student Outcomes and Program Criteria.

#### **D.4 Supplemental Criteria for Transfer Admissions.**

For transfer students, a study was performed at SJSU in 2014 showing that a significant fraction take lower division calculus and physics courses at SJSU during their first two semesters here. These courses start long prerequisite chains and course sequences, and prohibit students from graduating in a reasonable time period if not completed at a community college prior to transfer.

In response to this data, the SJSU College of Engineering instituted supplemental criteria for transfer admissions to all engineering programs starting with the Fall 2016 admitted cohort. An admissions ranking bump of 150 - 200 points (out of 1200) is given for completion of the following courses with a grade of C or better: Calculus I (Math 30), Calculus II (Math 31), and Physics 1 (Phys 50). The remaining 600 points is determined based on the community college GPA. Compared to previous years where admissions ranking was performed by GPA only, the new system allows us to prioritize students with a lower GPA but more supplemental courses completed, for admission to our program.

In Fall 2016 the AE Program admitted 93 transfer applicants. Applicants who had completed all three supplemental courses were admitted with a GPA above a 2.10. Applicants who had completed only two of the required courses were admitted with a GPA above 3.10. No applicants were admitted with fewer than two of the required courses completed.

Out of this admitted cohort, 32 new AE transfer students enrolled at SJSU in Fall 2016. None of these students required a seat in any of the supplemental courses in their first semester at SJSU. This enrollment pattern can be compared to the incoming Fall 2015 transfer cohort, who were not ranked based on their supplemental criteria. Of the 34 students enrolled in Fall 2015, two were registered in Math31 and three in Phys50 in their first semester at SJSU.

By comparing the two incoming cohorts, the effect of the supplemental criteria has been shown to eliminate the need for our transfer students to take the calculus and physics pre-requisite courses. As we continue this admissions practice and the new requirements are disseminated further, we expect the need for all of the pre-requisites to be eliminated in our transfer population, and this should improve the transfer graduation rates starting with the Fall 2015 cohort (i.e. 2-yr graduation rate in 2017 and 4-yr graduation rate in 2019) as a result.

#### **D.5 Admissions Ranking Algorithm for Freshmen.**

Similarly, for freshmen students, calculus preparedness was shown to be a significant factor in the six-year graduation rate for the Fall 2006, 2007, and 2008 entering cohorts, as shown in the following table.

6-year graduation rates for incoming freshman cohorts  
as a function of math and English preparedness

Math/English Preparedness	Cohort Size			Degree within 6 years		
	Fall 2006	Fall 2007	Fall 2008	Fall 2006	Fall 2007	Fall 2008
Calculus I (or above) ready	77	107	167	53%	55%	60%
Precalculus ready	85	108	131	35%	34%	37%
Remedial English, Calculus I (or above) ready	52	70	87	48%	56%	48%
Remedial English, Precalculus ready	85	96	118	34%	32%	40%
Remedial Math, switched major out of ENG	49	65	55	33%	19%	24%
Remedial Math, attempted ENG major	21	27	28	19%	33%	11%
<b>College Total</b>	<b>369</b>	<b>473</b>	<b>586</b>	<b>39%</b>	<b>40%</b>	<b>43%</b>

This table shows that freshmen who are ready to take Calculus I (or above) in their first semester graduate at much higher rates than students who place into pre-calculus or remedial math. It is also worth pointing out that placement into remedial English reduces the graduation rates somewhat, but not as dramatically as a math placement at pre-calculus or below.

The current applicants to our programs are ranked according to their Eligibility Index (EI) computed as follows:

$$EI = 800 * GPA + SAT(\text{math}) + SAT(\text{critical reading})$$

To place a higher weight on math preparedness, we propose to rank applicants to our programs using a modified ENG EI:

$$ENG EI = 800 * GPA + 3 * SAT(\text{math}) + SAT(\text{critical reading})$$

The first semester math placement of our entering freshman class in Fall 2016 is shown in the following table:

	AE	BME	ChE	CE	CMPE	EE	ISE	MatE	ME	SE	COE	%
New Freshmen	51	51	19	52	49	73	18	8	65	38	424	
Remedial Math	1	3	0	4	0	4	4	1	2	0	19	4.5%
Math 19	19	14	4	20	6	17	4	1	13	5	103	24.3%
Math 30	11	23	5	10	18	23	4	2	15	9	120	28.3%
Math 31	11	7	7	10	13	20	3	3	25	15	114	26.9%
Math 32	6	2	1	5	5	5	0	1	3	2	30	7.1%
Math 32H	3	1	0	1	5	3	1	0	6	1	21	5.0%

As shown by this table, almost 30% of our freshmen are in remedial math or pre-calculus in the Fall 2016 class. The Fall 2017 incoming class will be admitted under the ENG EI ranking, and theoretically should have a smaller percentage of students in these categories. This will be assessed after the census date of the Fall 2017 semester. Resulting improvements to graduation rates may be measureable starting with the 4-yr graduation rate in 2021 and the 6-yr graduation rate in 2023.

# CRITERION 5 – CURRICULUM

## A. Program Curriculum

### A.1 Recommended 4-Year Plan for the BSAE Degree

Table 5.1 shows the recommended 4-year plan for the BSAE degree. SJSU is on a semester system. All lower division courses, including AE20 and AE30, as well as all upper division non-AE courses shown in Table 5.1 (e.g. Engr.100W, Math129A, Math133A, etc.) are offered every semester and many of them are also offered during the summer. Upper division AE courses are offered once a year, either in the fall or in the spring, as shown in Table 5.1

### A.2 BSAE Curriculum Structure

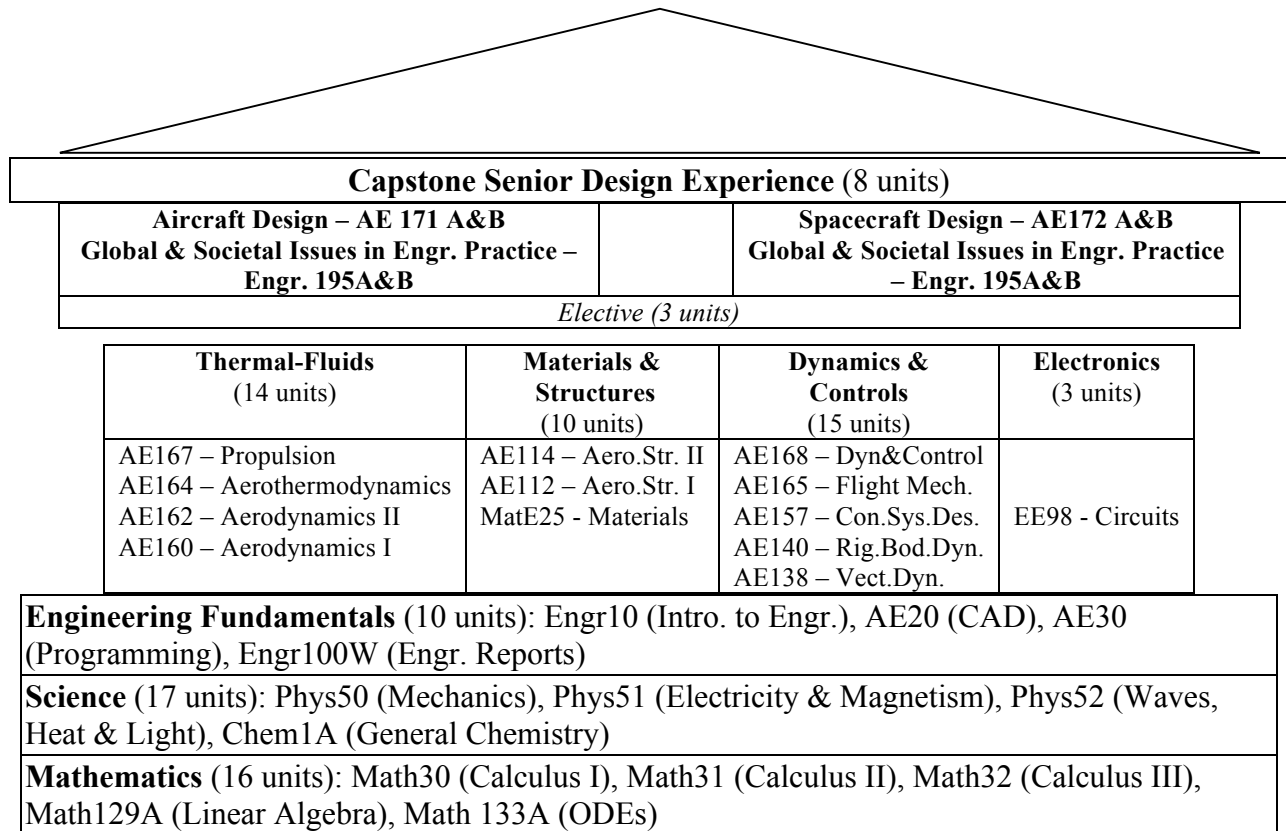


Figure 5.1 – BSAE curriculum structure

As shown in Figure 5.1, students build on a foundation of mathematics and physical sciences following up with engineering fundamentals and courses in four engineering disciplines: thermal-fluids, materials and structures, aerospace dynamics and controls, and electronics. The BSAE core includes aerospace structural analysis (AE112, AE114), aerodynamics (AE160, AE162) and aerothermodynamics (AE164), vector-based

dynamics (AE138, AE140), aerospace flight mechanics (AE165), aerospace propulsion (AE167), aerospace automatic control system design (AE157), aerospace vehicle dynamics and control (AE168), and computational fluid dynamics (AE169).

The BSAE curriculum aligns with the PEO with a strong emphasis on both technical and non-technical skills. Technical skills include analytical, laboratory, computational, and design. Non-technical skills include lifelong learning, communication, team and leadership, professionalism and ethics, as well as understanding of current events and how aerospace engineering is influenced by these events.

### A.3 AE Courses / Student Outcome Mapping

Table 5.2 illustrates the mapping of BSAE core and capstone courses to Student Outcomes, the course coordinators for each course, and the skill level in Bloom’s Taxonomy, at which each course addresses a particular outcome. The various levels of competency according to Bloom’s (revised) Taxonomy are shown respectively in Tables 5.3 and 5.4 for the cognitive<sup>14</sup> (Bloom, 1984) and affective<sup>15</sup> (Bloom, Karthwohl, and Massia, 1984) domains.

Table 5.2 – BSAE Course / Student Outcome Mapping

BSAE	Student Outcomes								
	A	B	C	D	E	F	G	H	I
Original ABET Outcomes	(a), (e)	(b)	(c)	(d)	(g)	(f)	(h), (j)	(i)	(k)
<b>BSAE Core Courses &amp; Course Coordinators</b>									
AE 112 – Prof. Hunter	++	O		O	O				O
AE 114 – Prof. Hunter	++	O		O	O				O
AE 138 – Prof. Hunter	++	O		O	O				O
AE 140 – Prof. Hunter	++			O	O			O	O
AE 157 – Dr. Turkoglu	++	O	O	O	O	O	O	O	O
AE 160 – Dr. Mourtos	++	O	O	O	O			O	+++
AE 162 – Dr. Mourtos	++	++		O	O		O	++	+++
AE 164 – Dr. Mourtos	++			O	O			O	O
AE 165 – Dr. Mourtos	++			O	O			O	O
AE 167 – Dr. Papadopoulos	++	O	O	O	O	O	O	O	O
AE 168 – Dr. Turkoglu	++	O	O	O	O			O	O
AE 169 – Dr. Papadopoulos	O			O	O			O	+++
AE 171 A, B – Dr. Mourtos	O	O	++	++	++	++	++	++	O
AE 172 A, B – Dr. Papadopoulos			+	+	+	+	+	+	

+: Skill level 1 or 2 in Bloom’s Taxonomy

++: Skill level 3 or 4 in Bloom’s Taxonomy

+++ : Skill level 5 or 6 in Bloom’s Taxonomy

O Skill addressed but not assessed

<sup>14</sup> Bloom, B.S. (1984). Taxonomy of educational objectives; Handbook 1: Cognitive domain. New York: Addison Wesley.

<sup>15</sup> Bloom, B.S., Karthwohl, D.R., & Massia, B.B. (1984). Taxonomy of educational objectives; Handbook 2: Affective domain. New York: Addison Wesley.

Table 5.3 – The 6 levels of competency in the cognitive domain

Level	Competence	Description
6	Create (Design)	Combine elements in novel ways to generate new products or ideas.
5	Evaluate	Judge the worth of ideas, theories and opinions, choose among alternatives, and justify their choice based on specific criteria.
4	Analyze	Deal with ambiguity in new, ill-defined situations by formulating models and seeing relationships (i.e. able to tackle open-ended problems)
3	Apply	Use information appropriately to solve well-defined problems.
2	Understand	Understand the meaning of information, so they can explain it to others (ex. share their own examples of how a principle applies in certain situations).
1	Remember	Recognize or recall information (ex. repeat verbatim definitions or principles).

Table 5.4 – The 5 levels of competency in the affective domain

Level	Competence	Description
5	Characterized (by a value system)	Work independently and diligently, practice cooperation when working in teams, act ethically. Personal value system reflects consistently in student behavior.
4	Organize (values into a system)	Balance responsibilities effectively; begin to formulate a systematic approach to learning.
3	Value (a behavior)	Committed to education, have positive attitudes about required coursework.
2	Respond (to a stimulus)	Study for courses, carry out assignments.
1	Receive (a stimulus)	Go to class, participate in class activities.

#### A.4 General Education

General Education requirements are organized into several areas, as shown on the left column of Table 5.5. The lower division areas are communication (A), sciences and mathematics (B), arts and humanities (C), social sciences (D), human understanding and development (E), and American institutions (US<sub>1,2,3</sub>). The upper division areas – also known as SJSU studies – are earth and environment (R), self, society and equality (S), culture, civilization and global understanding (V), and written communication (Z).

Area B is covered in the mathematics, physics, and chemistry courses required for the major, while Area E is integrated in Engr.10. Thus, AE students take 21 semester units of distinct lower division GE courses in arts (C<sub>1</sub>) and letters (C<sub>2</sub>), human behavior (D<sub>1</sub>), comparative systems (D<sub>2</sub>) and social issues (D<sub>3</sub>), and American institutions history, US Constitution and California Government. Carefully selected course pairs (6 semester units) may satisfy simultaneously areas D<sub>2</sub>, D<sub>3</sub>, as well as US<sub>1,2,3</sub>.

Upper division GE requirements (SJSU Studies) are all integrated into engineering courses (Engr.100W, AE171A&B, AE172A&B and Engr.195A&B) to better demonstrate the connection between general education concepts and engineering practice and prepare students for responsible, 21<sup>st</sup> century citizenship. Table 5.4 illustrates the mapping of GE courses to BSAE Student Outcomes and the skill level in Bloom's Taxonomy, at which each course addresses a particular outcome.

Table 5.5 – GE areas / Student Outcomes mapping

BSAE	Student Outcomes								
	A	B	C	D	E	F	G	H	I
Original ABET	(a), (e)	(b)	(c)	(d)	(g)	(f)	(h), (j)	(i)	(k)
Area A – Communication				++	++				
Area B – Science & Math*	++	++							
Area C – Humanities & Arts			++		++			+	
Area D – Social Sciences			++	++			++		
Area E – Human Understanding & Development			++	++		+		+	+
US 1, 2, 3 – American Institutions						++	++		
SJSU Studies Area R			++			+++	+++		
SJSU Studies Area S				++	+++	+++	+++	++	
SJSU Studies Area V				++	+++		+++	++	
SJSU Studies Area Z					+++				

\* Covered w. major required courses in math, physics & chemistry

+: Skill level 1 or 2 in Bloom’s Taxonomy

++: Skill level 3 or 4 in Bloom’s Taxonomy

+++ : Skill level 5 or 6 in Bloom’s Taxonomy

○ Skill addressed but not assessed

Clearly, GE courses contribute to AE Student Outcomes C (as it relates to design constraints such as economic, environmental, social, political, ethical, safety, and liability), D (ability to collaborate with people from different cultures, abilities, and backgrounds), E (communication skills), F (professionalism and ethics), G (broad education to understand current events), and H (lifelong learning skills).

### A.5 Mathematics and Basic Sciences

**Requirement = 1 year / 32 units.** The BSAE curriculum includes 33 units of mathematics and basic sciences (Table 5.6): five math courses (Calculus I, II, III, Differential Equations, Linear Algebra), three physics courses (Mechanics, Electricity & Magnetism, Waves, Light & Heat) and a course in General Chemistry (5 units).

### A.6 Technical Curriculum

**Requirement = 1.5 years or 48 units of engineering topics that include engineering sciences and engineering design.** The AE curriculum includes 61 units of engineering topics (not including Engr100W, Engr195A&B), 13 of which are lower division and 48 are upper division. All upper division courses emphasize engineering problem solving through mathematical and physical modeling, while several of them include open-ended problems and projects (AE114, AE160, AE162, AE165, AE164, AE167), computer modeling/ simulations (AE157, AE162, AE164, AE168, AE169, AE171A&B, AE172A&B among others), experimentation/product testing (AE112, AE114, AE157, AE160, AE162, AE167, AE168, AE171A&B, AE172A&B among others),



and design (AE114, AE157, AE160, AE164, AE167, AE171A&B, AE172A&B among others). Students also choose one technical elective from the courses listed in Table 5.5.

## A.7 Experimentation

The BSAE curriculum includes 11 required courses with laboratories (Phys.50, Phys.51, Phys.52, Chem.1A, AE112, AE114, AE157, AE160, AE162, AE167, AE168) with one more (AE164) soon to be added. In all upper division laboratory courses students are taught not only how to perform experiments but also how to design experiments that meet specific objectives. Moreover, they are taught to analyze, interpret, and present their data in formal laboratory reports and oral briefings.

## A.8 Senior Design Capstone Experience

In their senior year students integrate their knowledge and skills from all AE sub-disciplines in a year-long aerospace vehicle design experience, which introduces them to systems-level engineering. This experience involves a team-based design project of an aircraft (AE171A&B) or a spacecraft (AE172A&B) subject to realistic constraints, such as economic, environmental, social, political, ethical, safety, liability, and manufacturability. Additional exposure to such constraints comes through case studies, guest speakers and field trips. At the same time students may take electives in areas such as design and manufacturing, engineering management, economics, modeling / numerical methods, materials, structural analysis, thermal-fluids, controls / mechatronics, and sustainability (Table 5.6).

Students draw upon their knowledge of CAD (AE20), aerodynamics (AE162), and flight mechanics (AE165) to get started in their aircraft and spacecraft design projects. Aerospace vehicle stability and control (AE168) and aerothermodynamics (AE164) are taken concurrently with the first semester senior design courses (AE171A & AE172A). Students are given a semester-long project in AE168 that correlates with their aircraft or spacecraft design project. Similarly, spacecraft design students draw upon their experience in AE164 to design their high-speed vehicles or probes.

Aerospace propulsion (AE167) and CFD (AE169) are taken concurrently with the second semester senior design courses (AE171B & AE172B). Students are given a semester-long project in AE169 that correlates with their aircraft or spacecraft design project, namely to perform CFD studies on their vehicles.

The AE Department provides technical and financial support to seniors who participate in national design competitions (e.g. AIAA Design-Build-Fly and SAE Aero-Design). ***AE171 students have won two first places in the AIAA Design-Build-Fly competition (2012, 2016), a 3<sup>rd</sup> place (2014), a 6<sup>th</sup> place (2013) and 10<sup>th</sup> place (2015, 2017), all in very competitive, international fields with more than 100 teams, including some from the best engineering schools in the US and around the world.***

Similarly, AE172 students are involved in realistic design-build-test-launch and deploy projects under the guidance of Dr. Papadopoulos and Mr. Murbach from NASA Ames

Research Center. Many **AE172 students present papers at the annual International Planetary Probe Workshop (IPPW)**. A list of these papers from the past 6 years is presented in Appendix J.

Non-curriculum mechanisms that support the BSAE PEO and Student Outcomes include:

- Student chapters of AE professional societies:
  - ✓ American Institute of Aeronautics and Astronautics (AIAA)
  - ✓ Sigma Gamma Tau (AE Honor Society)
- Other AE student societies:
  - ✓ Design-Build-Fly (DBF)
  - ✓ Rocket Club
  - ✓ Students for the Exploration and Development of Space (SEDS)
- Other engineering student societies:
  - ✓ Society of Automotive Engineers (SAE)
  - ✓ Engineering Ambassador Program
  - ✓ Engineers without Borders
  - ✓ Society of Manufacturing Engineers (SME)
  - ✓ Society of Women Engineers (SWE)
  - ✓ Spartan Racing (Formula SAE)
  - ✓ Vietnamese Engineering Students Association (VESA)
  - ✓ Tau Beta Pi (Engineering Honor Society)
  - ✓ American-Indian Science and Engineering Society (AISES)
  - ✓ Black Alliance of Scientists and Engineers (BASE)
  - ✓ Society of Latino Engineers and Scientists (SOLES),
  - ✓ MESA Engineering Program (MEP)

Table 5.6 – BSAE Electives

AE180 – Individual Studies	
<i>AE Electives</i>	
AE 110 - Space systems engineering AE 142 – Astrodynamics AE 166 – Rocketry AE199.1 – Special Topics in AE: UAVs	
<i>Design / Manufacturing</i>	Tech 140 – Green & sustainable product design ISE 114 – Safety engineering
ME 110 – Manufacturing processes ME 136 – Design for manufacturability ME 154 – ME design ME 165 – CAD in ME	
<i>Management / Economics</i>	ISE 102 – Engineering economic systems ISE 105 – System engineering & activity costing ISE 151 – Managing engineering
<i>Mathematics, Numerical Methods &amp; Modeling</i>	
Math 112 – Vector calculus	

Math 129 B – Linear algebra II	
Math 133 B – PDE	
Math 143 M – Numerical analysis for scientific computing	
ISE 130 – Engineering probability & statistics	
ISE 170 – Operations research	
<i>Materials</i>	AE 135 – Composite materials MatE 160 – Fracture mechanics
<i>Applied Physics</i>	
Phys 105A&B – Advanced Mechanics	
Phys 120A – Electronics, Data Acquisition & Analysis	
Phys 120C – Advanced Physics Lab: Optics & Lasers	
Phys 158 – Modern Optics	
Phys 160 – Thermodynamics & Statistical Physics	
Phys 168 – Lasers	
<i>Structures</i>	ME 160 – Finite Element Method CE 160 – Structural Mechanics I CE 161 – Intermediate Structural Mechanics
<i>Thermal/Fluids</i>	ME 114 – Heat transfer ME 149 – Acoustics ME 182 – Thermal systems design
<i>Controls / Mechatronics</i>	
ME 106 – Mechatronics	
ME 190 – Mechatronic system design	EE 112 – Linear systems
<i>Sustainability</i>	Engr.103 – Life cycle engr. CE 173 – Engr. for sustainable environment

## A.9 BSAE Prerequisite Structure

Figure 5.2 shows the BSAE prerequisite structure; Table 5.7 lists the prerequisites of every course required in the major. Students begin by building first a foundation in mathematics and physics, and continue with their foundation in engineering sciences. This foundation enables them to properly identify, formulate, and solve AE problems, as expected in Outcome A. Students are first exposed to laboratory work in their science courses. This exposure, together with their foundation in mathematics, science, and AE science allows them to design and perform more complex experiments in AE core courses as well as to analyze and interpret the results from such experiments, as expected in Outcome B.

Designing a reasonable and effective prerequisite structure can be challenging, considering programmatic constraints, such as for example the need to fit all the required coursework in four years, as shown in Table 5.1. Ideally students would complete all their upper division coursework before embarking on their capstone, senior design experience. This, however, is neither possible, as it would add an extra year to the Program nor necessary, as some core courses are not essential for a meaningful and

deep learning experience in senior design. AE114, for example, is not deemed essential because senior design involves conceptual and preliminary design of airplanes and spacecraft and students typically do not have time for detail structural design in their projects.

Of the courses that are deemed essential, some have indeed been placed as prerequisites (AE162, AE165); others could only be placed as co-requisites (AE164, AE168) due to their own prerequisite sequence (e.g. AE168 requires AE157, which requires AE138; AE167 requires AE164, which requires AE160) as well as the need not to exceed 16 units per semester. Furthermore, some prerequisites / co-requisites are more essential for some of the senior design projects but not for others. For example, AE164 is essential for AE172 projects, which involve high-speed space vehicles. Unless students choose a high-speed airplane – usually not the case – AE164 is not essential for AE171 projects, which typically involve low-speed UAVs, as those designed for the AIAA Design-Build-Fly or the SAE Aero Design competitions.

General Education courses are essential in helping students realize that there is much more to the design of an airplane or spacecraft than simply satisfying a set of technical requirements. They certainly help students deal more effectively with the “realistic constraints” in Outcome C as well as with issues raised in Outcome G, namely understanding current events, how they may affect their product, and what may be the impact of their airplane or spacecraft in a global and societal context. The integration of Areas S and V into senior design is particularly effective in this sense.

Modern engineering software (C++ and Matlab) is introduced in AE20, so students can use these programs in upper division courses. For example, students use Matlab extensively in AE157 and AE168. CFD software is introduced in AE169, which is taken in the last semester, however, students still get to use it in their senior design projects. In AE160 students are first introduced into Wood’s Problem Solving Methodology<sup>16</sup> as an organized way to tackle open-ended problems and use it in AE160, AE162, and other AE core courses. Similarly, in AE138 students are introduced into vector-based dynamics, an approach which is indispensable in later courses, such as AE140, AE142, as well as for graduate courses that build on dynamics (e.g. AE242, AE243).

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<sup>16</sup> <http://www.sjsu.edu/people/nikos.mourtos/assessment/problem-solving/>

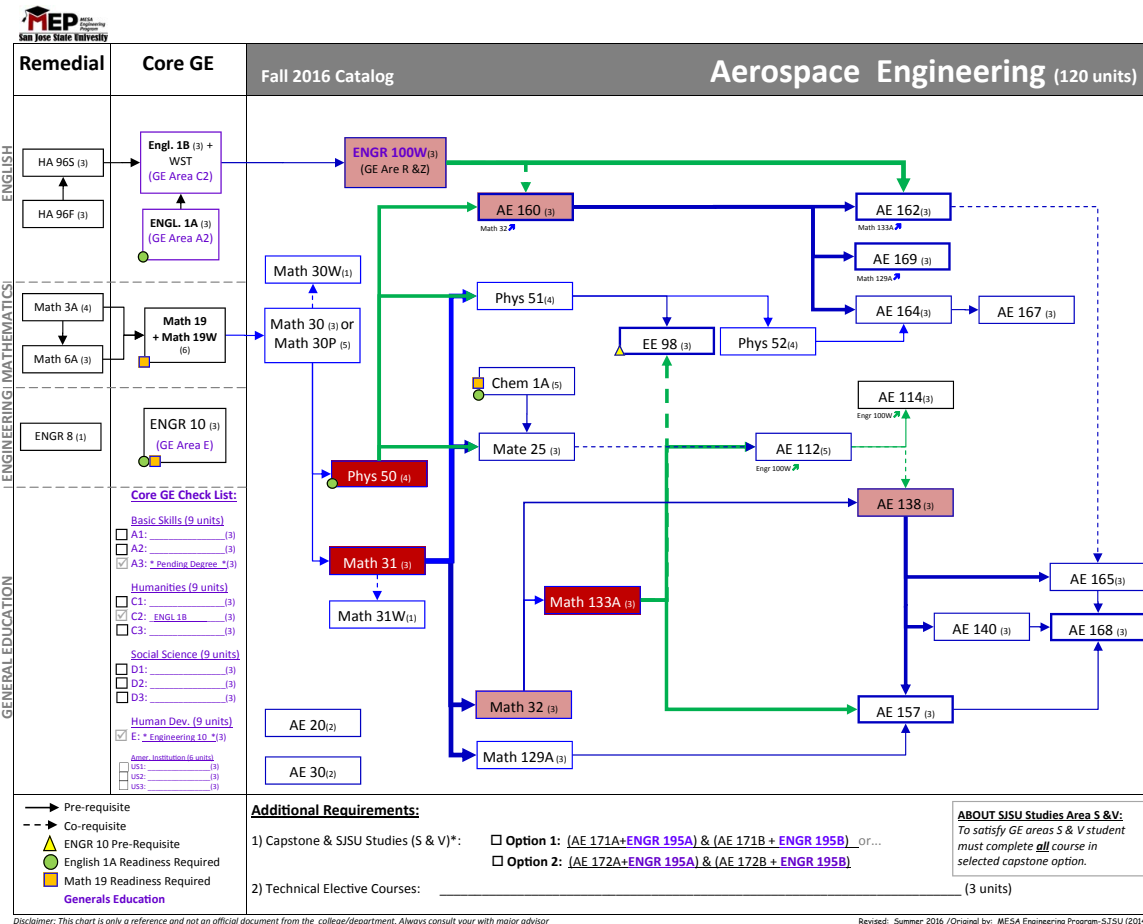


Figure 5.2 – BSAE prerequisite structure

Table 5.7 – BSAE course prerequisites

		<i>C or better is required in all prerequisite classes</i>	Co-requisites
Math 30	Calculus I	Satisfactory score on Math Placement Test <b>or</b> "B" or better in Math19	
Math 31	Calculus II	Math30 or Math30P	
Math 32	Calculus III	Math31	
Math 129A	Linear Algebra I	Math31	
Math 133A	Ordinary Differential Eqs.	Math32	
Chem 1A	General Chemistry	HS Chemistry <b>or</b> "C" or better in Chem10	Eligible for Engr.1A
Phys 50	Gen. Physics / Mechanics	Math30 or Math30P	
Phys 51	Gen. Physics / Elec. & Magnet.	Phys50, Math31	
Phys 52	Gen. Physics / Heat & Light	Phys51, Math31	
Engr10	Intro to Engineering	HS Algebra, Geometry & Trigonometry	
AE 15	AE: Past, Present & Future	None	
AE 20	CAD for AEs	None	
AE 30	Comp. Programming for AEs	None	
MatE 25	Intro to Materials	Chem1A, Phys50, Math31	
EE 98	Intro to Circuit Analysis	Engr10, Phys51	Math133A
English 1B	Argument		
Engr100W	Engineering Reports	Completion of Core GE, Pass WST,	

		Upper Division Standing	
AE 110	Space Systems Engineering	AE165	
AE 112	Aero Structural Analysis I	Math32, Phys050	
AE 114	Aero Structural Analysis II	AE112	
AE 138	Dynamics	Math32, Phys050	AE112
AE 140	Rigid Body Dynamics	AE138	
AE 142	Astroynamics	AE138, AE165	
AE 157	Aero Auto. Syst. Con. Design	Math129A, Math133A, AE138	
AE 160	Aerodynamics I	Math32, Phys50	E100W
AE 162	Aerodynamics II	AE160	E100W
AE 164	Compressible Flow	Phys052, AE160	
AE 165	Aerospace Flight Mechanics	AE138	AE162
AE 166	Rocketry	AE165	
AE 167	Aerospace Propulsion	AE164	
AE 168	Aero Vehicle Dyn. & Control	AE140, AE157, AE165	
AE 169	Comp. Fluid Dynamics	Math129A, AE160	
AE 171A	Aircraft Design I	AE20, AE162, AE165, E100W, Senior in good standing!	AE164, AE168, Engr195A
AE 171B	Aircraft Design II	AE164, AE168, AE171A, Senior in good standing!	AE167, AE169, Engr195B
AE 172A	Spacecraft Design I	AE20, AE162, AE165, E100W, Senior in good standing!	AE164, AE168, Engr195A
AE 172B	Spacecraft Design II	AE164, AE168, AE172A, Senior in good standing!	AE167, AE169, Engr195B
AE 180	Individual Studies	Upper Div. Standing & Instructor Consent	
Engr195A	Global & Soc. Issues in Engr. I	Engr100W	AE171A or AE172A
Engr195B	Global & Soc. Issues in Engr. II	Engr195A	AE171B or AE172B

## B. Course Syllabi

Appendix A includes syllabi for all courses used to satisfy the mathematics, science, and discipline-specific requirements, as shown in Table 5-6. A course binder will be available for review during the visit for each of the AE courses along with the required textbook and/or instructor notes for each course. Each course binder will include the following:

- Approved course syllabus
- Class roster showing all student scores and final grades
- Course materials provided to students, such as notes, Power Point slides, exams, lab instructions, project descriptions, etc.
- Student work samples as follows:
  - a. One sample for all graded work from an “A” student
  - b. One sample for all graded work from a “B” student
  - c. One sample for all graded work from a “C” student
  - d. One sample for all graded work from a “D” student
  - e. One sample for all graded work from an “F” student

Table 5.1 – Aerospace Engineering Program Curriculum

Course (Department, Number, Title) List all courses in the program by term starting with the first term of the first year and ending with the last term of the final year.	Indicate whether course is Required, Elective or a Selected Elective by an R, an E or an SE. <sup>1</sup>	Subject Area (Credit Hours)				Last two terms the course was offered: year and, semester, or quarter	Maximum section enrollment for the last two terms the course was Offered <sup>2</sup>
		Math & Basic Sciences	Engineering Topics Check if Contains Significant Design (√)	General Education	Other		
<b>Fall Semester – Year 1</b>							
MATH 30 – Calculus I (B4–Mathematical Concepts) <sup>3</sup>	R	3		3		F16/S17	102/38
CHEM 1A – General Chemistry (B1–Physical Science & B3– Laboratory Science) <sup>3</sup>	R	5		5		F16/S17	238/25
ENGR 10 – Intro to Engineering (E–Human Understand. & Develop.)	R		✓ 3	3		F16/S17	276/25
ENGL 1A – Composition I (A2–Written Communication)	R			3		F16/S17	25
AE 20 – CAD for AE	R		✓ 2			F16/S17	60/58
<b>Spring Semester – Year 1</b>							
MATH 31 – Calculus II (B4–Mathematical Concepts) <sup>3</sup>	R	4		4		F16/S17	154/47
PHYS 50 – General Physics/Mechanics (B1–Physical Science & B3– Laboratory Science) <sup>3</sup>	R	4		4		F16/S17	200/27
AE 30 – Computer Programming for AE	R		2			F16/S17	46/47
ENGL 1B – Composition II (C2–Letters)	R			3		F16/S17	25
GE Area A1 – Oral Communication	SE			3		F16/S17	25
<b>Fall Semester – Year 2</b>							

MATH 32 – Calculus III (B4–Mathematical Concepts) <sup>3</sup>	R	3		3		F16/S17	146
PHYS 51 – General Physics/Electricity & Magnetism (B1–Physical Science & B3– Laboratory Science) <sup>3</sup>	R	4				F16/S17	49/18
MATE 25 – Introduction to Materials	R		3			F16/S17	90
AMS 1A – American Civilization (C1–Arts, C2–Letters, D–Social Science & US American Institutions when completed with AMS 1B)	SE			6		F16/S17	35
<b>Spring Semester – Year 2</b>							
MATH 133A – Differential Equations	R	3				F16/S17	171
PHYS 52 – Heat & Light (B1–Physical Science & B3– Laboratory Science) <sup>3</sup>	R	4				F16/S17	52/18
EE 98 – Intro to Circuit Analysis	R		3			F16/S17	79
AMS 1B – American Civilization (C1–Arts, C2–Letters, D–Social Science & US American Institutions when completed with AMS 1A)	SE			6		F16/S17	35
<b>Fall Semester – Year 3</b>							
MATH 129A – Linear Algebra	R	3				F16/S17	239/245
ENGR 100W – Engineering Reports (R–Earth & Environment & Z – Written Communication)	R			3		F16/S17	27
AE 138 – Vector-Based Dynamics for Aerospace Applications	R		3			F15/F16	67/79
AE 112 – AE Structural Analysis I	R		4			F15/F16	74/76
AE 160 – Aerodynamics I	R		✓ 3			F15/F16	84/89
<b>Spring Semester – Year 3</b>							
AE 114 – AE Structural Analysis II	R		3			S16/S17	80/54
AE 140 – Rigid Body Dynamics	R		3			S16/S17	67/77
AE 157 – Aerospace Automatic Control Systems Design	R		✓ 3			S16/S17	78/74
AE 162 – Aerodynamics II	R		✓ 3			S16/S17	77/79
AE 165 – Aerospace Flight Mechanics	R		3			S16/S17	65/71
<b>Fall Semester – Year 4</b>							
AE 164 – Aerothermodynamics	R		✓ 5			F15/F16	64/71
AE 168 – Aerospace Vehicle Dynamics & Control	R		✓ 3			F15/F16	60/73
AE 171A – Aircraft Design I <i>or</i> AE 172A – Spacecraft Design I (S–Self & Society)	SE		✓ 3	2		F15/F16	27/26 & 32/32
ENGR 195A – Global & Social Issues in Engineering I	R			1		F16/S17	193



(S–Self & Society)							
<b>Spring Semester – Year 4</b>							
AE 167 – Aerospace Propulsion		R		3		S16/S17	71/57
AE 169 – Computational Fluid Dynamics		R		3		S16/S17	66/63
AE 171B – Aircraft Design II <i>or</i> AE 172B- Spacecraft Design II (V–Culture, Civilization, and Global Understanding)		SE		✓ 3	2	S16/S17	26/27 & 33/31
ENGR 195B – Global & Social Issues in Engineering II (V–Culture, Civilization, and Global Understanding)		R			1	F16/S17	201
Technical Elective		E		✓ 3		F16/S17	10/32
<i>Add rows as needed to show all courses in the curriculum.</i>							
TOTALS-ABET BASIC-LEVEL REQUIREMENTS				33	61	52	
OVERALL TOTAL CREDIT HOURS FOR COMPLETION OF THE PROGRAM		120					
PERCENT OF TOTAL				27.5%	50.8%		
Total must satisfy either credit hours or percentage	Minimum Semester Credit Hours			32 Hours	48 Hours		
	Minimum Percentage			25%	37.5 %		

1. **Required** courses are required of all students in the program, **elective** courses (often referred to as open or free electives) are optional for students, and **selected elective** courses are those for which students must take one or more courses from a specified group.
2. For courses that include multiple elements (lecture, laboratory, recitation, etc.), indicate the maximum enrollment in each element. For selected elective courses, indicate the maximum enrollment for each option.
3. Units double-count in multiple subject areas.

Instructional materials and student work verifying compliance with ABET criteria for the categories indicated above will be required during the campus visit.

## CRITERION 6 – FACULTY

### A. Faculty Qualifications

Table 6.1 shows the qualifications and activity levels of full-time and part-time faculty directly supporting the BSAE Program. In reference to Figure 5.1, the tenured/tenure-track faculty of the Program cover the core areas of thermal-fluids, dynamics and control, and aerospace vehicle design. Aerospace structures are covered by adjunct faculty.

Typically, tenured/tenure-track faculty teach five of the eleven required BSAE courses (AE157, AE160, AE162, AE168, AE169), one of the technical electives (AE110) plus one of the senior design capstone sequence (AE172A&B). Our full-time adjunct (Ms. Hunter), who joined the AE Department in 1989 after retiring from ESL, has been the best instructor in the Department. She typically teaches two of our BSAE core courses (AE138, AE140), which she developed from scratch, introducing the vector-based approach to aerospace dynamics into our curriculum. Depending on departmental needs, Ms. Hunter also teaches AE165, AE112, and AE114. She developed AE112 as new course with aerospace applications to suit the needs of the BSAE Program and developed also the Aerospace Structures Laboratory to support AE112 and AE114 with six experiments. Ms. Hunter developed recently AE142 as a new AE elective and has been very effective supervising MSAE projects in astrodynamics.

Our new tenure-track faculty member Dr. Vergine will be teaching AE164 and AE167. He has been very active and well-published in the areas of high-speed aerodynamics and combustion at the University of Texas, Arlington. He is also very experienced with experimental work in these areas and will be developing our new high-speed aerodynamics lab in E107 to support AE164. With the addition of Dr. Vergine in AY17-18, nine (9) of the eleven (11) BSAE core courses will be taught by full-time faculty.

Our adjunct faculty bring contemporary industrial expertise into the classroom. Many of them have had a sustained affiliation with the University and the Department, and have been active in updating the curriculum and the laboratories.

Mr. Mendoza graduated from our Program in 1998. He moved to Kansas because of his passion for airplanes and has since been working for Cessna / Textron Aviation. He is currently the Manager for the Loads, Acoustics, and Structural Dynamics Group and is involved in advanced design and production. He has been teaching our aircraft design sequence (AE171A&B) and his excellent work with our seniors has earned us two first places in the AIAA Design-Build-Fly competition (2012, 2016), a 3<sup>rd</sup> place (2014), a 6<sup>th</sup> place (2013) and 10<sup>th</sup> place (2015, 2017). Mr. Mendoza also serves on the AE Advisory Board.

Ms. Ishaya, another graduate of our Program (BSAE 1998) is the founder, owner, and president of Bryza Wind Lab, a laboratory that specializes in wind tunnel testing,

anemometer calibrations, and test consulting services. She taught AE160 in Fall 2016 and offers summer internships to AE students.

Mr. Murbach is a Senior Scientist at NASA Ames Research Center. In collaboration with Dr. Papadopoulos, he has been developing the On-Demand Sample Return Capability (SPQR) (TechEdSat-4)<sup>17</sup>, which is a unique, drag-based de-orbit system based on the 'Exo-Brake.' This system permits a non-propulsive means of achieving the change in velocity required for a normal de-orbit, an important new development, as propulsive systems, even cold-gas, can introduce crew hazards inside the International Space Station. Mr. Murbach has been teaching our propulsion courses. He is also involved in our spacecraft design courses, supervises MSAE projects, and serves on the AE Advisory Board.

Dr. Swei is a Senior Research Scientist in the Intelligent Systems Division at NASA Ames Research Center. He has been teaching courses in aircraft and spacecraft dynamics and control (AE165, AE168, AE245, AE246). He is currently developing a new elective on UAVs, which he will be teaching in Fall 2017 (AE199). Dr. Swei also supervises MSAE projects and serves on the AE Advisory Board.

Mr. Westerwelle, another graduate of our Program (BSAE 2014), is a flight engineer at Space Systems Loral. Together with two more AE seniors, designed and built a rocket as part of their senior design project in AE172A&B. They launched their rocket from the dry lake bed of Black Rock, Nevada on September 13, 2014 to a record altitude of 55,373 ft, crushing the 2013 N-class motor record of 51, 238 ft. Mr. Westerwelle has since developed a new elective in Rocketry (AE166), which he has taught twice, offering many students an exciting opportunity for a hands-on project and helping them earn their Tripoli Level-2 certification.

Resumes of all AE faculty are included in Appendix B.

## **B. Faculty Workload**

The contractual workload for all full-time, tenure-line faculty in the California State University is 15 Weighted Teaching Units (WTUs) for each fall and spring semester. Typically, a faculty member would receive 12 WTUs in teaching assignments (a 3-unit course is 3 WTUs) and 3 WTUs for service to the university. Within the 12 WTUs for teaching, it is common to receive assigned time for administrative duties (e.g. chair, associate chair, designated academic advisor, committee service, etc.) and/or research (e.g. research incentives program, research fellowships, research grants, etc.). In addition, the College of Engineering provides 6 WTUs of credit to new tenure-track faculty per semester for the first two years, and they are expected to use this release time to develop their course materials, initiate their research program, and seek external funding in disciplinary research or engineering education areas.

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<sup>17</sup> <[https://www.nasa.gov/mission\\_pages/station/research/experiments/1815.html#publications](https://www.nasa.gov/mission_pages/station/research/experiments/1815.html#publications)>

The workload for the aerospace engineering faculty is shown in Table 6-2.

## **C. Faculty Size**

### **C.1 Instruction**

In regards to instruction, the number of full-time faculty has been inadequate to support both the BSAE and the MSAE programs. As a result, most of the required BSAE core courses have been taught by adjunct faculty. For example, seven (7) of the nine (9) upper division BSAE core courses in Fall 2016 and eight (8) of the (11) upper division BSAE core courses in Spring 2017 were taught by adjunct faculty. This situation is exacerbated by the fact that the College awards faculty 0.2 release time for each journal article or five conference papers they publish. On a positive note, a fourth tenure-track AE faculty member (Dr. Vergine) will join the Department in Fall 2017 and one additional tenure-line faculty member will be recruited in AY 2017-2018. If the search is successful, there will be six full-time faculty beginning Fall 2018: five tenure-line plus one full-time adjunct (Ms. Hunter).

### **C.2 Academic and Professional Advising**

Dr. Mourtos advises sophomores, juniors, and seniors (~250 students); Ms. Hunter advises freshmen (~ 60 students). Ms. Hunter's involvement in freshman advising is critical, as she leads the AE Learning Community Initiative, with a goal to improve retention and graduation rates by connecting freshmen and sophomores with upperclassmen through projects, on-demand tutoring, participation in student societies, and other social activities. In a survey performed in AY 2015-2016 students indicated that they were very satisfied with their academic advising (additional discussion on the quality of student advising is provided in Criterion 4). The effectiveness of AE advising is clearly demonstrated by the graduation rates of AE students, which are the highest in the College.

In addition to academic advising and classroom / laboratory teaching, AE faculty work closely with students through counseling and extra-curricular activities. Some of these faculty-student relationships continue after graduation. For example, BSAE alumni serve on the AE Advisory Board and/or teach AE courses. AE faculty spend additional time with students while mentoring chapters of our professional societies (AIAA, Sigma Gamma Tau) and other AE student clubs (Rocket Club, Design-Build-Fly, Students for the Exploration and Development of Space). AE faculty mentor student teams who participate in design competitions and engage students in research, often co-authoring papers with them, which students present at professional conferences. Finally, AE faculty provide students career guidance, help them obtain internships, summer jobs, and full-time jobs upon graduation.

### **C.3 University Service**

Dr. Mourtos is a faculty member in the SJSU Ed.D. Program<sup>18</sup>. He is currently supervising one candidate, who is expected to complete his thesis in the Fall 2017. He will also be teaching a course on Leadership, Complexity & Systems Thinking (EdD 512) in the Summer of 2018. As a member of the core faculty of the Ed.D. Program Dr. Mourtos participates in monthly faculty meetings of the Program faculty and is involved in the evaluation of applicants for every new cohort admitted into the Ed.D. Program. Dr. Mourtos is also involved in faculty development activities at the University level. For example, in the summer of 2016 he delivered two workshops to 19 faculty visiting from the Mercantec Institute in Denmark, as part of an annual institute organized by the College of Education. He also served on the 2016-2017 Recruitment Committee for SJSU Associate Dean for Graduate Studies.

Dr. Turkoglu currently serves on the SJSU Undergraduate Curriculum Committee

### **C.4 Interaction with Industrial and Professional Practitioners**

Dr. Mourtos, as the Chair of the Department, interacts with Industrial and Professional Practitioners on a regular basis and in a variety of settings. For example, he interacts with the members of the College Industrial Advisory Council and the members of the AE Advisory Board. AE alumni who work in local companies and government organizations (e.g. NASA) reach out to the Department for new hires providing opportunities for discussion on skills required for a variety of job assignments. In Fall 2016 Dr. Mourtos invited a group of engineers and managers from Space Systems Loral to make a presentation to AE students about work and career opportunities at the company.

Dr. Papadopoulos collaborates in his research with Mr. Murbach at NASA Ames Research Center on the development of On-Demand Sample Return Capability (SPQR) (TechEdSat-4) project<sup>19</sup>. He is very much involved with the Interplanetary Probe Workshop (IPPW<sup>20</sup>) in which he contributes every year with papers co-authored with AE students. In 2013, he brought the Workshop to SJSU<sup>21</sup>, again giving the opportunity to many AE students to present papers at the Workshop.

## **D. Professional Development**

The University, College, and Department offer various opportunities for professional development of faculty and staff. They are listed and described as follows:

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<sup>18</sup> < <http://www.sjsu.edu/edd/faculty/faculty-bios/index.html>>

<sup>19</sup> <[https://www.nasa.gov/mission\\_pages/station/research/experiments/1815.html](https://www.nasa.gov/mission_pages/station/research/experiments/1815.html)>

<sup>20</sup> <<http://esaconferencebureau.com/2017-events/ippw-14/home>>

<sup>21</sup> <<https://www.ippw10.com>>

## **D.1 SJSU Professional Development Opportunities**

The Office of the Provost offers funding for faculty Research, Scholarship, and Creative Activities (RSCA) annually. Faculty are required to submit a proposal for one-month of summer salary, one course release during the academic year, or for travel. The awardees are selected by the Office of the Associate Vice President of Research. Typically, the College of Engineering has 7-8 faculty receiving funding from this program, annually.

## **D.2 College of Engineering Professional Development Opportunities**

### **D.2.1 Professional development grants for faculty and staff**

Faculty and staff can apply to the College for up to \$1,500 and \$1,000, respectively, for registration and travel to workshops, conferences, and other training that benefits their work. The faculty applications are evaluated by the Associate Dean of Research. The staff applications are evaluated by a Staff Council, comprised of elected representatives from staff groups. Typically, there is \$50K per year for the program.

### **D.2.2 Research incentive program**

Tenure-line faculty can apply for course release for demonstrated scholarly achievements, which include peer-reviewed journal (and some conference) publications and externally funded government and industry research grants exceeding a minimum amount. This post-award initiative is intended to enable time for research active faculty to continue pursuing their successful endeavors. The amount of course release provided is determined through a point system, with a maximum of two courses of release per semester.

### **D.2.3 Faculty research professors**

Tenure-line faculty can apply for a \$40K - \$60K grant over two years in support of their research programs. The proposals for these grants are evaluated by the Research Committee, which is comprised of faculty representatives from each department. This program, funded by our endowments, was initiated in Fall 2015, and the competitive process resulted in 6 funded research professors.

### **D.2.4 Centers of excellence**

A competition was held in our college for funding multidisciplinary centers of excellence starting in Fall 2014, to seed the development of collaborative and substantial research expertise. Two centers of excellence were funded starting in Fall 2014, based on an extensive review process involving our industry advisory committee and other experts. The centers are awarded \$150K per year for two years, with the renewal for the second year being contingent upon the progress of the center. Both centers involve 10-15 faculty from diverse departments working on a common research theme. The two current centers are:

- Smart Technology, Computing, and Complex Systems (STCCS). Lead department is Computer Engineering.
- Center for Service Systems Engineering and Innovation (CSSEI). Lead department is Industrial and Systems Engineering.

### **D.3 AE Department Professional Development Opportunities**

In regards to teaching, the Department offers a full-day workshop on course design and assessment (see discussion in Criterion 8 – Section E.2.1 and Appendix G) to introduce all new faculty (tenure-line as well as adjuncts) to course learning objectives, assessment requirements and methods, as well as alternative teaching methods.

Professional development funds are limited at the department level, however, there are multiple opportunities and funds available for all AE faculty to attend at least one conference / short course every year. To maximize the availability of resources, faculty are expected to first apply for College Professional Development funds. Dr. Mourtos and Dr. Turkoglu have each received \$ 2,000 per year for the past several years from College professional development grants. If a faculty member does not receive a College grant, the Department provides support typically up to \$ 2,000 depending on the availability of departmental funds. New faculty members with startup funds available are expected to use them for conference travel, to allow also senior faculty access to the limited departmental funds. However, when startup funds are exhausted, and while they are still on their probationary appointment, new faculty are given priority for departmental funds over senior faculty. This approach ensures that all faculty in the Department, whether junior, mid-career or senior, have opportunities for professional development and engagement in scholarly activities. At the same time, it ensures that new, probationary faculty are sufficiently supported in their scholarly activities.

Dr. Mourtos regularly participates in professional development activities related to (a) pedagogy, (b) leadership, and (c) aircraft design, his technical area of expertise. For example, in June 2017, he participated in a workshop on Flipped Learning at SJSU, as part of his preparation to flip AE271 in Fall 2017. In 2016, he attended a short course on UAV Design at UCLA and two conferences, the Sustainable Aviation Symposium and the CAFÉ Electric Aircraft Symposium, both in San Francisco. He also took with him to attend these conferences three undergraduate students, who showed interest in electric aircraft. In 2015, he participated in a CSU-sponsored workshop for new department chairs at CSU Long Beach.

## **E. Authority and Responsibility of SJSU Faculty**

San Jose State University has a strong history of collegial governance, and this is reflected in the processes of course and program creation, modification, and evaluation. The curriculum is owned by the faculty in the program, and any process involving the curriculum begins with them. Any faculty member can propose a new course, an experimental course, minor course changes, new degree programs, changes to degree programs, new minors, changes to minors, or new certificate programs. The proposal is

reviewed and discussed by the curriculum committee or by the faculty in the department and if approved, reviewed by the department chair. If the department chair approves, the proposal is submitted to the college curriculum committee for review. If the college curriculum committee approves by majority vote, it moves to the associate dean for review and approval. After the associate dean, the curriculum proposal is submitted to the Office of Graduate and Undergraduate Studies (GUP), under the Office of the Provost. The Office of GUP maintains forms required for the process and the course catalog; the course catalog is updated once per semester.

Minor course change proposals can bypass the college curriculum committee review, if the associate dean deems the changes to be minor enough to not impact other departments in the college. New degree program proposals undergo a more complex procedure, and require the approval of the Chancellor's Office of the California State University. The proposal due to GUP requires the signature of the proposer, department chair, associate dean, and library liaison, who checks our collections to ensure that we have the library resources required. An updated syllabus is required that meets our campus requirements for accessibility and program review, and complies with applicable curriculum policies.

The faculty in the program are collectively responsible for the definition and revision of the program educational objectives, student outcomes, and assessment of student outcomes. Their role and authority in curriculum development and maintenance supports their ability to make the changes necessary to attain the student outcomes, and design a curriculum that meets their program educational objectives.

Curriculum policies for the university are brought forth by the Academic Senate, comprised of elected faculty representing all colleges. Policies that are approved by the Academic Senate are forwarded to the President for approval, at which point they are posted as University Policies. Current curriculum policies encompass requirements and guidelines for course syllabi, credit hour policy, general education, graduation, majors, minors, concentrations, and certificates.

The Board of Academic Freedom and Professional Responsibility is a faculty committee of the Academic Senate that makes recommendations to the Senate and University as necessary. They address complaints of academic freedom in consultation with the Office of Faculty Affairs, including those involving infringement of curriculum rights.

### **E.1 Authority and Responsibility of AE Faculty**

The following serve as recent examples of AE faculty (tenure-line as well as adjunct) exercising their authority and responsibility to create / modify courses in recent years, to keep the BSAE Program current and better serve the needs of our constituents:

- Dr. Mourtos proposed and established as permanent courses AE15, AE160, AE164, AE262, AE264, and AE271 and developed the aerodynamics, propulsion, and aircraft design laboratories in support of AE160, AE162, AE262, AE167, AE171A&B, and AE271.



- Dr. Papadopoulos proposed and established as permanent courses AE169, AE269, AE280.
- Dr. Turkoglu proposed and established as permanent courses AE30, AE157, AE200, AE247 and developed the Flight Control Systems & UAV and the Control Science & Dynamic Systems laboratories in support of AE157, AE168, AE200, AE245, AE246, and AE247.
- Ms. Hunter (adjunct faculty member) proposed and established as permanent courses AE112, AE138, AE140, AE142, AE243 and developed the Aerospace Structures Laboratory in support of AE112 and AE114.
- Mr. Benzio (adjunct faculty member) proposed and established as permanent course AE20.
- Mr. Mendoza (adjunct faculty member) proposed and established as permanent course AE273.
- Mr. Westerwelle (adjunct faculty member) proposed and established as permanent course AE166.
- Dr. Swei (adjunct faculty member) has proposed a new permanent course on UAVs (AE173). It will undergo review in Fall 2017 to become a permanent course.

AE faculty modify their courses as they see fit to meet their course learning objectives. The AE workshop on course design as well as discussions during Department meetings help establish (a) realistic course goals and learning objectives based on topics of interest in each course, (b) authentic assessment methods and rubrics for assessing complex course learning objectives, (c) effective pedagogies that help students achieve course learning objectives, and (d) ways to implement effective course changes, when performance targets are not met. AE faculty also have a strong input in drafting, modifying, and approving the BSAE Program Education Objectives.

**Table 6-1. Faculty Qualifications**

**Aerospace Engineering Program**

Faculty Name	Highest Degree Earned- Field and Year	Rank <sup>1</sup>	Type of Academic Appointment <sup>2</sup> T, TT, NTT	FT or PT <sup>3</sup>	Years of Experience			Professional Registration/ Certification	Level of Activity <sup>4</sup> H, M, or L		
					Govt./Ind. Practice	Teaching	This Institution		Professional Organizations	Professional Development	Consulting/summer work in industry
Nikos J. Mourtos	PhD AAE 1987	P	T	FT	0	32	32	Prof. Engr. License Mechanical - Greek Technical Chamber	H	H	L
Periklis Papadopoulos	PhD AAE 1993	P	T	FT					H	L	H
Kamran Turkoglu	PhD CS & Dyn. Systems 2012	AST	TT	FT					H	L	L
Fabrizio Vergine	PhD AE 2014	AST	TT	FT					L	L	H
Arun Banerjee	PhD ME 1969 & 1972	A	NTT	PT	37	27	20		L	L	L
Robert Benzio	BSAE 2003	A	NTT	PT	10				L	L	H
Alexander Carlozzi	MSAE 2015	A	NTT	PT		2	2		L	L	H
Jeanine Hunter	MS AAE 1981	A	NTT	FT					L	L	L
Rachael Ishaya	MS Mech&Aero Engr. 2004	A	NTT	PT	29	7	1		M	L	H
Darryl LeVasseur	BSAE 2013	A	NTT	PT					L	L	H

Lorenzo Limonta	PhD AAE 2017	A	NTT	PT					L	L	L
Long K. Lu	MSAE 2015	A	NTT	PT	0	2	2		L	M	L
Gonzalo E. Mendoza	MSAE 2008	A	NTT	PT	19	6	6		H	L	H
Sean Montgomery	MSAE 2013	A	NTT	PT	5	4	4		L	L	L
Davon Mukhar	MSAE 2016	A	NTT	PT					L	L	H
Marcus S. Murbach	MSME 1987	A	NTT	PT	30	9	9		M	M	H
Jimmy Rico	MSAE 2016	A	NTT	PT	1	1	1		L	L	L
Dimitrios Soukeras	MBA(ER) 2010	A	NTT	PT					H	H	H
Sean Swei	PhD AAE 1993	A	NTT	PT	24	13	10		H	M	L
Jay Westerwelle	BSAE 2014	A	NTT	PT					L	M	H
Cecilia Larrosa Wilson	PhD AAE 2013	A	NTT	PT	5	4	4	Prof. Engr. License Mechanical	M	M	H

1. Code: P = Professor ASC = Associate Professor AST = Assistant Professor I = Instructor A = Adjunct O = Other

2. Code: TT = Tenure Track T = Tenured NTT = Non-Tenure Track

3. At the institution

4. The level of activity, high, medium or low, should reflect an average over the year prior to the visit plus the two previous years.

**Table 6-2. Faculty Workload Summary**

**Aerospace Engineering Program**

Faculty Member	PT or FT <sup>1</sup>	Classes Taught (Course No./Credit Hrs.) Term and Year <sup>2</sup>	Program Activity Distribution <sup>3</sup>			% of Time Devoted to the Program <sup>5</sup>
			Teaching	Research or Scholarship	Other <sup>4</sup>	
Nikos J. Mourtos		Fall 2016: AE271 (3hrs); AE295A&B/AE299 (3hrs) Spring 2017: AE295A&B/AE299 (3hrs)	20%	20%	60%	100%
Periklis E. Papadopoulos		Fall 2016: AE172A (3hrs); AE210 (3hrs); AE269 (3 hrs) Spring 2017: AE169 (3hrs); AE172B (3hrs); AE267 (3hrs)	60%	20%	20%	100%
Kamran Turkoglu		Fall 2016: AE 200 (3hrs); AE295A&B/AE299 (3hrs) Spring 2017: AE 157 (3hrs); AE 246 (3hrs)	40%	40%	20%	100%
Arun Banerjee	PT	Spring 2017: AE 114 (3hrs)	20%			20%
Robert Benzio	PT	Fall 2016: AE 20 (5hrs) Spring 2017: AE 20 (5hrs)	33%			33%
Alexander Carlozzi	PT	Fall 2016: AE 164 (5hrs)	33%			33%
Jeanine Hunter	FT	Fall 2016: AE 138 (3hrs); AE 168 (3hrs) Spring 2017: AE 140 (3hrs); AE 199 (3hrs)	40%		60%	100%
Rachael Ishaya	PT	Fall 2016: AE 160 (3hrs)	20%			20%
Darryl LeVasseur	PT	Fall 2016: AE 110 (3hrs)	20%			
Lorenzo Limonta	PT	Fall 2016: AE 280 (3hrs)	20%			
Long K. Lu	PT	Fall 2016: AE 30 (5hrs) Spring 2017: AE 30 (5hrs)	33%			33%
Gonzalo E. Mendoza	PT	Fall 2016: AE 171A (3hrs)	20%			20%

		Spring 2017: AE 171B (3hrs)				
Sean Montgomery	PT	Fall 2016: AE 15 (1hr); Spring 2017: AE 262 (3hrs)	20%			20%
Davon Mukhar	PT	Spring 2017: AE 162 (3hrs)	20%			20%
Marcus S. Murbach	PT	Spring 2017: AE 167 (3hrs)	20%			20%
Jimmy Rico	PT	Fall 2016: AE 199-UAVs (3hrs)	20%			20%
Dimitrios Soukeras	PT	Spring 2017: AE 297 (3hrs)	20%			20%
Sean Swei	PT	Spring 2017: AE 165 (3hrs)	20%			20%
Jay Westerwelle	PT	Spring 2017: AE 199-Rocketry (3hrs)	20%			20%
Cecilia Larrosa Wilson	PT	Spring 2017: AE 250 (3hrs)	20%			20%

1. FT = Full Time Faculty or PT = Part Time Faculty, at the institution
2. For the academic year for which the Self-Study Report is being prepared.
3. Program activity distribution should be in percent of effort in the program and should total 100%.
4. Indicate sabbatical leave, etc., under "Other."
5. Out of the total time employed at the institution.

## CRITERION 7. FACILITIES<sup>22</sup>

### A. Offices, Classrooms and Laboratories

#### A.1 Aerospace Engineering Office Suite

All full-time, tenure-line faculty members in the Department have their own office in the AE Office Suite. Faculty offices are between 110 and 150 square feet, and include a desk, computer, phone, whiteboard, bookshelves, and a file cabinet. Internet is available through Ethernet, and wi-fi is available throughout the building. Unfortunately, due to lack of space in the College all part-time faculty in the AE Department share one office (E272E). The only exception is Ms. Hunter, a full-time lecturer, who contributes to the AE Department as a tenure-line faculty member and has therefore been assigned her own office (E272F).

The AE Office suite includes a conference room, equipped with a state-of-the-art multimedia screen. The administrative assistant (Ms. Wilcox) has a desk in the office suite, which is shared with one student assistant. Teaching assistants (ISAs) are provided with desk space and desktop computers in the laboratories.

#### A.2 Classrooms

The Engineering Building contains lecture rooms shared by all programs in the College of Engineering. The classroom capacities are listed in Table 7.1. Once these are full, additional sections are scheduled in the university classrooms through the Academic Scheduling Office.

Table 7.1 – Engineering lecture rooms

Room	Type	Seat Cap.	LCD Proj.	Board Type	Equipment and Remarks
232	Lecture	42		3C/2W	Pull-down projector screen
301	Lecture	40		3W	TV & clock, fixed tables.
303	Lecture	42	1	3W	TV, powered projection screen, clock, phone, LCD.
327	Lecture	31	1	2W	Pull-down Projector screen, TV, overhead projector & clock, LCD.
329	Lecture	81	1	3W/1C	Pull-down projector screen, TV, overhead projector & clock, LCD.

<sup>22</sup>Include information concerning facilities at all sites where program courses are delivered.

331	Lecture	80	1	3W/1C	Pull-down projector screen, TV, overhead projector & clock, LCD, SMART.
335	Lecture	22		3W	Clock, phone & pull down projector screen.
336	Lecture	29		1C/2W	Pull-down screen, clock & phone.
338	Lecture	20		W	TV & pull-down screen.
339	Lecture	64	1	5W	TV on roller, phone, clock & pull down screen, LCD.
340	Lecture	42	1	2W	Pull-down screen, LCD.
341	Lecture	88	1	3W/1C	Clock, phone, speaker system, and, pull-down projector screen, LCD, SMART.
343	Lecture	84	1	3W/1C	Clock, pull-down screen, TV & speakers, LCD, SMART.
395	Lecture	34		2W	
401	Lecture	39		3W	Overhead projector, TV on roller, powered-down screen, clock & phone, SMART.
403	Lecture	43		3W	Overhead projector, TV on roller, powered-down screen, clock & phone.
405	Lecture	44		W	Attached door to room 407.

Nearly all classrooms are equipped with projection, speakers, whiteboards, and wi-fi, and there are plans to update the few rooms without projection and speakers in the near future. Several of the rooms also have document cameras.

The College of Engineering also manages a 210-seat auditorium (Room 189), several meeting rooms (335, 285/287, 493, and 494H), and an open study area on the third floor. The auditorium is regularly used for professional presentations, symposiums, and for large class lectures and exams. The meeting rooms are used for faculty and staff meetings and events. All of these rooms are equipped with projection capability and audio. Furthermore, Room 189 has sliding whiteboards, and Room 494H is equipped with Cisco telepresence, allowing for video conferencing.

The AE Program can also schedule courses in the computer laboratories maintained by the Engineering Computing Services in the College of Engineering.

The labs are equipped with discipline-specific and general engineering software. These rooms include 388, 392, 384, 333, and 407. AE 20 and AE30 are typically scheduled in these rooms. In addition, the College has an open computer lab, Room 390, that is open from 7am-11pm Monday through Friday during the semesters to all students in the College.

Due to shortage of University and College classrooms, the AE Department schedules many AE classes in the AE Multimedia Classroom and Laboratory (E164). The Engineering Computing Services (ECS) provides all the necessary support for the software and the hardware in this lab, which includes 30 computers used exclusively by AE students. The multimedia classroom includes a state-of-the-art teaching console with Elmo, instructor's terminal, switch box, and four TV screens to ensure that students seated anywhere in the room can follow a presentation. The room is also equipped with 18 round tables to facilitate cooperative learning during class sessions. However, the use of this laboratory as a classroom limits the availability of the computer lab to AE students. AE needs a new designated classroom or the ability to schedule all AE classes in university / college classrooms.

### A.3 Laboratories

The AE laboratories are listed in Table 7.2. Figure 7.1 illustrates how the various laboratories support the BSAE curriculum and in particular the capstone senior design experience. A short description of each lab follows in this section. A more detailed list of equipment and experiments performed in each lab is presented in Appendix C.

Table 7.2 – Aerospace Engineering laboratories

<i>Name</i>	<i>Room</i>	<i>Floor Space (ft<sup>2</sup>)</i>	<i>Director</i>
Aerodynamics	E107	1,357	Dr. Vergine
Propulsion	E164	340	Dr. Vergine
AE Multimedia Classroom & Laboratory	E164	2,521	Dr. Mourtos
Aerospace Structures	E164A	285	Prof. Hunter
Flight Control Systems; UAV, Control Science & Dynamic Systems	E164C	340	Dr. Turkoglu
Space Systems Engineering Laboratory	E236	1,318	Dr. Papadopoulos



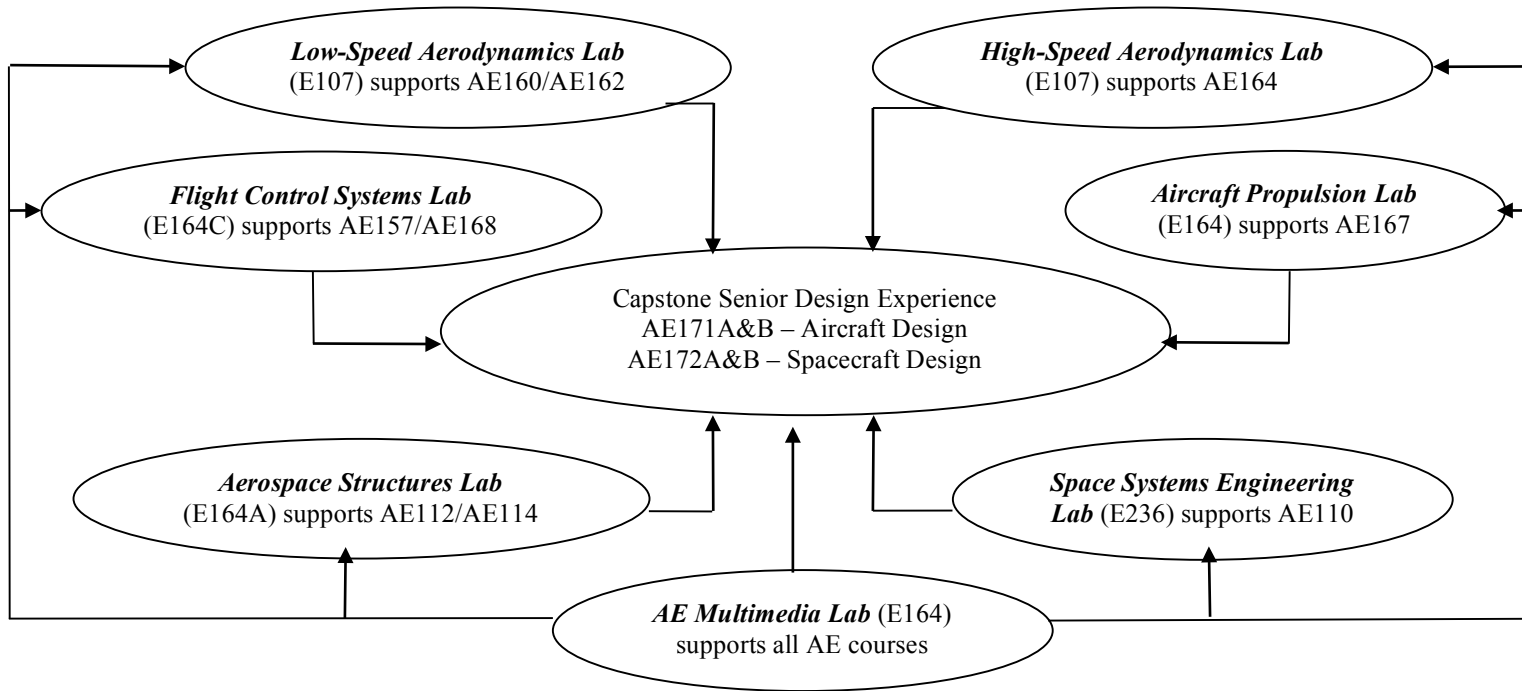


Figure 7.1 – BSAE curriculum laboratory support.

### *Aerodynamics Laboratory*

The purpose of the Aerodynamics Laboratory is to provide students with experiments and flow visualization in low subsonic and supersonic aerodynamics. The Subsonic Aerodynamics Laboratory includes two major pieces of equipment: an open circuit wind tunnel and a water tunnel. Experiments in the wind tunnel include pressure distributions on airfoils, lift and drag measurements of wings and other aerodynamics bodies and boundary-layer measurements. Flow visualization includes study of low and high-angle-of-attack flow patterns around airfoils, conical bodies and delta wing aircraft. The laboratory supports AE160, AE162, and AE262 as well as any graduate or undergraduate student projects involving wind tunnel testing.

The Supersonic Aerodynamics Laboratory will provide students with experiments in supersonic flow and visualization, including familiarity with instrumentation and data acquisition software (LabVIEW), Schlieren / shadowgraph techniques for shock and expansion waves visualization, nozzle flow characterization, intrusive pressure and temperature measurements for free-stream flow characterization, measurement of aerodynamic forces on bodies in supersonic flows and comparison with theoretical models. The laboratory will support the

following courses: AE164, AE264, AE280 as well as any graduate or undergraduate student projects involving supersonic wind tunnel testing.

The Aerodynamics Laboratory includes also a 3D printer in support of student projects. For example, in AE162 in Spring 2017, student teams designed an open-ended experiment, which they later performed in the wind tunnel. The 3D printer generated all the models for these projects. Mr. Meininger, Manufacturing Lead in Central Shops, supervises the use of the 3D printer. Students submit a request with appropriate drawings, based on which Mr. Meininger provides a cost estimate. The Department Chair approves – depending on the cost and availability of funds – and the model is then produced.

### *Aerospace Propulsion Laboratory*

The purpose of the Aerospace Propulsion Laboratory is to provide students with experiments in thermodynamic and flowdynamic analysis of jet engines. It comprises of two major pieces of equipment: a Pratt & Whitney JT3C turbojet engine used to explain various engine parts and a gas turbine with control panel. The Laboratory supports AE167.

### *Aerospace Structures Laboratory*

The purpose of the Aerospace Structures Laboratory is to demonstrate structural concepts in the design and analysis of aerospace vehicles, such as bending and torsional strain and stress, shear flow, shear center, nodal displacement, natural frequency and mode shape. Furthermore, students learn how to design experiments and how to use strain gage technology and the attachment technique. The laboratory supports AE112 and AE114.

### *Flight Control Systems & UAV Laboratory*

The focus in Flight Control Systems and UAV Laboratory is the analysis and implementation of control theories on atmospheric and space flight systems. Students perform (real-time) trajectory optimization, real-time optimal guidance and flight strategies, apply multivariable robust control techniques (such as H-infinity, mu-synthesis, D-K iteration, ...) time-delayed systems, orbital mechanics, spacecraft attitude determination and control and their vast application on UAVs, aircrafts and satellites. The laboratory supports AE157, AE168, AE200, AE245, and AE246.

### *Space Systems Integration Laboratory*

The Space Systems Laboratory engages in cutting-edge research projects with the goal of directly contributing to the present and future exploration and development of space. The objective of the laboratory is to explore innovative concepts for the design and integration of future space systems, and train the next generation of aerospace engineers.

The original Space Systems Laboratory helped with the development of the TechEdSat I, II, III and IV<sup>23</sup> spacecraft and provided a laboratory environment to support NASA, and other researchers with a long term, replenishable, and upgradable testbed for the validation of on-orbit space-qualified systems. Students perform space systems design, integration, and manufacturing in projects for AE110, AE172A&B, and AE210.

Currently the AE laboratory space is not adequate to meet student or programmatic needs for the following reasons:

- (a) There is a need for a designated AE Student Projects space. Due to lack of such space, AE students currently use tents in the Engineering Courtyard for building their airplanes rockets. These tents do not provide adequate space and they are not safe for storing student projects, not to mention the weather conditions during the winter.
- (b) The designated club room in E240 (240 ft<sup>2</sup>) is entirely inadequate for housing five AE clubs (AIAA, SEDS, Rocket, DBF, and Sigma Gamma Tau) in a program with almost 400 majors.
- (c) The extensive use of E164 as a classroom limits student accessibility to their dedicated AE Computer Lab as well as their only space available for student teamwork.

## **B. Computing Resources**

University-wide computing resources are available to all students at SJSU. The SJSU Academic Technology Computer Center is located centrally in the Clarke Building on campus, and is open from 8am to 10pm Monday through Thursday, and from 8am to 5pm on Fridays, during session. The computers include Macs and PCs, and are equipped with general purpose software, including programs from Adobe and Microsoft.

The Associated Students also offer a computer lab open in the Student Union from 8am to 10pm Monday through Thursday, 9am to 5pm Friday, and 10am to 4pm Saturday, during session, in addition to installation, computer repair, laptop rentals, copying, faxing, scanning, and e-Waste disposal. The Martin Luther King Library, jointly owned by SJSU and the city of San Jose, has a Student Computing Services Center, which provides free laptop, MacBook Pro, and iPad loans for SJSU students, faculty, and staff. On-campus residents are provided with internet, telephone, computer lab, and a study room with computers. The Campus Village Computer Lab is open from 3pm to 11pm during the week, 2pm to 6pm on Friday and Saturday, and 7pm to 11pm on Sundays.

The Aerospace Engineering Multimedia Laboratory (E164) is designed for the exclusive use of AE students to provide support for all their coursework, workspace staging areas, bibliographic data systems, networked high-power

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<sup>23</sup> < [http://www.nasa.gov/mission\\_pages/station/research/experiments/1815.html#overview](http://www.nasa.gov/mission_pages/station/research/experiments/1815.html#overview) >

workstations, and electronic data bases. It includes 30 computers, fully supported by the Engineering Computing Services and is open 8 am–11 pm Monday through Friday as well as on the weekends during the fall and spring semesters. The Laboratory is also open with a reduced schedule during the winter and summer sessions.

### **C. Guidance**

Course experiments in all the laboratories are performed under supervision of trained laboratory assistants, who are usually graduate students. Students who wish to use the College machine shop facilities are required to take a safety course (ME 041).

### **D. Maintenance and Upgrading of Facilities**

In regards to tools and equipment used in instructional laboratories, low-cost items are replaced immediately, if necessary, using department funds. If an item costs more than our annual Department budget can bear, and is critical for providing laboratory experience to our students, a request is made to the College for emergency funds. This scenario is very rare and has not occurred since the last accreditation visit.

In terms of acquiring new and expensive equipment, which would certainly be outside the departmental annual budget, the AE Program (prior to 2013) and the AE Department (after 2013) have periodically received additional equipment funds of the order of ~ 100 K from the College, for the purpose of buying new, expensive pieces of equipment or replacing old and expensive items. For example, AE has acquired the wind tunnel (2011, ~ 75 K), the jet engine (2013, ~ 45 K), and the equipment for our new high-speed aerodynamics lab (2017, ~ 100 K) from such funds.

The University also offers a Computer Refresh Program, to ensure that all faculty and staff have a good working computer. The program pays up to \$1,000 every four years for each faculty and staff member to get a new computer.

Four years ago there was a one-time funding approved by the president to refresh all computer labs<sup>24</sup>. Lab computers in the AE Multimedia Classroom and Laboratory (E164) are now at their four-year mark, as do computers in E107, E236, E240 (AIAA Club Room), and E164C, which were all replaced in 2013. Campus is going to invest in a new solution for computer labs, namely to virtualize them. There will be a split cost model involved in this new process, with details and implementation expected in fall 2017.

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<sup>24</sup> <<http://its.sjsu.edu/service-catalog/computers-devices-data-storage/workstation-refresh/>>

## E. Library Services

San Jose State University Library and San Jose Public Libraries have jointly developed and managed a library, Dr. Martin Luther King, Jr. Library since August 2003. This Library is the first joint library between a university and a city in the country. Its success can be measured by the dramatic increase in circulation statistics of SJSU faculty and students. Its success is also measured by the many awards it has received, including the prestigious national Thomson/Gale Library of the Year award.

The King Library is jointly managed by the Dean of the University Library, the Director of the San Jose City Public Library System, with four integrated key operational units: Access Services, Information Technology, Reference, and Technical Services. The Dean, Director, and key unit heads make up the King Management Team for issues of common concern. However, all academic and related collection development decisions are the sole responsibility of the University Library. Special attention is paid to areas in which collaboration may yield benefits.

Organizationally, the San Jose State University Library is in the Academic Affairs division. It is headed by the Dean of the University Library, who reports to the Provost. The library services are fully adequate for the needs of the AE Program.

### E1. Acquisitions and Expenditures

The following tables summarize library acquisitions and expenditures over the last five years.

Table 7.3 – SJSU library acquisitions

Summary of Acquisitions	Current total holdings	Books Added 2010 - 2014
Engineering	87,302	10,634
Related Subjects	206,217	28,866

Table 7.4 – SJSU library expenditures

Summary of Expenditures	2010/2011	2011/2012	2012/2013	2013/2014
Budget for Collections Management	\$ 2,355,690	\$ 2,465,023	\$ 2,466,289	\$ 2,719,828
Total Engineering Funds	280,398	281,822	314,323	355,440
Books	21,401	9,415	4,344	11,155
eBooks	28,711	29,517	40,055	54,307
Periodicals	5,790	6,808	4,597	5,485
eJournals	1,420	6,254	9,818	6,145
Electronic Resources	50,023	41,019	43,187	45,293
Additional funds for electronics resources	\$ 169,580	\$ 183,526	\$ 210,716	\$ 233,054

\* Refers to State general funds. They do not include gifts, donations, and grants.

## **E2. Printed Engineering Collection**

The Engineering collection consists of books classified in the Library of Congress call numbers of HD, HE, T, TA, TC, TD, TE, TF, TG, TH, TJ, TK, TL, TN, TP, and about 50% of the TS area. About 25% to 30% of the QA books are purchased for engineering. These include QA76 for the subjects of Control Systems/Theory, Optimization, Operations Research, and QA901-931 for the subjects of Hydrodynamics, Fluid Mechanics and Elasticity. Related subject areas include Biology, Chemistry, Computer Science, Environmental Studies, Geology, Math, Medicine, and Physics. The ranges of call numbers are GE, GF, QA, QB, QC, QD, QE, QH, QM, QP, QR, S, SB, SD, SF.

Engineering related materials are acquired through the joint efforts of the engineering collection development librarians and the engineering faculty. Recommendations are encouraged from students and are honored if the subject matter is appropriate and funds are available. Books are purchased through the Yankee Book Peddler approval plan, from other vendors, and directly from professional societies. The engineering librarians attend the College of Engineering Curriculum Committee, and work closely with engineering faculty to coordinate purchases of library materials to meet the needs of the changing engineering curricula.

## **E3. Electronic Resources**

Access to SJSU's library collection is through an online catalog searchable in the King Library and from remote sites both on and off campus. Users may search by title, author, subject, keyword, call number, and other standard numbers. During the last five years, many ebooks are added to the collection. Students and faculty can easily read ebooks online anywhere at any time via personal computer or other digital devices.

There are many Internet access stations in the King Library. Starting with the Library Home Page <http://library.sjsu.edu>, there are links to a large variety of the World Wide Web based electronic resources. A total of more than 300 full-text and bibliographic databases are available for students and faculty to use. Among them, fifteen are the essential engineering related databases, namely, Academic Search Premier, Aerospace and High Technology Database, ACS Publications, ACM Digital Library, ASCE Database, ASME Digital Library, Engineering Village, GeoRef, INSPEC, IEEE Xplore, ScienceDirect, SciFinder Scholar, SPIE Digital Library, Web of Science, and Wiley Online Library. Most of these databases have full-text coverage, so that students and faculty can print or download the complete articles they want to read.

In addition, the Library subscribes to ProQuest Dissertations & Theses, a primary database for doctoral dissertations and master's theses which is an essential

resource for student and faculty research. More recently, the Library has launched SJSU ScholarWorks, a digital service representing scholarship of SJSU faculty and students. Its primary goal is to provide access to and preserve the unique work of the SJSU community.

#### **E4. Reference Services**

The King library is open 8am-1am Monday through Thursday, 8am-6pm on Fridays, 9am-6pm on Saturdays, and 1pm-1am on Sundays. The Library's person-to-person reference services are available to students and faculty 62 hours per week in the Library. In addition, the reference questions are also answered by telephone, by email, and through the live online reference service. Users are encouraged to select the most appropriate type of help through the Reference Help-Ask a Librarian Web Page (<http://library.sjsu.edu/ask-librarian-0>).

#### **E5. Interlibrary Services**

Interlibrary Services (ILS) provides access to materials not owned by the San Jose State University Library. Link+ and ILLiad are the two interlibrary loan services. Users can place a request electronically by filling out a form through the Library's web page. Users can request books, periodical articles and materials of other types. San Jose State University is a member of Link+, a book request service and union catalog that allow SJSU faculty and students to borrow books unavailable at SJSU from other academic or public libraries in California. ILLiad is able to borrow from virtually any library in the world willing to lend from their collections. These services are free for students and faculty.

#### **E6. Professional Engineering Librarians**

There are two library faculty members who are subject specialists in engineering. These engineering librarians, with professional information degrees, have extensive knowledge of the nature and organization of engineering information and a good understanding of the information-seeking behavior of engineering students and faculty. With their knowledge and understanding, they are able to provide in-depth research assistance to students and faculty when requested, as well as to collect engineering materials for the library according to the engineering curriculum requirements, faculty research interests, and student needs. The engineering librarians are also responsible for instruction in library research.

The library services are fully adequate for the needs of the AE Program.

## **F. Overall Comments on Facilities**

SJSU acts in accordance with Executive Order 1039 of the CSU, which mandates the development and enforcement of appropriate injury and illness prevention programs (IIPP). The SJSU IIPP is found here ([http://www.sjsu.edu/fdo/docs/EHS SJSU IIPP.pdf](http://www.sjsu.edu/fdo/docs/EHS_SJSU_IIPP.pdf)). The College of Engineering IIPP is here (<http://engineering.sjsu.edu/facilities/health-and-safety>). The administering agency is the State of California, Department of Industrial Relations, Division of Occupational Safety and Health (Cal/OSHA). Our facilities are subject to unannounced, periodic inspections by Cal/OSHA.

All labs in the College of Engineering containing hazards are subject to monthly safety inspections by the Building Coordinator and Safety Specialist. Hazards in our college include chemicals, batteries, machinery, compressed gas, heights, extreme temperatures, and high voltage. Furthermore, labs with chemical hazards are subject to campus inspections by the SJSU EH&S staff once a semester. Lab directors are ultimately responsible for ensuring safety within their labs. Technicians are required to take safety training appropriate for their departments. Lab directors and students are required to complete a short online training course and pass a safety quiz prior to being granted access to the labs in question.

The College of Engineering maintains building hours between 7am to 10pm during the week, and 8am to 8pm during the weekends during the semesters. Only faculty and staff have access to the building outside of these hours. Students may apply for a building key card or lab access code only if: (1) no hazards will be involved in their work or appropriate supervision is available, and (2) the lab director approves.



## CRITERION 8. INSTITUTIONAL SUPPORT

### A. Leadership

The Aerospace Engineering Department Chair is Dr. Nikos J. Mourtos. Following a joint recommendation from the AE and the ME faculty, the Aerospace Engineering Program was separated from the Mechanical & Aerospace Department effective **19 August 2013**. Dr. Mourtos was then appointed AE Program Director by Dean Andrew Hsu. For all practical purposes, the AE Program operated as an independent department for three academic years (2013-14 through 2015-16). The Director participated in the College Council of Chairs and was given full authority as well as a budget to run the AE Program during this time. An AE faculty member represented the Program on each and every College committee.

Following a petition from the AE faculty (Appendix I), Dean Andrew Hsu, with consent from the Provost, re-established the Aerospace Engineering Department effective **22 August 2016**. The AE faculty held elections in April 2016 and Dr. Mourtos was elected unanimously Chair of the newly re-established AE Department.

The responsibilities of the department chair include fiscal management of the department, faculty assignments and course scheduling, mentoring and evaluation of probationary faculty, appointment, mentoring, and evaluation of adjunct faculty, and general oversight over department accreditation, academic advising, curriculum, and vision.

The Department of Aerospace Engineering is housed in the College of Engineering at SJSU. The Dean of Engineering is Sheryl Erhman, as of Summer 2017. Prior to this, the Interim Dean was Dr. Ping Hsu (2016-17), preceded by Dean Andrew Hsu (2013 – 2016), Interim Dean Ping Hsu (2012-2013), and Dean Belle Wei (2003 – 2012). There are three associate deans in the college. The Associate Dean of Engineering is Dr. Jinny Rhee, who oversees the undergraduate programs, personnel, and facilities in the college. The Associate Dean of Graduate and Extended Studies is Dr. Ahmed Hambaba, and the Associate Dean of Research is Dr. Essam Marouf. The Budget Analyst is Patricia Rodriguez, and she works with the deans and chairs on fiscal issues. The Academic Resources Manager is Molly Crowe, and she works with departments on faculty, staff, and student assistant hiring and employee relations. The Council of Chairs meets once a month, and the dean meets with each chair on a weekly basis.

As part of its shared governance, the departments in the college send faculty representatives to the following college committees, which contribute to policy and operations within the college:

- Undergraduate Curriculum Committee
- Graduate Studies Committee
- Research Committee
- Assessment Committee
- Sabbatical Committee (elected)
- Retention, Tenure, and Promotion Committee (elected)
- Designated Faculty Advisors

The Aerospace Engineering Department currently has four tenured / tenure-track faculty members, including the Chair. Due to the small size of the faculty, all faculty members participate in discussions on curricular and advising issues, research, and assessment. For this purpose, department meetings are held weekly to ensure a timely discussion and decision making on important issues. Ms. Hunter, an adjunct faculty member who has been with the Aerospace Engineering Department since 1989, is a full contributor to the AE Program and as such, participates in all AE Department meetings.

To meet the minimum number of three members for personnel committees, the Department solicits from the AE faculty nominees for one full-time, tenured faculty member from another department in the College. The membership of the AE Faculty Recruitment Committee as well as the AE Retention Tenure and Promotion (RTP) Committee is decided by secret ballot and consists of the two tenured professors plus the elected professor from outside the Department.

## **B. Program Budget and Financial Support**

### **B1. Process and Sources Used to Establish AE Department Budget**

The primary source of financial support for the department comes from the operating fund which provides funding for faculty and staff salaries as well as operating expenses. The department also receives financial support from four other funding sources: Student Success, Excellence and Technology Fee Fund, Continuing Education Revenue Fund, research grants, and donations and gifts.

#### *Operating Fund (CSUOF)*

The annual budget allocation for each department is determined by the Dean of the college with assistance from the college budget analyst. The department receives an allocation covering 100% of their fixed costs (tenure-line and staff salaries). For the most part, the allocation for temporary faculty is formula-driven. The formulas are based on each department fraction of the College FTES and includes incentives for non-resident FTES, large classes, lab sections and

SFR. The operating expenses allocation is based on the FTES ratio for each department. Table 8.1 shows the AE base budget for the last three years.

Table 8.1 – Aerospace Engineering CSUOF base budget

	<b>2014-15</b>	<b>2015-16</b>	<b>2016-17</b>
Academic Salaries	305,847	393,146	331,178
Department Chair	-	-	60,182
Support Staff Salaries	22,880	22,992	22,972
Temporary Faculty <sup>25</sup>	121,865	151,529	172,725
Operating Expenses	16,545	15,165	23,734
<b>Totals</b>	<b>\$467,137</b>	<b>\$592,832</b>	<b>\$610,791</b>

In addition to the base budget, departments receive Open University (OU) revenue in CSUOF at \$1,300/FTES per semester (\$2,600/FTES for the academic year). Prior to AY 2015-16, departments received 80% of the net allocation given to the college; starting in fall 2015, they receive 100%.

The San José State University Open University program allows students from outside the university to enroll in university courses on a space-available basis and gain college credit. Former SJSU students, SJSU alumni, members of the general community and disqualified students from SJSU or elsewhere may take courses. Open University also allows students to earn credits while waiting for admission. Table 8.2 shows the AE OU allocations for the last three years.

Table 8.2 – Aerospace Engineering OU allocations

	<b>2014-15</b>	<b>2015-16</b>	<b>2016-17*</b>
Fall	1,613	4,021	2,822
Spring	3,411	2,620	3,770
<b>Totals</b>	<b>\$5,024</b>	<b>\$6,641</b>	<b>\$6,592</b>

\* *Estimate*

### *Student Success, Excellence and Technology Fee (SSETF)*

In fall 2012, Miscellaneous Course Fees were subsumed by the Student Success, Excellence & Technology Fee (SSETF). Beginning fall 2014, the university unbundled and split SSETF into three components: the Instructionally Related Activities Fee (\$103), Course Support Fee (\$21), and Student Success Fee (\$83)<sup>26</sup>. The purpose was to enhance transparency and ensure the revenues collected are used in ways that were detailed in the fee proposals. The use of SSETF funds is limited to activities that support direct instruction. Tables 8.3

<sup>25</sup> This allocation is to be used for temporary faculty as well as teaching associates, graduate assistants and instructional student assistants. At their discretion, Chairs may elect to use a portion of this allocation to fund student assistants; otherwise, the Operating Expenses base is used.

<sup>26</sup> Amounts effective FY 2016-17.

and 8.4 shows the AE SSETF base and one-time budgets respectively for the last three years.

Table 8.3 – Aerospace Engineering SSETF base budgets

	<b>2014-15</b>	<b>2015-16</b>	<b>2016-17</b>
IRA	-	-	-
Course Support	1,392	2,894	2,963
Student Success	-	-	-
Totals	\$1,392	\$2,894	\$2,963

Table 8.4 – Aerospace Engineering SSETF one-time budgets

	<b>2014-15</b>	<b>2015-16</b>	<b>2016-17</b>
IRA	-	-	-
Course Support	55,000	214	156
Student Success	-	-	-
Totals	\$55,000	\$214	\$156

The Course Support base is legacy from the Category III miscellaneous courses fees collected in 2011-12 and is prorated by department based on their needs requests. One-time allocations are also pro rata, except for approved one-time proposals (none in 2015-16 and 2016-17).

#### *Continuing Education Revenue Fund (CERF)*

Continuing Education funds are derived from three sources: intersessions, Open University and professional degree programs offered through Special Session. CERF funds are used “for the support and development of self-supporting instructional programs of the California State University.” (Education code §89704) Costs are apportioned throughout the year in a manner that resembles the enrollment split at year-end (the number of seats in self-support versus regular session programs).

#### *Intersessions*

Winter and summer intersessions provide current San José State University students and eligible adult members of the community with an opportunity to take classes for college credit. Departments offering intersession courses receive 100% of faculty salary and benefits and 80% of the allocation received by the college.

#### *Open University*

The San José State University Open University (OU) program allows students from outside the university to enroll in university courses on a space-available basis and gain college credit. Former SJSU students, SJSU alumni, members of the general community and disqualified students from SJSU or elsewhere may

take courses. Open University also allows students to earn credits while waiting for admission. Starting in AY 2014-15, the College receives Open University revenue in CSUOF at \$2,600/FTES; 80% is allocated to the departments.

### *Professional Degree Programs*

Professional Degree Programs (PDP) offered through Special Session allow working people to earn graduate degrees and certificates at their own pace and schedule, often online or off-campus. 20% of the net revenue is distributed to the academic departments that contribute to the teaching of the programs.

Table 8.5 provides a high-level budget summary of Aerospace Engineering CERF fund during the last three fiscal years.

Table 8.5 – Aerospace Engineering CERF balances

	<b>2014-15</b>	<b>2015-16</b>	<b>2016-17*</b>
Prior Year Roll Forward	4,688	8,377	8,888
Revenue	7,611	511	9,867
Salaries	(2,643)	-	(2,529)
Benefits	-	-	(1,575)
Operating Expenses	(1,278)	-	-
<b>Totals</b>	<b>\$8,377</b>	<b>\$8,888</b>	<b>\$14,651</b>

\* *Estimate*

### *Research Grants*

Faculty research grants are used by faculty to advance their knowledge in their research areas. The department also derives support from the return on indirect charges collected by the SJSU Research Foundation in connection with faculty research grants. The funding distributed to the college, which is used to support research-related activities, is divided into three equal portions: one-third goes to the Dean, one-third to the principal investigator's department, and one-third to a research account controlled by the principal investigator. In addition, grants that support instructional materials and laboratory development typically include budgets for lab equipment or computers. Tables 8.6 and 8.6 provide respectively the AE Research Foundation grant account and self-support balances.

Table 8.6 – Aerospace Engineering Research Foundation grant account balances as of 01/20/2017

<b>Account</b>	<b>Account Title</b>	<b>Grant Period</b>	<b>Balance</b>
21-1315-5478	NASA - SPHERES Program (Unsolicited)	06/11/15 – 06/10/16	0.00
21-1315-5521	2015 MUREP/SEAP (Scholarship)	09/01/15 – 08/31/17	2,052.00
<b>Total</b>			<b>\$2,052.00</b>

Table 8.7 – Aerospace Engineering Research Foundation  
self-support account balances as of 06/06/2017

<b>Account</b>	<b>Account Title</b>	<b>Balance</b>
34-1315-0001	Spacecraft Design Operating Account	1,727.66
34-1315-0002	Int'l Planetary Probe Workshop	11,885.62
51-1315-0001	Aerospace Engineering F&A Sh	577.56
53-1315-0001	F&A Allocations – Papadopoulos	214.48
Total		\$14,405.32

### *Donations and Gifts*

The Department receives donations and gifts from our industry partners and individual donors. These contributions take the form of equipment donations and cash grants from friends, alumni, and Silicon Valley companies. Table 8.8 shows the AE Tower Foundation balances.

Table 8.8 – Aerospace Engineering Tower Foundation expendable balances  
for the date ending 06/06/2017

<b>Account</b>	<b>Account Title</b>	<b>Balance</b>
034-1310-0360	Aircraft Design Projects	323.70
034-1310-0897	Aerospace Engineering Discretionary Account	8,541.02
034-1310-0921	Control and Dynamic Systems Account	427.71
Total		\$9,992.43

## **B2. Institutional Support for Teaching**

There is no university-wide or college-wide funding for graders or teaching assistants. If departments have enough in their budget to assign graders they use their own internal method of apportioning such students. Teaching Associates (TAs) are graduate students who are assigned as instructor of record to teach a specific course. Again, their hiring is dependent upon departments having sufficient funds.

AE faculty – tenured, tenure-track and lecturers – are fully supported with graders and lab assistants, who are hired by the Department as ISAs (Instructional Student Assistants). ISA appointments are typically offered to graduate students, as a way to provide financial support for them, while pursuing their MSAE degree at SJSU. If it is not possible to identify qualified and willing MSAE students to assist with a course, ISA appointments are offered to undergraduate students.

Table 9 shows the ISA allocation formula, which is based on course enrollment as well as whether the course involves lab experiments or not. Table 10 provides an estimate of the AE ISA Budget (~ 32 K annually) based on typical fall/spring enrollments and course offerings. This estimate includes “on-demand-tutoring” offered to all AE students from freshman to senior level.

The AE Department offers a full-day workshop on course design and assessment at the start of every semester for new faculty. The topics of the workshop are shown in Appendix G and discussed in Section E2.1 below.

Table 8.9 – ISA allocation formula

Enrollment	hrs/week	Semester	Cost
		Total	\$12.5/hr
< 40	2	32	400
41-50	3	48	600
51-60	4	64	800
61-70	5	80	1,000
71-80	6	96	1,200
81-100	7	112	1,400
<a href="#">GWAR (AE271)</a>	x 2		

### **B3. Additional Resources for Equipment**

In 2014-15 the College set aside \$1.3M in one-time funds to upgrade eight “showcase” state-of-the-art, multifunctional labs for student, faculty and industry use and collaboration. Upgrades are expected to be completed within five years. The AE Department received from the College \$ 300 K to develop a new Space Systems Engineering Laboratory, which is housed in Engr.236. Additional funds are often available from the Provost’s Office and/or from the College to purchase expensive pieces of equipment, which would normally not be affordable using the annual Operating Fund. For example, the AE Program received ~ \$ 85K from the Provost’s Office in AY11-12 to purchase a new wind tunnel and ~ \$ 100K from the College in Spring 2017 to purchase equipment for a new High-Speed Aerodynamics Laboratory.

FD&O (Facilities Development and Operations) staff maintain facilities on an on-going basis. College and department technicians are responsible for maintaining equipment.

Table 8.10 – AE Department ISA budget estimate based on typical fall / spring enrollments and course offerings

Courses	Enrol.	Allotted	Grading	#	#	hrs	Lab	Total	Rate	Fall	Spring	AY
		hrs	hrs	of	of	per	hrs	hrs		Semester	Semester	Cost
		Week	Semester	teams	exper.	exper.				Cost	Cost	
			(16 weeks)									<b>32,213</b>
										<b>16,144</b>	<b>16,069</b>	
AE 15	25	2	32		0	0	0	32	13	400	400	
AE 20	60	4	64				0	64	13	800	800	
AE 30	60	4	64				0	64	13	800	800	
AE 110	20	2	32				0	32	13	400		
AE 112	90	7	112	23	3	1	68	180	13	2,244		
AE 114	90	7	112	23	3	1	68	180	13		2,244	
AE 138	90	7	112				0	112	13	1,400		
AE 140	90	7	112				0	112	13		1,400	
AE 142	25	2	32				0	32	13		400	
AE 157	90	7	112				0	112	13		1,400	
AE 160	90	7	112	23	4	1	90	202	13	2,525		
AE 162	90	7	112	23	4	1	90	202	13		2,525	
AE 164	70	5	80				0	80	13	1,000		
AE 165	90	7	112				0	112	13		1,400	
AE 168	70	5	80	18	3	1	54	134	13	1,675		
AE 171A+GE(S)	35	4	64				0	64	13	800		
AE 172A+GE(S)	35	4	64				0	64	13	800		
AE 171B+GE(V)	35	4	64				0	64	13		800	
AE 172B+GE(V)	35	4	64				0	64	13		800	
AE 199	20	2	32				0	32	13	400	400	
AE 200	25	2	32				0	32	13	400		
AE 210	35	2	32				0	32	13	400		
AE 243	25	2	32				0	32	13		400	
AE 246	20	2	32				0	32	13		400	
AE 250	50	3	48				0	48	13		600	
AE 264	20	2	32				0	32	13		400	
AE 267	40	2	32				0	32	13		400	
AE 269	40	2	32				0	32	13	400		
AE 271	25	4	64				0	64	13	800		
AE 280	25	2	32				0	32	13	400		
AELearning Community Tutors										500	500	

#### B4. Adequacy of Resources

The AE Program has always given much emphasis in hands-on education from its early days. This is demonstrated by the number of courses which involve hands-on experiments or projects: AE112, AE114, AE160, AE162, AE157, AE166, AE167, AE168, not to mention the senior design projects in AE171A&B, AE172A&B. With help from College technicians and student assistants, these labs are maintained in very good shape. Additional labs are currently under development, such as, for example, the High-Speed Aerodynamics Laboratory in Engr.107, which will provide additional hands-on experiments for AE164, as well as research opportunities for students. The financial resources provided to the AE



Department are adequate to ensure achievement of student outcomes. As discussed above, however, what is currently not adequate, is student project and classroom space allocated to the AE Department.

## **C. Staffing**

### **C1. Department Staff**

#### **C1.1 Administrative staff**

The administrative staff (Admin and Office Assistants) has been adequate to support AE students and faculty. Ms. Karen Wilcox is the AE Department Coordinator. She is assisted in her duties by three students. Her primary responsibilities are described below.

#### *Finances*

Ms. Wilcox oversees the departmental budget for all CSUOF, Tower Foundation, Research Foundation, SSETF, and CERF accounts. She tracks all purchases to ensure they are within department budget limitations and negotiates with vendors to get the best prices to facilitate adherence to the budget. She processes and tracks all purchase requisitions (US and international) as well as student travel and reimbursements. She oversees all departmental facilities and equipment acquisition projects in compliance with budget resources and assists faculty with processing travel documents. She also prepares the Faculty Workload Spreadsheet and updates it as needed each semester.

#### *Appointments*

For tenure-line faculty members, Ms. Wilcox coordinates, oversees, communicates, and processes faculty documentation, ensuring that each member is hired according to University guidelines. In faculty searches, she coordinates with Faculty Affairs to ensure an approved job announcement and coordinates with JobElephant to advertise at various venues, according to the departmental outreach plan. She coordinates the phone interview process and acts as Committee Manager to provide administrative support in Interfolio, as needed. She coordinates travel arrangements for faculty candidates and assists with the recruitment report. Finally, she prepares all appointment paperwork and necessary documentation for Faculty Affairs.

For adjunct faculty, teaching associates (TAs) and instructional student assistants (ISAs), Ms. Wilcox coordinates, oversees, communicates, and processes appointments, ensuring that all are hired according to University guidelines.

### *Course Scheduling*

Ms. Wilcox prepares course schedules in PeopleSoft and communicates with the Department Chair to insure completeness and accuracy. She works with Academic Scheduling for schedule changes (adds, cancels, meeting patterns, etc.) and coordinates nonstandard class schedules, such as condensed classes, and special sessions. She also coordinates class catalog updates. During the registration period, she requests additional add codes for classes and updates the instructor table with new faculty instructors. She also prepares enrollment reports for past, current, and future enrollments for planning and scheduling purposes.

### *Faculty Support*

Ms. Wilcox extracts pertinent information from the Student Affairs Multi-Interface (SAMI) Gateway for the Chair and admits MSAE applicants via PeopleSoft. She coordinates social events for the AE Learning Community, reserves conference rooms for professors, and assists faculty with class rosters and grade changes. She coordinates the visa process and housing for international faculty as well as the absence management process for the department and acts as the department time keeper. She prepares paperwork associated with faculty retention, tenure, and promotion and distributes SOTEs to faculty every semester. Lastly, she assists all new faculty ordering their computers, keys, getting door codes, setting up email and PeopleSoft access.

### *Student Support*

Ms. Wilcox responds to student inquiries related to their academic records, assists them with Registrar's forms and reviews graduation applications. She generates Optional Practical Training letters for MSAE students to help them obtain practical experience related to their degree field. Lastly, she requests lab keys for students from FD&O.

## **C1.2 Technical staff**

The AE Department does not have a dedicated technician, however, technical support from College technicians has been good. It should be noted that technical support from Engineering Computer Systems has been exceptional.

## **C1.3 Instructional staff**

In regards to instruction, the number of full-time faculty has been inadequate to support both the BSAE and the MSAE programs. As a result, most of the required BSAE courses are taught by adjunct faculty. For example, seven (7) of the nine (9) upper division BSAE courses in Fall 2016 and eight (8) of the (11) upper division BSAE courses in Spring 2017 were taught by adjunct faculty. This situation is exacerbated by the fact that the College awards faculty 0.2 release

time for each journal article or five conference papers they publish. On a positive note, a fourth tenure-track AE faculty member (Dr. Vergine) will join the Department in Fall 2017 and one additional tenure-line faculty member will be recruited in AY 2017-2018. If the search is successful, there will be six full-time faculty beginning Fall 2018: five tenure-line plus one full-time adjunct (Ms. Hunter).

## **C2. College Staff**

The College of Engineering has significant staff supporting all the departments. This includes the staff of the Engineering Student Success Center (ESSC), the Engineering Computing Services (ECS), the Central Shops, and the College webmaster.

The ESSC staff includes the Director (Sarah Johnson) and the Assistant Director of Student Programs (Blanca Sanchez-Cruz). In addition, there are four instructor-advisors (Jack Warecki, Ahmed Banafa, Dr. Smita Dourah, and Dr. Monika Kress), five to ten Peer Mentors, and an administrative assistant (Ester Burton). The instructor-advisors teach freshman courses for our majors, and hold office hours in the ESSC to consult on Lower Division Pathways for our freshman students and Change of Major inquiries. In addition, the ESSC provides general education advising, advising for students who are in remedial status or not calculus-ready, probation advising, and career advising (in collaboration with the SJSU Career Center). They also support programs targeting women, underrepresented minorities, and first-generation college students, and maintain a MESA Engineering Program. They also serve as the liaison between the university advising team and the faculty advisors in the departments on the Designated Faculty Advisor Committee.

The ECS group is comprised of the Director (Lee Anderson) and three computer support technicians (Scott Pham, Ben Rashid, and Mina Guirguis). This group installs and maintains the computers, network, software, wireless, and other technology infrastructure necessary in our offices, labs, and classrooms.

The Central Shop is staffed by the Building Coordinator and Safety Specialist (Neil Peters), a machinist (Kyle Meininger) and an equipment technician (Jonathan Rye). This group oversees facilities and safety in the college; undertakes custom machining projects for instruction, research, and student projects; maintains and manages the OmniLock door code system in the building; handles shipping and receiving; manages the Building Emergency Management Team, and provides setup for college and department events.

The College web designer is Bryan Seagrave. He manages and maintains the College of Engineering website, as well as provides support on department websites and faculty web profiles.

### **C3. Staff Retention and Training**

The staff are trained largely through university resources as needed for their positions. Administrative staff are eligible for training in the campus systems for financial transactions, scheduling, absence management, and enrollment reports. The student success staff are eligible for training in advising tools, student records, and admissions reports. The Building Coordinator and Safety Specialist maintains his certification on Chemical and Hazmat Safety in Laboratories, as do the student assistants working with him and the department technicians required to handle hazardous materials.

Occasionally, cohort training in special topics is arranged for the college staff. During the winter break in 2015, the staff attended a workshop on the Insights method of teamwork and personality.

The College of Engineering has a Faculty and Staff Professional Development Fund, typically funded at \$50K per year. Both faculty and staff can submit applications to attend workshops and conferences to enhance their performance on the job. The staff applications are reviewed and approved by a college staff council, comprised of a representative cross section of all college staff.

The staff have a breakfast meeting with the Dean and Associate Dean once per semester. It is a chance to reconnect with all the staff in the college and discuss their concerns.

Finally, all staff undergo quarterly evaluations and reviews during their first year of employment, and annual evaluations thereafter. The evaluations are a time to evaluate possible changes in duties and scope, as well as pay.

## **D. Faculty Hiring and Retention**

### **D1. New Faculty Hiring Process**

Each department or program must first justify the need for hiring new faculty. The process generally begins with the department chair justifying to the Dean the need for additional faculty. This is usually based on demonstrating why the current number of faculty are insufficient to maintain a quality program, typically based on the number of students and/or need to cover certain thematic or programmatic areas within the department or program, among others. This is a formal request with supporting documentation. The Dean, receives similar requests from other departments within the College as well. Based on resources available, the Dean decides which hiring requests to approve, subject to approval by the Provost. A Position Available Announcement is then drafted and submitted to the Office of Faculty Affairs for their approval. Once this is approved the position is posted on the SJSU website, and also advertised nationally in relevant journals, and also sent to the following for

posting: *Northern California Higher Education Recruitment Consortium, HigherEdJobs, CSU Career Opportunities, CalJobs/Employment Development Department.*

Simultaneously, a departmental recruiting committee is also formed with 5 (or more) tenure-line faculty from the program, but no fewer than 3 in the case of small departments. Since this is a personnel committee, potential members have to be nominated (self-nomination is acceptable) and then elected by secret ballot which is administered by the Dean's Office.

As of the 2013-2014 hiring cycle, all applications are accepted electronically. We require, at a minimum, a complete curriculum vitae, a statement of teaching philosophy, a statement of research interests, and a list of three references. The deadline for submission for priority consideration is usually in early December. These applications are logged in by the department admin. The department chair first reviews the applications to make sure that the minimum qualifications, i.e., a PhD in aerospace engineering or a closely related field, are met. After this first screening, the entire recruitment committee reviews all other applications. The committee meets in person to discuss the various candidates, with a view to narrowing the field down to approximately four to six candidates, who are then invited for a phone interview. Telephone interviews are conducted with a predetermined set of questions, decided by the committee and posed to all candidates. Based on the outcome of the telephone interviews, three to five candidates are invited for on-campus interviews. They are also simultaneously requested to provide their permission to contact their references.

The on-campus interview lasts one full day and includes: (a) meetings with individual program faculty, (b) meeting with recruitment committee members who are from other departments, (c) meeting with the Dean and Associate Deans, (d) meeting with students, (e) one presentation based on the candidate's research interests, accomplishments and future plans, (f) one classroom interaction with students, and (g) lunch and dinner. The students who attend the meeting with the candidate and/or the lecture presentation are invited to provide their feedback as well.

At the completion of all on-campus interviews, the recruitment committee meets again for further deliberations to identify the most suitable candidate(s). The Dean's request is for the recruitment committee to provide at least three acceptable candidates without ranking. The final hiring decision is made by the Dean, based on the recommendations made by the recruitment committee and transmitted to the Dean by the department chair.

The Dean sends the selected candidate an offer letter, detailing the terms of the offer. The candidate is required to sign the offer letter, indicating his/her acceptance of the terms. In the event that this first offer does not materialize, the offer is then made to the next acceptable candidate.

## **D2. Strategies to Retain Faculty**

In regards to their teaching and RTP process, new faculty are mentored by the AE Department Chair. Faculty Affairs and CFA also offer workshops and support to help new faculty navigate the RTP process, while the Center for Faculty Development and Support provides help with the use of technology in the classroom or laboratories. The Department Chair visits each faculty member's classroom at least once every semester to provide unofficial as well as official feedback on their teaching.

In regards to their research, the AE Department Chair assigns a senior faculty member (tenured or lecturer) and/or an engineer from industry/NASA to mentor new faculty and help them gain connections to the local industry/NASA. Faculty are expected to collaborate with each other within the Department in research as well as in course and laboratory development; they are also encouraged to collaborate with other engineering of SJSU faculty at large. Such collaborations have resulted in multiple joint proposals submitted in the past few years both in discipline-based research as well as in pedagogy/engineering education.

A Department retreat is typically scheduled at the start of the fall semester in some location off campus, to discuss ideas about how to better support our students, how to better support the faculty in their various functions, and how to improve the quality and rigor of our programs.

The Department Chair has an open-door policy for all AE faculty and offers to go for lunch with new faculty at least once a month, as a way to provide opportunities for informal discussion on anything that may be of interest to them. A holiday party as well as an end-of-the year party is organized at the Chair's residence and on several occasions (e.g. after departmental elections, awards, etc.) AE faculty celebrate by going for lunch or dinner in the downtown area.

New faculty receive a startup package of \$ 30 K to help them with travel, student assistants, lab development, and other teaching or research activities. They also receive a \$10K stipend each of the first two summers to support their research and proposal development. Each new faculty member also receives laboratory space, as needed based on their proposed laboratory development plan.

"Mini" probationary reviews are conducted every year in the spring semester, to provide new faculty with timely feedback on their teaching, scholarly, and service performance. A major probationary review, requiring submission of a full dossier, takes place in the third year. If a candidate is found lacking in some area, a 4<sup>th</sup> or a 5<sup>th</sup> year review may be recommended as well.

## **E. Support of Faculty Professional Development**

### **E1. Sabbatical Leave**

The purpose of sabbatical leave is to benefit the university, students, and programs through the professional development of the faculty. Sabbatical projects include scholarly and professional activities, which enhance a faculty member's pedagogical and professional competencies, as well as projects which contribute significantly to the development of a discipline or curricular area. Faculty can either take a one-semester sabbatical with full pay, or a two-semester sabbatical with half pay. The number of awards given to the engineering faculty is typically between three to five annually and is dependent on the university budget. Faculty are eligible to apply every 6 years but are not guaranteed.

Dr. Mourtos was awarded a one-semester sabbatical in the spring of 2000; Dr. Papadopoulos was awarded a two-semester sabbatical in AY2015-2016. Currently the number of AE tenure-line faculty members is too small to allow for sufficient coverage of key curricular areas when a faculty member is awarded a sabbatical leave. Furthermore, there is currently no faculty member in the Department sufficiently experienced and willing to take charge of the AE Department should the Chair were to go on sabbatical leave. The situation is expected to change in four to five years as more faculty are hired and mentored to take on leadership responsibilities in the Department.

### **E2. Support for New Faculty**

The College of Engineering has established a policy, which gives all new assistant professors a two-course reduction in teaching load per semester during the first two years. This allows them time to develop their teaching repertoires and initiate research programs. In addition, new faculty receive a \$10K stipend during the first two summers to support research and proposal development.

#### **E2.1 Departmental support for new faculty in pedagogy**

The AE Department offers an all-day workshop on course design<sup>27</sup> (Appendix G) at the start of every semester to prepare new faculty – full-time and part-time – with their course development and assessment. Course design and assessment are also discussed in Department meetings. One additional goal of these workshops is to build a learning community among AE faculty, so we can support each other in our efforts to provide the best education possible for our students. Eleven lecturers have participated in the workshop so far. The effect of the workshop on teaching effectiveness, at least as measured by SOTEs, is clearly shown in Table 8.11.

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<sup>27</sup> < [http://www.sjsu.edu/people/nikos.mourtos/faculty\\_development/aefaculty/](http://www.sjsu.edu/people/nikos.mourtos/faculty_development/aefaculty/)>

Table 8.11 – Effect of AE course design workshop on adjunct faculty SOTEs; most recent scores are shown for each faculty member

Faculty w. no training in pedagogy	Overall Teaching Effectiveness*	Faculty w. training in pedagogy	Overall Teaching Effectiveness
Adjunct Faculty #1	4.3	Adjunct Faculty #9	4.2
Adjunct Faculty #2	3.5	Adjunct Faculty #10	4.8
Adjunct Faculty #3	3.6	Adjunct Faculty #11	4.1
Adjunct Faculty #4	4.1	Adjunct Faculty #12	5.0
Adjunct Faculty #5	3.1	Adjunct Faculty #13	3.7
Adjunct Faculty #6	4.4	Adjunct Faculty #14	3.7
Adjunct Faculty #7	4.3	Adjunct Faculty #15	4.7
Adjunct Faculty #8	4.4	Adjunct Faculty #16	4.3
		Adjunct Faculty #17	4.9
		Adjunct Faculty #18	4.1
		Adjunct Faculty #19	4.7

\*SOTE item # 13

As seen in Table 8.11, the average overall teaching effectiveness for faculty with training in pedagogy is 4.38 (column 4) compared to 3.96 (column 2) for faculty with no training in pedagogy. This is a statistically significant difference (0.42 on a scale from 0 to 5) indicating that the workshop results in improvements in teaching and learning.

The content of the workshop is reinforced through peer-reviews and mentoring, using an instrument that emphasizes research-based pedagogies (Appendix H). Peer reviews can serve as valuable tools for steering new faculty members towards new and effective pedagogies, while at the same time providing a meaningful way to assess and/or evaluate their teaching effectiveness. Peer reviews conducted in AY15-16 and 16-17 clearly show that AE faculty members are proficient in effective pedagogies, such as active and cooperative learning, project-based learning and multimedia use in the classroom.

### **E3. College Research Incentives**

The College of Engineering rewards research productivity through a point system to grant reductions in teaching load. Points are earned in proportion to research achievements, such as publications or grants. Teaching release time earned can then be used at the discretion of the faculty recipient.

#### **E3.1 Professional development fund**

The College of Engineering has a Faculty and Staff Professional Development Fund, typically funded at \$50K per year. Faculty and staff can submit applications to attend workshops and conferences to enhance their performance on the job. The faculty applications are reviewed and approved by the Associate Dean of Research.



Drs. Mourtos and Turkoglu have received generous support from this fund to attend conferences and short courses in the past three years. Ms. Wilcox also received support from this fund this year to attend a short course off campus.

### **E3.2 Departmental research incentives**

One of the main problems in supporting faculty research at SJSU is that our graduate students can only pursue a Master's degree, so their stay in the AE Department is typically somewhere between one-and-a-half years (for full-time students) to two-and-a-half years (for part-time students) and their MSAE project or thesis work is limited to two semesters or six units. The Department allows the best MS students to extend their research efforts by an additional three units by taking AE298 – Special Projects in AE – in lieu of an elective. A faculty member receives 3 WTUs or 0.2 release when he/she completes supervision of eight (8) MSAE projects or theses.

Similarly, at the undergraduate level students can expand their senior design (AE171A&B or AE172A&B) by an additional three units through AE180 – Individual Studies – which again may be taken as an elective.

Allowing BSAE and MSAE students to register for nine units of design and/or research work provides more support to AE faculty, as well as more time for students to write and submit papers co-authored with faculty to professional conferences and academic journals.

## PROGRAM CRITERIA

### A. Curriculum

*Aeronautical engineering programs must prepare graduates to have a knowledge of aerodynamics, aerospace materials, structures, propulsion, flight mechanics, and stability and control. Astronautical engineering programs must prepare graduates to have a knowledge of orbital mechanics, space environment, attitude determination and control, telecommunications, space structures, and rocket propulsion. Aerospace engineering programs or other engineering programs combining aeronautical engineering and astronautical engineering, must prepare graduates to have knowledge covering one of the areas – aeronautical engineering or astronautical engineering as described above – and, in addition, knowledge of some topics from the area not emphasized. Programs must also prepare graduates to have design competence that includes integration of aeronautical or astronautical topics.*

The following courses in the BSAE curriculum address the *aeronautical engineering* requirement (see also Figure 5.1):

- Aerodynamics – required courses: AE160, AE162, AE164, AE169; electives ME149, Math133B
- Materials – required courses: MatE25; electives: AE135, MatE160
- Aerospace Structures – required courses: AE112, AE114; electives: CE160, ME160
- Aerospace Propulsion – required courses: AE167
- Flight mechanics – required courses: AE165.
- Stability and control – required courses: AE157, AE165, AE168.
- Aircraft Design – AE171A & B; electives AE199 (UAVs), ME110, ME136, ME154, ME160, ME165, ISE105, ISE114

The following courses in our BSAE curriculum address the *astronautical engineering* requirement (see also Figure 5.1):

- Orbital mechanics – required course: AE165; elective AE142
- Space environment – required courses: AE172A & B; elective: AE110
- Attitude determination and control – required courses: AE157, AE168
- Telecommunications – required courses: AE172A & B; elective: AE110
- Space structures – required course: AE114
- Rocket propulsion – required course: AE167; elective AE166
- Spacecraft Design – AE172A & B; electives: AE166, ME110, ME136, ME154, ME160, ME165, ISE105, ISE114

Clearly, the BSAE Program addresses all the subject areas required under aeronautical and astronautical engineering. Furthermore, program graduates demonstrate design competence in at least one of the two fields:

- **Aeronautical Engineering:** students perform a year-long aircraft design project (AE171A&B), which requires integration of aerodynamics, flight mechanics, propulsion, aircraft structures and materials, stability and control.
- **Astronautical Engineering:** students perform a year-long spacecraft design project (AE172A&B), which requires integration of orbital mechanics, space environment, attitude determination and control, telecommunications, space structures, and rocket propulsion.

## **B. Faculty**

*Program faculty must have responsibility and sufficient authority to define, revise, implement, and achieve program objectives. The program must demonstrate that faculty teaching upper-division courses have an understanding of current professional practice in the aerospace industry.*

The AE Department has formed an AE Advisory Board (Appendix F). In the most recent meeting on May 11, 2017, the Board examined the PEO for currency and the BSAE curriculum to ensure it adequately addresses these objectives. The AE faculty is charged with the responsibility and authority to develop courses and laboratories in support of the PEO. As discussed in Criterion 4, AE faculty have been very active in curriculum and laboratory development since the last ABET visit.

The faculty information in Table 6.1 clearly shows that both the full-time and the part-time faculty who teach upper division courses are well qualified and current in their area of specialization. Faculty stay current in various ways, such as discipline-based research, interaction with industry, participation in professional societies, workshops, conferences, and publishing.

# APPENDIX A – COURSE SYLLABI

## Math 30 – Calculus I

Credit: 3 semester units  
Contact time: 2 hrs: 30 min lecture

Instructor: *Mathematics Department Staff*

Textbook:

Calculus: Early Transcendentals, by James Stewart, Thomson/Brooks/Cole, 7<sup>th</sup> Ed.  
Student Solutions Manual for Single Variable Calculus: Early Transcendentals, by Daniel Anderson, Jeffery Cole, Daniel Drucker, Thomson/Brooks/Cole.

Course Description:

*Introduction to calculus including limits, continuity, differentiation, applications and introduction to integration. Graphical, algebraic and numerical methods of solving problems.*

Prerequisite: *Satisfaction of ELM requirement; Satisfactory score on the Calculus Placement Exam, or Math 19 (with a grade of "B" or better to waive the placement exam).*

Co-requisite: *Math 30W*

### **Required** course

Course Goals

*To learn the concepts and techniques of differential calculus and use them in solving applied problems. To study limits, continuity, differentiation and applications of the derivative.*

Relationship of Course to Student Outcomes:

*This lower-division basic science course contributes to Outcome A:  
Ability to use mathematics, science, and engineering principles to identify, formulate, and solve aerospace engineering problems.*

Topics:

- *The tangent and velocity problems, the limit of a function, limit laws, the definition of the limit, continuity, limits at infinity, infinite limits, horizontal and vertical asymptotes, tangent lines, velocity and other rates of change, the definition of the derivative.*
- *Derivatives of polynomials, exponential functions, trigonometric functions, logarithmic functions, and hyperbolic functions.*
- *The product rule, quotient rule and chain rule. Implicit differentiation, higher order derivatives, related rates, differentials and linear approximations.*

- *Maximum and minimum values, the Mean Value Theorem, curve sketching, indeterminate forms, and L'Hopital's Rule*
- *Optimization problems.*
- *Newton's method, an introduction to anti-differentiation.*

## Math 31 – Calculus II

Credit: 4 semester-units

Contact time: 4 hours lecture

Instructor: Mathematics Department Staff

Textbooks:

*Calculus: Early Transcendentals*, by James Stewart, Thomson/Brooks/Cole, 7th. Ed.  
*Student Solutions Manual for Single Variable Calculus: Early Transcendentals*, by Daniel Anderson, Jeffery Cole, Daniel Drucker, Thomson/Brooks/Cole.

Description:

*Definite and indefinite integration with applications. Sequences and series. Graphical, algebraic and numerical methods of solving problems.*

Prerequisite: Math 030 or Math 030P (with a grade of "C-" or better).

Co-requisite: Math 031W

### **Required** course

Course goals:

*To learn the concepts and techniques of integral calculus and to use them in solving applied problems. To learn the concept of infinite sequences and series. To investigate convergence properties of numerical and power series and their application to representation of functions as power series.*

Relationship of Course to Student Outcomes:

*This lower-division basic science course contributes to Outcome A:*

*Ability to use mathematics, science, and engineering principles to identify, formulate, and solve aerospace engineering problems.*

Topics:

- ✓ *Areas and distances. The definite integral.*
- ✓ *The Fundamental Theorem of calculus. Indefinite integrals. The substitution rule.*
- ✓ *Areas between curves. Volumes. Volumes by cylindrical shells. Work*
- ✓ *Integration by parts. Trigonometric integrals.*
- ✓ *Trigonometric substitution. Integration of rational functions by partial fractions.*
- ✓ *Approximate integration. Improper integrals*
- ✓ *Arc length. Area of a surface of revolution. Applications to Physics and Engineering*
- ✓ *Sequences. Series. The integral test. The comparison tests. Alternating series. Absolute convergence and the ratio and root tests.*
- ✓ *Power series. Representation of functions as power series. Taylor and MacLaurin series.*
- ✓ *Complex numbers*

## Math 32 – Calculus III

Credit: 3 semester-units

Contact time: 3 hours lecture

Instructor: Mathematics Department Staff

Textbooks:

*Calculus: Early Transcendentals*, by James Stewart, Thomson/Brooks/Cole, 7th. Ed.  
*Student Solutions Manual for Multivariable Calculus: Early Transcendentals*, by Dan Clegg and Barbara Frank, Thomson/Brooks/Cole.

Description:

*Functions of more than one variable, partial derivatives, multiple integrals and vector calculus. Graphical, algebraic and numerical methods of solving problems.*

Prerequisite: Math 031 (with a grade of "C-" or better)

**Required** course

Course goals:

*To learn 2- and 3- dimensional vector algebra and analytic geometry. To understand and apply the basic ideas of multivariable calculus: functions, limits, continuity, differentiation, and integration. To master the concepts and techniques of multivariable calculus and to use these methods in solving applied problems.*

Relationship of Course to Student Outcomes:

*This lower-division basic science course contributes to Outcome A:  
Ability to use mathematics, science, and engineering principles to identify, formulate, and solve aerospace engineering problems.*

Topics:

- ✓ Curves defined by parametric equations. Polar coordinates.
- ✓ Three-dimensional coordinate systems. Vectors.
- ✓ The dot product. The cross product. Equations of lines and planes. Cylinders and quadric surfaces.
- ✓ Vector functions and space curves. Derivatives and integrals of vector functions.
- ✓ Arc length and curvature
- ✓ Motion in space: velocity and acceleration.
- ✓ Functions of several variables. Limits and continuity.

- ✓ Partial derivatives. Tangent planes and linear approximations. The chain rule. Directional derivatives and the gradient vector. Maximum and minimum values, Lagrange Multipliers.
- ✓ Double integrals over rectangles. Iterated integrals. Double integrals over general regions. Double integrals in polar coordinates. Applications of double integrals.
- ✓ Triple integrals. Triple integrals in cylindrical coordinates. Triple integrals in spherical coordinates.



## **Math 129A – Linear Algebra I**

Credit: 3 semester-units

Contact time: 3 hours lecture

Instructor: Math Department Staff

Textbook: Elementary Linear Algebra 2<sup>nd</sup> ed.,  
L. Spence, A. Insel, and S. Friedberg, 2008

Description:

*Matrices, systems of linear equations, vector geometry, matrix transformations, determinants, eigenvectors and eigenvalues, orthogonality, diagonalization, applications, computer exercises. Theory in  $R^n$  emphasized; general real vector spaces and linear transformations introduced.*

Prerequisites: Math 31 (with a grade of "C-" or better) or instructor consent

### **Required course**

Course goals:

- ✓ Learn about matrices and determinants and their importance in solving systems of linear equations
- ✓ Learn applications of linear algebra

Relationship of Course to Student Outcomes

*This lower-division basic science course contributes to Outcome A:*

*Ability to use mathematics, science, and engineering principles to identify, formulate, and solve aerospace engineering problems.*

Topics:

- ✓ Systems of linear equations
- ✓ Vector geometry
- ✓ Vector space
- ✓ Matrix transformation
- ✓ Matrix algebra
- ✓ Determinants
- ✓ Eigenvectors and eigenvalues
- ✓ Diagonalization
- ✓ Orthogonality

## Math 133A – Ordinary Differential Equations

Credit: 3 semester-units

Contact time: 3 hours lecture

Instructor: Slobodan Simić

Textbooks:

*Blanchard, Devaney, Hall, Ordinary Differential Equations, Brooks/Cole (Thompson), 4<sup>th</sup> edition, 2011*

*Polking, Boggess, Arnold, Differential Equations, 2<sup>nd</sup> edition, Pearson/Prentice Hall, 2005*

*Boyce, DiPrima, Elementary Differential Equations, Wiley, 10<sup>th</sup> edition, 2012*

Description:

*First order differential equations, first order linear systems, second order linear equations, applications, Laplace transforms, series solutions. Additional topics*

Prerequisite: *Math 32 (with a grade of "C-" or better) or instructor consent*

**Required** course

Course goals:

- ✓ Demonstrate understanding of the basic ideas of ODEs: the notion of the solution, phase portrait and qualitative behavior.
- ✓ Analyze and solve a variety of applications including problems involving the harmonic oscillator, predator-prey systems, and RC circuits.
- ✓ Solve a system of two linear first order ODEs.
- ✓ Solve second order constant coefficient homogeneous ODEs.
- ✓ Solve second order constant coefficient forced ODEs using the Laplace transform or the method of the "lucky guess".
- ✓ Give practical interpretations of the solutions of ODEs coming from applications.
- ✓ Use the computer to solve ODEs numerically.

Relationship of Course to Student Outcomes:

*This lower-division basic science course contributes to Outcome A:  
Ability to use mathematics, science, and engineering principles to identify, formulate, and solve aerospace engineering problems.*

## Topics

- ✓ *First order differential equations: definition of solution, existence and uniqueness, slope fields, separation of variables, linear ODEs, phase line and equilibria, changing variables. Euler's method.*
- ✓ *First order (planar) linear systems: modeling examples, geometry of systems. Linear algebra preliminaries (matrices, matrix multiplication, determinants). Straight-line solutions, eigenvectors and eigenvalues, phase plane for linear systems with real distinct/complex/real repeated eigenvalues, the trace-determinant plane.*
- ✓ *Linear second order equations: reduction to systems, characteristic equation and general solution of the homogeneous equation, method of undetermined coefficients. Forced mechanical vibrations.*
- ✓ *Laplace transform: definition, properties, inverse transform, solving initial value problems, transforms of discontinuous functions, convolution, impulses and Dirac delta function.*
- ✓ *Series solutions: Taylor series method, power series, analytic functions.*

## Chem 1A – General Chemistry

**Units:** 5, Contact Hours: Lecture 3 hours / Seminar 1 hour / Lab 3 hours

**Instructor:** N. Melody Esfandiari, Ph.D.

**Textbook:** Brown, LeMay and Bursten. Chemistry: The Central Science. 12th Edition. Prentice Hall. 2011  
Lab Manual for Chemistry 1A  
Chem. 1A Booklet by Singmaster

### Specific course information

Description: Topics include stoichiometry, reactions, atomic structure, periodicity, bonding, states of matter, energy changes, solutions using organic and inorganic examples. Lab program complements lecture.

Prerequisite: Proficiency in high school chemistry or CHEM 010 (with a grade of "C" or better; "C-" not accepted) or instructor consent; proficiency in high school algebra and eligibility for MATH 019; eligibility for ENGL 001A

Designation: Required

### Specific goals for the course

To gain knowledge and understanding of the basic principles of chemistry, and of their applications.

**Relationship of Course to Student Outcomes:** This lower-division basic science course contributes to:

- 1) Ability to apply knowledge of mathematics, science and engineering
- 2) Ability to design/conduct experiments and analyze/interpret data

### Brief list of topics to be covered

Units, Significant Figures, Dimensional Analysis, Density Temperature, Atomic and Molecular Weight

Mole, Percent Composition, Empirical Nomenclature

Solubility and Dissociation Rules

Net Ionic Equations

Stoichiometry

Concentration and Solution Stoichiometry

Structure of Atoms

Periodicity

Bonding

Molecular Structure

Gases

Liquids and Solids

Heat Transfer and Thermochemistry

Organic Chemistry

## **Phys 50 – General Physics I: Mechanics**

**Units:** 4, Contact Hours: Lecture 3 hours / Lab 3 hours

**Instructor:** Monika Kress, Ph.D.

**Textbook:** University Physics, Young and Freedman (13th Edition)  
Other supplemental materials: Mastering Physics (Online Material)

### **Specific course information**

Description: A calculus-based treatment of particle kinematics and dynamics, work, energy, momentum, rotational motion, equilibrium, and simple harmonic motion.

Prerequisites: Math and English Remediation Completed or a post baccalaureate. 3 or better on AP Calc Test Or 'C' or better in Math 30 or Math 30P

Designation: Required

### **Specific goals for the course**

Solve complex mechanics problems in a systematic manner by applying the laws of physics and calculus

Describe the motion of objects using physics terms and concepts, such as velocity, acceleration, force, kinetic and potential energy, momentum, torque, conservation of energy, and conservation of momentum.

Assign the proper units and significant digits to solutions of physics problems

Understand the relationship between forces and the response that objects have to those forces

Relate physics concepts to the world around you

Predict the behavior of simple mechanical systems

### **Relationship of Course to Student Outcomes:**

This lower-division basic science course contributes to Program Educational Objectives and Outcomes as follows:

- (1) Proficiency in the ability to apply knowledge of mathematics, science and Engineering through problem solving.
- (2) Proficiency in the ability to design and conduct experiments, as well as to analyze and interpret data.

### **Brief list of topics to be covered**

Vectors and Vector Addition

Acceleration, Velocity and Displacement in 1-D

Projective Motion and Circular Motion

Newton's Laws of Motion

Work, Kinetic Energy, Potential Energy, Momentum

## Phys 51 – General Physics II: Electricity and Magnetism

Units: 4, Contact Hours: Lecture 3 hours / Lab 3 hours

Instructor: Ranko Heindl, Ph.D.

Textbook: University Physics, Young and Freedman (13th Edition)

Other supplemental materials: Mastering Physics (Online Material)

### Specific course information

Description: A calculus-based introduction to electricity and magnetism, covering electric charges, electric and magnetic fields, dc and ac circuits, and electromagnetic waves.

Prerequisite: PHYS 050, MATH 031, both with grades of "C" or better

Designation: Required

### Specific goals for the course

Be familiar with basic concepts of electrostatics, Coulomb and Gauss's Laws.

Be familiar with circuit elements such as resistors, capacitors, inductors, battery.

Be able to use Ohm's and Kirchhoff's rules to analyze DC electric circuits.

Be familiar with concepts of magnetic field and magnetic force.

Be able to analyze AC electric circuits.

Be familiar with Maxwell's equations and electromagnetic waves.

Be familiar with historical figures who contributed to the development of electricity and magnetism

explicitly indicate which of the student outcomes listed in Criterion 3 or any other outcomes are addressed by the course

Relationship of Course to Student Outcomes: This lower-division basic science course contributes to student outcomes as follows:

(1) Proficiency in the ability to apply knowledge of mathematics, science and Engineering through problem solving.

(2) Proficiency in the ability to design and conduct experiments, as well as to analyze and interpret data.

### Topics:

- ✓ Electric Charge and Electric Field
- ✓ Gauss Law
- ✓ Electric Potential
- ✓ Capacitance and Dielectrics
- ✓ Current, Resistance, and Electromotive Force
- ✓ Direct-Current Circuits
- ✓ Magnetic Field and Magnetic Forces
- ✓ Sources of Magnetic Field
- ✓ Electromagnetic Induction
- ✓ Inductance
- ✓ Alternating Current
- ✓ Electromagnetic Waves

## **Phys 52 – General Physics III: Heat and Light**

Credits and contact hours: 4 semester-units; 3 hours lecture + 3 hours lab per week

Instructor: Physics Department Staff

Textbook: University Physics, 14th ed, volumes 1 and 2, Young, H. and Freedman, R., 2015

**Description:** Mechanical Waves, Light, Spectra, Quantization of electromagnetic radiation; Geometric and Physical Optics; Temperature, Heat and Thermodynamics. Intensive Science Package GE Area: B1 and B3.

**Prerequisites or co-requisites:** Prerequisite: PHYS 051 and Math 31 both with grade of "C" or better. College of Science or Engineering majors only.

**Designation:** Required

### **Specific goals for the course**

Understand the basics of optics and thermodynamics and their applications

Explain the day to day optical and thermal phenomena

Solve simple problems involving geometrical and physical optics

Solve simple problems involving thermal conduction

Solve simple problems involving heat engines

Solve simple problems involving wave nature of particles

### **Relationship of Course to Student Outcomes**

This lower-division basic science course contributes to:

- a. Ability to apply knowledge of mathematics, science, and engineering
- b. An ability to design and conduct experiments, as well as to analyze and interpret data

### **Brief list of topics to be covered:**

Mechanical oscillations, wave motion, the wave nature of light, reflection refraction and polarization of light, optical instruments and geometric optics, interference and diffraction of light waves. Temperature and heat, thermal properties of matter, the First and Second Laws of Thermodynamics.

## Engr. 10 – Introduction to Engineering

Credit: 3 semester units  
Contact time: 2 hrs lecture + 3 hrs lab

Instructors:

*Lecture: Ken Youssefi and Jack Warecki*

*Lab: Ahmed Banafa, Smita Duorah, Chuck Foster, Kanotha Kamau-Devers, Steve Sepka, Luis Tapia, Javier Valencia, Jack Warecki, Ken Youssefi*

Textbook: None

All lecture notes, lab handouts, homework assignments, and supplemental reading

Course Description:

Introduction to engineering through hands-on design projects, case studies, and problem-solving using computers. Students also acquire non-technical skills, such as team skills and the ability to deal with ethical dilemmas.

Prerequisites: Eligible for Math 19 or English 1A.  
Engineering Majors Only

### ***Required*** course

Course Goals:

- Summarize the steps of the engineering design process
- Apply basic physics concepts to the design and analysis of built systems
- Apply teamwork skills and resolve team conflict
- Write a simple engineering report and present the report orally
- Use tools such as spreadsheets, C++ programming, and CAD software to support engineering design and analysis
- Use ethical reasoning to address to evaluate ethical dilemmas

Relationship of Course to Student Outcomes

Outcome	Level (N, L, M,H)	Demonstrate Proficiency
Ability to apply knowledge of mathematics, science, and engineering	M	Homework, Quizzes, Final Exam
Ability to design and conduct experiments, as well as to analyze and interpret data	L	Project Reports
Ability to design a system, component, or process to meet desired needs within realistic	H	Activity reports, Project reports



constraints		
Ability to function on multi-disciplinary teams	H	Activity Reports, Team Assessment
Ability to identify, formulate, and solve engineering problems	L	Homework
Understanding of professional and ethical responsibility	H	Homework, Final Exam
Ability to communicate effectively	M	Written reports, Oral Presentations
Broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	L	Final Exam
Recognition of the need for, and an ability to engage in life-long learning	L	Not assessed
Knowledge of contemporary issues	M	Quizzes, Final Exam
Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	M	Homework, Project reports

#### Topics

- The engineering profession
- Engineering tools (Excel, Solid Modeling, C++ programming)
- The design process
- Communication skills (report writing and oral presentations)
- Team skills
- Sustainability
- Global and environmental issues
- Engineering ethics
- Student success

## AE 15 – Air & Space Flight: Past, Present, and Future

Credit: *1 semester unit*

Contact time: *50 min lecture*

Instructor: *Sean Montgomery*

Textbook: *None*

Other supplemental materials: *Instructor notes*

Catalog description:

*Introduction to the history, basic principles, current and future developments of the aerospace engineering field.*

Prerequisites or co-requisites: *None*

Lower Division **Elective** Course

Course Goals: Introduce students to...

- The historical context in which aeronautical and astronautical systems have been developed.
- The basic principles of atmospheric flight and aircraft design.
- The basic principles of space flight and spacecraft design.
- The current and future developments in the field of aerospace engineering, the aerospace engineering industry status and outlook.

Course Learning Outcomes:

Upon successful completion of this course, students will be able to...

1. Identify the major milestones in the history of atmospheric and space flight, explain the driving forces behind each milestone, and discuss the impact on society and globalization.
2. Explain how aerospace vehicles generate lift and calculate lift using approximate methods.
3. Explain how aerospace vehicles generate drag at various flight regimes and calculate drag using approximate methods.
4. Communicate and collaborate effectively with teammates (by setting goals, managing time, resolving conflicts, delegating tasks, making critical decisions, etc.) while working on aerospace engineering problems.
5. Identify current and future development in aerospace engineering and discuss the challenges facing the aerospace industry in the 21st century.

### Course Relationship to BSAE Student Outcomes

	A	B	C	D	E	F	G	H	I
<i>Learning Outcomes</i>									
1							O		
2, 3	O								
4				O					
5							O		

- +: Skill level 1 or 2 in Bloom's Taxonomy
- ++: Skill level 3 or 4 in Bloom's Taxonomy
- +++: Skill level 5 or 6 in Bloom's Taxonomy
- O: Skill addressed but not assessed

#### Topics:

- Introduction and early aviation.
- Overview of World War I, World War II, and the Golden Age.
- Post World War II Aircraft.
- The Space Race.
- Spyplanes.
- Launch Vehicles.
- Airliners.
- Space Probes.
- Stealth Aircraft.
- Unmanned Aircraft.
- Current and Future Aircraft.
- Current and Future Spacecraft.

## **AE 20 – Computer-Aided Design for Aerospace Engineers**

Credit: 2 semester units  
Contact time: 1hr lecture + 3hrs lab

Instructor: Robert Benzio

Textbook: *Engineering Drawing & Design – W/CD*  
5<sup>th</sup> ed., Cengage Learning,  
David A. Madsen, David P. Madsen  
ISBN: 9781111309572

Other supplemental materials: *Instructor notes and other readings.*

Catalog description:

*The course provides an introduction to the fundamentals of drafting and computer-aided design with applications in aircraft and spacecraft design. Students will team up with juniors and seniors to work on aerospace engineering design projects.*

Prerequisites or co-requisites: *None*

### **Required** course

Course Goals: Introduce students to...

- *Technical freehand sketching.*
- *Technical drawing.*
- *2D and 3D computer-aided design tools (CATIA, Inventor, or other CAD software available).*

Course Learning Outcomes:

Upon successful completion of this course, students will be able to...

1. *Freehand sketch a 3D view of an object (isometric, oblique and perspective).*
2. *Draw the standard 2D views (top, front and profile) of an object.*
3. *Apply simple and complex constrained 2D sketches to create solid features.*
4. *Construct 3D solid models from sketch geometry using extrusions, revolutions, and sweeps.*
5. *Create part features such as holes, shells, fillets, chamfers, threads and drafts.*
6. *Construct and annotate layout drawings.*
7. *Build basic 3D assemblies with assembly constraints.*
8. *Layout 3D exploded assembly drawings with balloon labels and a bill of materials parts list.*

### Course Relationship to BSAE Program Outcomes

	A	B	C	D	E	F	G	H	I
<i>Learning Outcomes</i>									
1 – 2	+								
3 – 4,	++								
5	+++	+++							
6, 12 – 13		+++		O	O			++	+++
7 - 11	++								
14	+++	+++	O	O	O		O	++	

- +: Skill level 1 or 2 in Bloom's Taxonomy
- ++: Skill level 3 or 4 in Bloom's Taxonomy
- +++ : Skill level 5 or 6 in Bloom's Taxonomy
- O Skill addressed but not assessed

#### Topics:

*Introduction to CAD.*

*Creating sketches.*

*Creating parts.*

*Creating features.*

*Cover basic drafting standards.*

*Creating drawings.*

*Creating assemblies.*

*Creating exploded views.*

*Advanced sketching, constraining and modeling techniques.*

## AE 30 – Programming for Aerospace Engineers

Credit: 2 semester units  
Contact time: 1hr lecture + 3hrs lab

Instructor: Long Lu

Textbooks: Attaway, Stormy, *MATLAB: A Practical Introduction to Programming and Problem Solving*, 3<sup>rd</sup> ed., Elsevier Inc., 2013.  
Kernigham, Brian W., and Ritchie, Dennis M., *The C Programming Language*, 2<sup>nd</sup> ed., Prentice Hall, NJ, 1988.

Other supplemental materials: Instructor Notes

Catalog description:

*Introduction to the fundamentals of programming in MATLAB/Simulink and C. Topics in MATLAB programming include variables, characters and encoding, vectors and matrices, input and output, user-defined functions, selection and loop statements, modular programming, debugging, and plotting techniques. Topics in Simulink programming include block diagrams and libraries, wiring techniques, modeling, and simulations. Topics in C programming include variables, data types, operators, expressions, statements, input and output, arrays, functions, arguments, control flow, and program structure.*

Prerequisites or co-requisites: None

### **Required** course

Course Goals: Introduce students to...

- *Developing algorithms, pseudocode, and flowcharts.*
- *Writing, compiling, analyzing, and debugging computer programs in MATLAB/Simulink and C.*
- *Applying computer programming in solving aerospace engineering problems.*

Course Learning Outcomes:

Upon successful completion of this course, students will be able to...

1. *Develop algorithms, pseudocode, and flowcharts.*
2. *Define and manipulate variables in MATLAB.*
3. *Define, index, and manipulate vectors and matrices in MATLAB.*
4. *Write, compile, analyze, and debug user-defined functions in MATLAB.*
5. *Incorporate selection and loop statements in MATLAB.*
6. *Utilize modular programming to write a program in MATLAB.*
7. *Plot and interpret data in MATLAB.*
8. *Draw and interpret block diagrams.*
9. *Derive transfer functions from block diagrams.*
10. *Construct block diagrams in Simulink.*

11. Model and simulate dynamic systems in Simulink.
12. Define variables, data types, operators, and expressions in C.
13. Define and utilize control flow in C.
14. Write, compile, analyze, and debug programs in C.
15. Work effectively in teams to define, propose, and solve an aerospace engineering problem utilizing MATLAB/Simulink programming.

Course Relationship to BSAE Program Outcomes

	A	B	C	D	E	F	G	H	I
<i>Learning Outcomes</i>									
1 – 15									++

- +: Skill level 1 or 2 in Bloom’s Taxonomy
- ++: Skill level 3 or 4 in Bloom’s Taxonomy
- +++: Skill level 5 or 6 in Bloom’s Taxonomy
- O Skill addressed but not assessed

Topics:

- Introduction to MATLAB programming.*
- Selection statements.*
- Loop statements and vectorizing code.*
- MATLAB programs.*
- Plotting techniques.*
- Introduction to Simulink.*
- Introduction to C programming.*
- Types, operators, and expressions.*
- Control flow.*
- Functions and program structure.*

## MatE 25 – Introduction to Materials

Units: 3, Contact Hours: Lecture 2 hours / Lab 3 hours

Instructor: Michael Oye, Ph.D.

Textbook: Materials Science And Engineering, An Introduction, Ninth Edition, William D. Callister, Jr., John Wiley & Sons, Inc.  
Materials Engineering 25 Laboratory Handbook

### Specific course information

Description: Atomic and crystal structures; imperfections and atom movement; phase equilibria and transformations; boundaries; heat treatment of metals; mechanical, physical and chemical properties of engineering materials.

Prerequisite: CHEM 001A; PHYS 050; MATH 031

Designation: Required

### Specific goals for the course

Recognize the role materials have played in shaping the history of the world including present day technologies.

Identify how materials properties impact performance and reliability in specific engineering technologies.

Identify how materials engineers interact with other engineering disciplines

Relationship of Course to Student Outcomes: This lower-division engineering fundamentals course contributes to student outcomes as follows:

- (1) Ability to apply knowledge of mathematics, science and engineering
- (2) Ability to design/conduct experiments and analyze/interpret data
- (3) Ability to communicate effectively

### Brief list of topics to be covered

Atomic and crystal structures

Imperfections and atom movement

Phase equilibria and transformations

Boundaries

Heat treatment of metals

Mechanical, physical and chemical properties of engineering materials



## **EE 98 – Introduction to Circuit Analysis**

**Units:** 3, Contact Hours: 3

**Instructor:** David W. Parent

**Textbook:** Fundamentals of Electric Circuits, 4th Edition, by Alexander and Sadiku, McGraw Hill

### **Specific course information**

Description: Circuit laws and nomenclature, resistive circuits with DC sources, ideal operational amplifier, controlled sources, natural and complete response of simple circuits, steady-state sinusoidal analysis and power calculations

Prerequisites: ENGR 10 and Phys 51 with a C or better Corequisite: MATH 133A or MATH 123

Designation: Required

### **Specific goals for the course**

Determine voltages and currents in a DC circuit consisting of resistors, current sources, voltage sources, and dependent sources

Determine Thevenin and Norton equivalent circuit of a DC circuit and find the maximum power output of a DC circuit

Determine the DC gain and operating point of an OP amp circuit

Determine the transient response of a first and second order circuit consisting of RLC

Determine the sinusoidal steady state response of a circuit consisting of RLC

Determine the power delivered and absorbed by an element in a RLC circuit

**Relationship of Course to Student Outcomes:** This lower-division engineering fundamentals course contributes to student outcomes as follows:

(1) Ability to apply knowledge of mathematics, science and engineering

### **Topics**

Ohm's law and Kirchhoff's laws

Series and parallel circuits

Superposition

Thevenin and Norton Equivalent

Maximum power transfer

Nodal and mesh analysis

Active and op amp circuits

Capacitors and inductors

Transient analysis

Steady state analysis

AC power

## **Engr. 100W – Engineering Reports**

Units: 3, Contact Hours: 3

Instructor: Thalia Anagnos, Ph.D., Stacey Knapp, MFA

**Textbook:** Technical Communication, 10<sup>th</sup> edition, by Mike Markel, Print ISBN: 978-0-312-67948-4 Bedford/St.Martin  
Environmental Studies: Principles of Environmental Science, 7<sup>th</sup> edition

### **Specific course information**

***Description:*** Regular technical writing assignments and company-focused oral presentations while integrating effects of environmental factors as they relate to products, systems and engineering processes.

***Prerequisite:*** ENGL 1B (with a grade of C or better); Completion of core GE, satisfaction of Writing Skills Test and upper division standing.  
Undergraduates must have successfully completed GE Areas A2, A3 (English 1A, 1B) with at least a C grade (C- or below is not accepted) and must have passed the WST Exam or the 100A course.

***Designation:*** Required

### **Course Goals**

Write complete essays that demonstrate college-level proficiency  
Produce discipline-specific written work that demonstrates upper-division proficiency in language use, grammar, and clarity of expression  
Explain, analyze, develop, and criticize ideas effectively, including ideas encountered in multiple readings and expressed in different forms of discourse  
Organize and develop essays and documents for both professional and general audiences  
Organize and develop essays and documents according to appropriate editorial and citation standards  
Locate, organize, and synthesize information effectively to accomplish a specific purpose, and to communicate that purpose in writing

### **Course Relationship to Student Outcomes:**

This upper-division course contributes to student outcomes as follows:

- (1) Understanding of professional and ethical responsibility
- (2) Ability to communicate effectively
- (3) Understand the impact of engineering solutions in a global/societal context
- (4) Recognition of the need for and an ability to engage in life-long learning
- (5) Knowledge of contemporary issues

**Topics:**

Formal Letter and Resume  
Analysis of Professional Journal Articles  
Interview with an Engineer  
Team proposals

## **Engr. 195A – Global & Social Issues in Engineering I**

Credit: *1 semester unit*

Contact time: *50 min lecture*

Instructor: *Dr. Megan Thiele*

Course Coordinator: *Dr. Patricia Backer*

Textbook: *None.*

### Course Description:

*Interdisciplinary seminar treating social and global impacts of technology and engineering. This integrated GE experience requires students to apply these concepts in their senior project classes. Students must enroll concurrently in their department senior project course Part A.*

### Prerequisites:

*Engr. 100W. Engineering majors only; passage of the Writing Skills Test (WST) or English/LLD 100A, completion of Core General Education and upper division standing are prerequisites to all SJSU studies courses.*

### **Required** course

### Course Learning Outcomes

Upon successful completion of this course, students will be able to:

*S-LO1: Describe how identities (i.e. religious, gender, ethnic, racial, class, sexual orientation, disability, and/or age) are shaped by cultural and societal influences within contexts of equality and inequality.*

*S-LO2: Describe historical, social, political, and economic processes producing diversity, equality, and structured inequalities in the U.S.*

*S-LO3: Describe social actions which have led to greater equality and social justice in the U.S. (i.e. religious, gender, ethnic, racial, class, sexual orientation, disability, and/or age).*

*S-LO4: Recognize and appreciate constructive interactions between people from different cultural, racial, and ethnic groups within the U.S.*

### Course Relationship to BSAE Student Outcomes

*This course addresses Outcome G:*

*Broad education to understand current events, how they relate to aerospace engineering, as well as the impact of engineering solutions in a global and societal context.*

### Topics

- *Culture & Identity in the Social World; Identity, Positionality, and Power*
- *Identity, Positionality, and Social Justice*
- *Understanding the Framework for Environmental Justice in Silicon Valley*
- *Immigrants and the Pre-World War II Era: The Valley of the Hearts Delight*

- *“The Secrets of Silicon Valley” Environmental and Social Consequences of the High-Tech Global Economy*
- *Technologies, educational access, and social justice.*
- *Access to engineering education and careers.*
- *How inclusion helps engineers meet the needs of diverse publics.*
- *A Call to Action: How can community and industry respond to contemporary social issues?*

## **Engr. 195B – Global & Social Issues in Engineering II**

Credit: *1 semester unit*

Contact time: *50 min lecture*

Instructor: *Kyle Yrigoyen*

Course Coordinator: *Dr. Patricia Backer*

Textbook: *None.*

### Course Description:

*Interdisciplinary seminar treating social and global impacts of technology and engineering. This integrated GE experience requires students to apply these concepts in their senior project classes. Students must enroll concurrently in the 2<sup>nd</sup> semester of their senior design course.*

### Prerequisites:

*Engr. 195A. Engineering majors only with the passage of the Writing Skills Test (WST) or English / LLD 100A, completion of Core General Education and upper division standing are prerequisites to all SJSU studies courses.*

### **Required** course

### Course Learning Outcomes

Upon successful completion of this course, students will be able to:

*V-LO1: Compare systematically the ideas, values, images, cultural artifacts, economic structures, technological developments, and/or attitudes of people from more than one culture outside the U.S.*

*V-LO2: Identify the historical context of ideas and cultural traditions outside the U.S. and how they have influenced American culture.*

*V-LO3: Explain how a culture outside the U.S. has changed in response to internal and external pressures.*

### Course Relationship to BSAE Student Outcomes

*This course addresses Outcome G:*

*Broad education to understand current events, how they relate to aerospace engineering, as well as the impact of engineering solutions in a global and societal context.*

### Topics

- Overview of the history of technology; What is technology? Technology and values
- The impacts of biotechnologies
- Technology, culture, and human values
- Time as artifact
- Technology, culture, and history
- The impacts of mobile technologies
- Mobile technologies and social justice

## AE 110 – Space Systems Engineering

Credit: 3 semester units  
Contact time 2 hrs:30 min lecture

Instructor: Darryl LeVasseur

Textbook: Systems Engineering: Design Principles and Models  
Author: Dahai Liu  
ISBN13: 978-1466506831  
ISBN10: 1466506830

Other supplemental materials: Instructor Notes

Catalog description:

Introduction to design, analysis and operation of spacecraft power, communications, attitude determination/control, structures, propulsion, thermal management systems. Typical payload systems design and operation, including remote Earth sensors. System integration issues. Lab experiments and field trips.

Prerequisite: AE 165

Upper Division *Elective* Course

Course Goals:

- Provide descriptions of the various elements comprising a space system.
- Expose students to the challenge of integrating space system elements.
- Provide an in-depth exposure to at least one spacecraft subsystem groups.
- Educate students in the area of analysis and optimization of multidisciplinary space systems during the conceive and design phases.
- Become familiar with the basic concepts of multi-objective optimization.

Course Learning Outcomes:

Upon successful completion of this course, students will be able to...

1. Identify each element of a space system.
2. Identify each subsystem of a spacecraft.
3. Describe the effects of space environments on a spacecraft.
4. Describe and implement system requirements.
5. Describe systems contingency, margins, factors, and budgets.
6. Apply model based system engineering techniques to design of product development.
7. Decipher manufacturer data sheets.
8. Subdivide a complex system into smaller disciplinary models, manage their interfaces and reintegrate them into an overall system model.

9. Perform a systems-level analysis of spacecraft subsystems including communication, power, thermal, attitude control, structures, guidance and navigation.
10. Use traditional numerical optimization algorithms and interpret result.
11. Conduct a risk assessment of a system and generate a risk matrix.
12. Study a single spacecraft subsystem in detail within a team of 2-3 students and present their findings in class in a series of lectures.
13. Rationalize and quantify a system architecture or product design problem by selecting appropriate objective functions, design parameters and constraints.
14. Formulate a high-level spacecraft design given basic design parameters with imposed student generated requirements and constraints, involving trade-offs between competing subsystems demands.

#### Course Relationship to BSAE Student Outcomes

	A	B	C	D	E	F	G	H	I
Learning Outcomes									
1 – 2			O						
3 – 4					O				
5 – 6			O						
7 – 8				O				O	
9 – 10	O			O	O				O
11 – 12	O			O	O	O	O		O
13 – 14	O		O	O	O	O	O	O	O

+: Skill level 1 or 2 in Bloom's Taxonomy

++: Skill level 3 or 4 in Bloom's Taxonomy

+++: Skill level 5 or 6 in Bloom's Taxonomy

O: Skill addressed but not assessed

#### Topics:

- Introduction to model based systems engineering.
- Project life cycles, scope, & con ops.
- System hierarchy, WBS.
- Requirements, writing and understanding.
- Space vehicle subsystems.
- Space environments.
- Design, trade studies, iterations, technical reviews.
- Risk, optimization, lessons learned.
- Requirements verification- inspection, demonstration, test, analysis.
- Management, ethics.



## AE 112 – Aerospace Structural Analysis I

Credit: 4 semester units  
Contact time 2 hrs:30 min lecture

Instructor: Dr. Peggy Boylan-Ashraf

Textbook: Riley, Struges & Morris: Statistics and Mechanics of Materials (2<sup>nd</sup>).  
ISBN 10: 0471434469

Other supplemental materials: Instructor Notes

### Catalog description:

Introduction to aerospace structures through problem solving and experiments in fundamentals of equilibrium analysis, which leads to stress analysis –a highly essential component for failure prediction. All topics are applied to aerospace vehicles and will include aircraft and spacecraft loads, introduction to axial (compression and tensile), torsional, and flexural loadings; safety factor; and shear force-bending moment diagrams.

Prerequisites: “C” or better in Math 32, Phys 50

### **Required** course

Course goals: Introduce students to...

- Equilibrium analysis of aerospace rigid bodies under various combinations of applied loads.
- Solid body mechanics.
- Fundamentals of stress analysis.

### Course Learning Outcomes:

Upon successful completion of this course, students will be able to...

1. Analyze force and moment vectors by using appropriate coordinate systems and units.
2. Construct complete and correct free-body diagrams and develop equilibrium equations.
3. Calculate reactions of supports necessary to ensure static equilibrium of rigid bodies.
4. Explain the concept of and perform calculations for centroids and center of mass.
5. Analyze complex distributed loads, perform calculations of internal forces and moments, and draw shear force-bending moment diagrams.
6. Describe and perform stress, strain, and deformation calculations.
7. Analyze structures experiencing combined loads and characterize multiaxial stress states.
8. Construct stress states and perform calculations of principal stresses and maximum shear stress.

9. Analyze stresses and deflections of beam structures experiencing a combination of internal transverse shear and bending moment.
10. Classify types of loadings (axial, torsional, and flexural) on a solid aerospace structures.

Course Relationship to BSAE Student Outcomes

	A	B	C	D	E	F	G	H	I
<i>Learning Objectives</i>									
1 – 5	++								
6	++	O		O					O
7 – 10	++								

- +: Skill level 1 or 2 in Bloom’s Taxonomy
- ++: Skill level 3 or 4 in Bloom’s Taxonomy
- +++: Skill level 5 or 6 in Bloom’s Taxonomy
- O: Skill addressed but not assessed

Topics:

- Forces Resultants.
- Rectangular vs Non-Rectangular Components.
- Particles: Equilibrium (2D and 3D).
- Moments (Characteristics) and Moments (2D and 3D).
- Couples.
- Equivalent Force-Couple (3D).
- Center of Mass, Centroids, and Composite Bodies.
- Distributed Loads.
- Rigid Bodies: Free Body Diagram.
- Equilibrium (2D and 3D).
- Frames and Machines (spoilers, elevator bell crank mechanism, conventional aircraft mechanical systems, aircraft control linkages, landing gear).
- Stress-Strain Concepts, Deformation (Hooke’s Law experiment).
- Thermal Effects, Safety Factor.
- Axial Loading (tensile and compression).
- Torsional Loading.
- Stresses on Oblique Planes.
- Flexural Loading.
- Second Moments.
- Elastic Flexural Formula.
- V&M Diagram.
- General Combined Loading (rudder pedals, propeller shafts, cargo compartment).
- Principal Stresses and Maximum Shear Stress.
- Mohr’s Circle.

## AE 114 – Aerospace Structures II

Credit: 3 semester units  
Contact time: 2hr: 30min lecture

Coordinator: Dr. Arun K. Banerjee

Textbook: Bruhn: *Analysis and Design of Aircraft Structures*

Other supplemental materials:

*Niu: Airframe Structural Design: Practical Design Information on Aircraft Structures*

*Megson: Aircraft Structures for Engineering Students*

*Yang: Finite Element Structural Analysis*

*Inman: Engineering Vibration*

Catalog description:

*Aircraft and spacecraft structural analysis and design. Conventional and introductory finite element methods. Bending and shear stress analysis as well as shear flow analysis. Aircraft wing and fuselage design considerations. Matrix structural analysis of spacecraft truss structure joint displacement.*

Prerequisite: “C” or better in AE112 or graduate standing

### **Required** course

Course Goals:

- *Demonstrate the iterative design/analysis process of aerospace structures.*
- *Delineate the tradeoffs present in the structural design of aerospace vehicles.*
- *Examine actual aircraft design successes and failures via case studies.*
- *Show the application of air loads, mass properties and materials in the consideration of aircraft structural design.*

Course Learning Outcomes:

Upon successful completion of this course, students will be able to...

1. *Construct the axial force, shear force and bending moment diagrams for aircraft beam structures*
2. *Perform a buckling analysis for a beam-column-type structure.*
3. *Compute bending moment diagram and the position of maximum bending moment for a wing strut and a landing gear strut in compression*
4. *Experimentally determine the effect on bending of the rib lightening holes of the Beechcraft 99 tail section.*
5. *Determine the shear flow distribution for a (closed) multiple-cell wing section under torsion.*
6. *For a wing section subjected to multiple bending moments, find the bending stress in the wing stringers.*

7. *Plot the shear flow distribution and find the location of the shear center for an (open) thin-walled wing cross section under a shear load.*
8. *Experimentally and analytically determine the shear center of the C-channel cantilever beam.*
9. *Determine the shear flow distribution and shear center location for a (closed) thin-walled section with stringers.*
10. *Calculate and experimentally verify the shear center of the Alouette helicopter rotor blade section.*
11. *Using the Finite Element Method, assemble the stiffness matrix for a spacecraft truss structure.*
12. *Analyze a spacecraft truss structure to determine axial force and joint displacement.*

Course Relationship to BSAE Student Outcomes

	A	B	C	D	E	F	G	H	I
<i>Learning Outcomes</i>									
1 – 3	++								
4, 8, 10		++							
6, 7, 9, 12	++								
11									+

- +: Skill level 1 or 2 in Bloom’s Taxonomy
- ++: Skill level 3 or 4 in Bloom’s Taxonomy
- +++: Skill level 5 or 6 in Bloom’s Taxonomy
- O Skill addressed but not assessed

Topics:

- Statics of Aircraft & Two-Dimensional Inertia Properties of Wing Sections.*
- History of Aircraft & Spacecraft Structures.*
- Structural Design Considerations for Contemporary Aircraft.*
- Bending Moments on Beam Columns.*
- Pure Torsion and Pure Bending.*
- Aircraft Static Testing: Strain Gauges and Data Acquisition.*
- Torsion of Circular Cross Sections, Thin-Walled Cross Sections.*
- Non-symmetrical Bending Stresses; Shear Center.*
- Structural Design Considerations for Contemporary Aircraft.*
- Shear Flow and Shear Center in an Open Section and a Section with Stringers.*
- Analysis of Wing Structures & Analysis of a Whole Wing.*
- Components of Fuselage Design.*
- Fuselage Stress Analysis.*
- Loads and Stresses on Ribs & Frames.*
- Booms and Truss Structures; Introduction to Finite Element Analysis.*
- Axial Force and Joint Displacement.*

## AE 138 – Vector-Based Dynamics for Aerospace Applications

Credit: 3 semester units  
Contact time: 2 hrs:30 min lecture

Coordinator: Jeanine M. Hunter

Textbook: Mitiguy: *Dynamics of mechanical, Aerospace and Biomechanical Systems*, MotionGenesis, Inc.

Other supplemental materials: Hibbeler: *Engineering Mechanics and Dynamics*  
Greenwood: *Principles of Dynamics*  
Kane: *Dynamics*  
Thomson: *Introduction to Space Dynamics*  
Anderson: *Introduction to Flight*

Catalog description:

*Vector mechanics of three degree-of-freedom particle motion. Particle kinematics, reference frames and rotational relative motion. Two degree-of-freedom rigid body motion, moments/products of inertia. Particle & rigid body equations of motion and numerical time histories.*

Prerequisite: "C" or better in Math 32, Phys 50

Co-requisite: AE112

### **Required** course

Course Goals:

1. Provide a fundamental knowledge of vector dynamics for aerospace applications.
2. Establish the basics of reference frame mechanics and relative motion.
3. Provide the fundamentals of aerospace vehicle center of mass (particle) kinematics of using Newtonian methods.
4. Write center of mass (three-dimensional) equations of motion using vector mechanics.
5. Understand the influence of vehicle moments/products of inertia on rigid body rotational motion.
6. Develop physical intuition about aerospace vehicle motion by examining the connection between the differential equations (equations of motion) and their time history solution.

Course Learning Outcomes:

1. Combine and solve for vectors using the operations of vector algebra.
2. Find area using vector algebra.
3. Set up aerospace-vehicle-fixed basis vectors and use them to express and solve for cm (particle) position.
4. Set up a direction cosine matrix relating the planar orientation of two reference frames.

5. *Express and resolve vectors (position, velocity, acceleration) into reference frames related by direction cosine matrices.*
6. *Differentiate scalars representing vehicle states; differentiate vectors in arbitrary reference frames.*
7. *Express vehicle angular velocity/acceleration and relate these concepts to the direction cosine matrix.*
8. *Solve kinematic (position/velocity/acceleration) problems when multiple reference frames are involved.*
9. *Express particle and rigid body constraints for rolling and sliding (slipping) situations.*
10. *Calculate mass center of a system of particles and of a rigid body.*
11. *Calculate aerospace vehicle model (rigid body) mass moments/products of inertia (mass properties). Intuitively understand the relationship between mass properties and rigid body motion.*
12. *Write the linear/angular momentum vectors of a dynamic system.*
13. *Inertially differentiate linear/angular momentum vectors, set them equal to applied forces/moments and thereby write the equations of motion of the system.*
14. *Write the total kinetic energy and use it to solve for the motion/reaction forces, etc. of a dynamic system.*
15. *Use MotionGenesis to model the equations of motion of a dynamic system.*
16. *Pose an end-of semester dynamics question and carry out a team project which answers the question.*

#### Course Relationship to BSAE Student Outcomes

	A	B	C	D	E	F	G	H	I
<i>Learning Objectives</i>									
1 - 14	++								O
15	++			O	O				O
16	++			O	O				O

- +: Skill level 1 or 2 in Bloom's Taxonomy
- ++: Skill level 3 or 4 in Bloom's Taxonomy
- +++: Skill level 5 or 6 in Bloom's Taxonomy
- O Skill addressed but not assessed

#### Topics:

- Rigid body translational kinematics.*
- General motion with respect to the rotating Earth.*
- Euler angles. Rigid body rotational kinematics.*
- Angular momentum of a rigid body.*
- Moments/products of inertia, principal axes.*
- Euler's moment equation.*
- Solution of general gyro equations.*
- General rigid body gyroscopic motion. Gyroscopic instruments.*
- Stable platform for inertial guidance.*
- Six degree of freedom rigid body equations of motion.*
- Satellite de-spinning. Spacecraft attitude drift.*
- Lagrange's equations.*

## AE 140 – Rigid Body Dynamics

Credit: 3 semester units  
Contact time: 2 hrs:30 min lecture

Coordinator: Jeanine M. Hunter

Textbook: *Mitiguy: Dynamics of Mechanical, Aerospace and Biomechanical Systems*

Other supplemental materials: *Cannon, Robert: Dynamics of Physical Systems*  
*Greenwood: Principles of Dynamics*  
*Kane: Dynamics*  
*Syngé & Griffith: Principles of Mechanics*

Catalog description:

*Co-ordinate frames and descriptions of absolute and relative motion. Particle motion with respect to the rotating Earth. General equations of rotation motion in Newtonian and Lagrangian formulations. Spinning bod motions. Gyroscopic instruments. Stable platform for inertial guidance. Applications to aerospace vehicles.*

Prerequisite: “C” or better in AE138.

### **Required** course

Course goals:

- *Introduce students to the fundamentals of intermediate dynamics of rigid bodies using Newtonian, Lagrangian and Eulerian dynamics.*
- *Provide a review of point-mass dynamics.*
- *Show the different approaches available in analyzing an equation of motion.*
- *Demonstrate the connection between modeling, simulation, numerical solution.*

Course Learning Outcomes:

Upon successful completion of this course, students will be able to...

1. *Develop a direction-cosine matrix and use it to transform vectors among reference frames.*
2. *Different a vector in multiple reference frames.*
3. *Choose the appropriate reference frames for writing equations of motion.*
4. *Derive point-mass equations of motion using Newton’s or Lagrange’s method.*
5. *Write equations which define the motion of a particle with respect to the rotating Earth; identifying Coriolis and centripetal contributions.*
6. *Integrate Earth-relative particle equations to determine particle position.*
7. *Predict Earth-relative particle position using engineering judgment*
8. *Describe the differences between northern- and southern- hemisphere motion, e.g. rotation of low pressure systems.*
9. *Calculate rigid body mass properties and transform them among reference frames.*

10. *Compose the angular momentum vector and differentiate it inertially.*
11. *Write rigid body equations of motion using Newtonian and Lagrangian methods.*
12. *Apply concepts of nutation and precession in describing the motion of aerospace vehicles.*
13. *Compute and draw the orientations of the space and body cones.*
14. *Distinguish between direct and retrograde motion; understand and predict the differences in dynamic response from the equations of motion.*
15. *Understand and predict the motion of a top.*
16. *Apply the principles of rigid body motion to gyroscopic instruments.*

Course Relationship to BSAE Student Outcomes

	A	B	C	D	E	F	G	H	I
<i>Learning Outcomes</i>									
1 – 16	++								

+: Skill level 1 or 2 in Bloom's Taxonomy

++: Skill level 3 or 4 in Bloom's Taxonomy

+++: Skill level 5 or 6 in Bloom's Taxonomy

✓ Skill addressed but not assessed

Topics:

- *Rigid body translational kinematics.*
- *General motion with respect to the rotating Earth.*
- *Euler angles.*
- *Rigid body rotational kinematics.*
- *Angular momentum of a rigid body.*
- *Moments/products of inertia, principal axes.*
- *Euler's moment equation.*
- *Solution of general gyro equations.*
- *General rigid body gyroscopic motion.*
- *Gyroscopic instruments.*
- *Stable platform for inertial guidance.*
- *Six degree of freedom rigid body equations of motion.*
- *Satellite de-spinning.*
- *Spacecraft attitude drift.*
- *Lagrange's equations.*



## AE 142 – Astrodynamics

Credit: 3 semester units  
Contact time: 2 hrs:30 min lecture

Coordinator: Jeanine M. Hunter

Textbook: Hunter: *Astrodynamics Course Reader (Maple Press)*

Other supplemental materials: *Curtis: Orbital Mechanics for Engineering Students*  
*Anderson: Introduction to Flight*  
*Szebehely: Adventures in Celestial Mechanics*  
*Sellers: Understanding Space*  
*Thomson: Introduction to Space Dynamics*  
*Bate, Mueller & White: Fundamentals of Astrodynamics*  
*Mitiguy: Dynamics of Mechanical, Aerospace and Biomechanical Systems*

Catalog description:

*Two-body and restricted three-body problem analysis and orbit design; Kepler's Laws; Keplerian elements; Single-impulse orbit transfers; Hohmann transfers; Circularization; Plane changes; Kepler's Equation; Planetary sphere of influence; Interplanetary flight; Patched conic trajectory model; Gravity-assist trajectories.*

Prerequisites: "C" or better in AE138 & AE165.

### ***Elective*** course

Course Goals:

- *Provide a fundamental knowledge of orbital mechanics.*
- *Understand the assumptions of the various astrodynamics models.*
- *Apply the equations of three-dimensional particle dynamics to orbits & trajectories.*
- *Use vector mechanics to model interplanetary flight.*
- *Examine case studies and develop an understanding of optimal orbit design strategies.*
- *Model the Earth/Moon/spacecraft system using the assumptions of the restricted three-body problem.*

Course Learning Outcomes:

Upon successful completion of this course, students will be able to...

1. *Derive two-body problem equations of motion.*
2. *Model two-body orbit as a conic section.*
3. *Solve for velocity variation as a function of position along orbit.*
4. *Define elliptical orbit from burnout conditions.*
5. *Orbit determination from two observations.*
6. *Calculate circular velocity and escape velocity as a function of altitude.*
7. *Derive and understand the significance of Kepler's Laws of Planetary Motion.*

8. Calculate Earth-centered Newtonian position and velocity from Keplerian elements.
9. Find time along the orbit (time since periapsis passage) using Kepler's equation.
10. Calculate velocity along a hyperbolic orbit, turn angle, aiming radius, hyperbolic excess speed, etc.
11. Model orbits from case studies; discuss tradeoffs made in the design decisions.
12. Design single impulse  $\Delta v$  burns for orbit transfers.
13. Calculate total  $\Delta v$  for a Hohmann transfer around a single central force body.
14. Optimize the circularization maneuver.
15. Find wait time and phasing angle for a rendezvous scenario.
16. Design an impulse burn to pivot the orbital plane and calculate the required  $\Delta v$ .
17. Compute the sphere of influence of a given central force body.
18. Using appropriate reference frames and knowledge of relative motion, design patched conic trajectories for interplanetary travel.
19. Design & analyze planetary flyby opportunities for changing heliocentric orbital energy.
20. Derive equations of motion for the restricted 3-body problem; solve simple cases

#### Course Relationship to BSAE Program Outcomes

	A	B	C	D	E	F	G	H	I
<i>Learning Outcomes</i>									
1 – 15, 17, 20	++								
16, 18, 19	+++			O	O			O	O

+: Skill level 1 or 2 in Bloom's Taxonomy

++: Skill level 3 or 4 in Bloom's Taxonomy

+++ : Skill level 5 or 6 in Bloom's Taxonomy

O Skill addressed but not assessed

#### Topics:

- *The Two-Body Problem.*
- *Conic Section Solution to the Equations of Motion.*
- *Orbit Energy.*
- *Relationship of Orbit Energy to Orbit Type.*
- *Escape Velocity, Circular Velocity.*
- *Orbit Determination from Observations.*
- *History of Celestial Mechanics.*
- *Kepler's Laws of Planetary Motion.*
- *The Six Keplerian Elements.*
- *Hohmann Transfer, Single Central Force Body.*
- *Rendezvous and Phasing.*
- *Interplanetary Flight Strategies & Case Studies.*
- *Sphere of Influence; Patched Conic Trajectory Approximation.*
- *Gravity-Assist (Flyby) Trajectory.*
- *The Restricted Three-Body Problem.*

## **AE 157 – Aerospace Automatic Control Systems Design**

Credit: 3 semester units  
Contact time: 2 hrs:30 min lecture

Coordinator: Dr. Kamran Turkoglu

Textbook: K. Ogata, *Modern Control Engineering*, Prentice Hall, 5<sup>th</sup> Edition, 2010.

Other supplemental materials: Instructor Notes

Catalog description:

*Modeling and analysis of aerospace feedback control systems. Stability analysis, root locus design, and frequency response methods for aerospace vehicles and associated automatic control systems. Nyquist/Bode diagrams. Lead-lag, PID compensator designs for aircraft and spacecraft.*

Prerequisites: “C” or better in Math 129A, Math 133A, AE138.

### **Required Course**

Course Goals:

- *Develop an understanding of aerospace automatic control systems design and develop specific strategies to tackle practical engineering problems in aerospace engineering.*
- *Provide background in automatic control systems design with specific applications on aircraft, spacecraft and satellites.*
- *Develop an understanding of the fundamental elements in classical control theory as applied to aircraft and spacecraft.*

Course Learning Outcomes:

Upon successful completion of this course, students will be able to...

1. *Outline the fundamental concepts of classical control theory as applied to aircraft and spacecraft.*
2. *Describe transient response and frequency response of aerospace automatic control systems.*
3. *Formulate basic control actions and frequency response of aerospace automatic control systems.*
4. *Explain the concept of feedback and its function in aerospace vehicles.*
5. *Analyze stability and stability margins in aerospace vehicle motions.*
6. *Outline the fundamentals of modern control theory as it is applied to aerospace vehicles.*
7. *Determine the natural frequencies and damping ratios of aerospace vehicle dynamics. Evaluate the effect of time-delay on aircraft and satellite control system performance.*
8. *Evaluate the effect of time-delay on aircraft and satellite control system performance.*

9. *Justify the significance of the negative and positive feedback.*
10. *Derive transfer functions and plot vehicle time response.*
11. *Use root locus and frequency response techniques to design closed-loop control systems: rate-damping, attitude control, altitude control.*
12. *Design a satellite control law using classical/modern automatic control system design principles.*
13. *Design a 3-axis control law for a spacecraft controlled by cold-gas jets.*

Course Relationship to BSAE Program Outcomes

	A	B	C	D	E	F	G	H	I
<i>Learning Outcomes</i>									
1 – 13	++	O	O	O	O	O	O	O	O

+: Skill level 1 or 2 in Bloom’s Taxonomy

++: Skill level 3 or 4 in Bloom’s Taxonomy

+++: Skill level 5 or 6 in Bloom’s Taxonomy

O Skill addressed but not assessed

Topics:

- *Introduction to aerospace control systems design.*
- *Laplace transforms, Introduction to Matlab & Simulink.*
- *Mathematical modeling of aerospace and dynamic systems.*
- *Stability analysis of aerospace control systems.*
- *Time domain response of aerospace vehicle dynamics.*
- *Classical control techniques.*
- *Effect of zeros and poles on aerospace vehicle response.*
- *Interconnection of systems.*
- *Impulse response analysis.*
- *Steady-state frequency response of aerospace vehicle dynamics.*
- *Bode-plots and frequency domain analysis of aerospace systems.*
- *Loop shaping design and practical applications on aerospace sys.*
- *Gain, phase, and time-delay margins in stability analysis of aerospace system.*
- *Nyquist stability theorem.*
- *Robustness margins and applications on aerospace systems.*
- *Implementation of discreet aerospace automatic control systems.*

## AE 160 – Aerodynamics I

Credit: 3 semester units  
Contact time: 2 hrs:30 min lecture

Coordinator: Dr. Nikos J. Mourtos

Text book: Anderson, J.D., *Fundamentals of Aerodynamics*, 6<sup>th</sup> ed., 2017.  
ISBN 978-1-259-12991-9

Other supplemental materials: *Instructor Notes*

### Catalog description:

*Introduction to incompressible, inviscid, and viscous aerodynamics through problem solving, computer simulations, water and wind tunnel experiments, films, and service learning. Topics include aerodynamic forces and moments, flow classification and similarity, conservation laws with applications in the calculation of lift and drag, and boundary layer theory with emphasis on calculation of skin friction and pressure drag.*

Prerequisites: “C” or better in Math 32, Phys 50 or graduate standing.

Co-requisite: Engr. 100W

### **Required** course

Course Goals: Introduce students to...

- *Modeling of low speed, viscous and inviscid flows.*
- *Calculation of aerodynamic forces on aerospace and ground vehicles.*
- *Aerodynamic design for low drag.*
- *Water and wind tunnel testing.*

### Course Learning Outcomes:

Upon successful completion of this course, students will be able to...

1. *Explain the nature of aerodynamic forces.*
2. *Define the aerodynamic center and the center of pressure for an airfoil.*
3. *Calculate aerodynamic forces and moments on bodies by integrating surface pressure and shear stress distributions.*
4. *Use flow similarity to design wind tunnel tests.*
5. *Classify a flow as 1-D, 2-D or 3-D, uniform / non-uniform, viscous / inviscid, compressible / incompressible, steady / unsteady, subsonic, transonic, supersonic, or hypersonic.*
6. *Design and perform flow visualization tests to study the characteristics of the flow around 2-D and 3-D aerodynamic bodies and analyze the results from such experiments.*
7. *Use the momentum equation to calculate (a) lift from given pressure distributions on the top and bottom of an aerodynamic body and (b) drag from given velocity profiles ahead and downstream of an aerodynamic body.*

8. Describe qualitatively and quantitatively laminar and turbulent boundary layers in terms of thickness, velocity profiles, and shear stress variation.
9. Predict transition from laminar to turbulent flow on an aerodynamic surface.
10. Calculate the skin friction drag and estimate the pressure drag of aerodynamic bodies.
11. Predict location on an airfoil surface and inside a nozzle, where boundary layer separation is likely to occur.
12. Design and perform wind tunnel experiments to measure the drag of a 2-D aerodynamic body and analyze the results from such experiments.
13. Design and perform wind tunnel experiments to study boundary layer characteristics on an aerodynamic surface and analyze the results from such experiments.
14. Work effectively in teams to (a) define and solve open-ended aerodynamics problems, (b) design and perform water / wind tunnel experiments, and (c) analyze and present results from such experiments.

#### Course Relationship to BSAE Program Outcomes

	A	B	C	D	E	F	G	H	I
<i>Learning Outcomes</i>									
1 – 5	++			O	O			O	O
6, 12, 13	++	+++		++	++			++	++
7 – 11	++			O					
14		+++		+++	+++			+++	+++

+: Skill level 1 or 2 in Bloom's Taxonomy

++: Skill level 3 or 4 in Bloom's Taxonomy

+++ : Skill level 5 or 6 in Bloom's Taxonomy

O Skill addressed but not assessed

#### Topics:

- Introduction to fluids; fluid properties.
- Newton's law of viscosity: calculation of viscous forces.
- Aerodynamic forces and moments. Aerodynamic coefficients. Center of pressure. Aerodynamic center.
- Flow similarity. Application to wind tunnel testing.
- Flow description. Streamlines. Flow classification.
- Continuity. Flow quality. Wind tunnel design.
- Bernoulli's equation. Airspeed measurement. Airfoil pressure distributions.
- Momentum equation. Drag calculation for two-dimensional bodies.
- Boundary layers. Thickness, velocity, and shear stress distribution.
- Skin friction and pressure drag calculation.
- Boundary layer transition and separation. Boundary layer control.

## AE 162 – Aerodynamics II

Credit: 3 semester units  
Contact time: 2 hrs:30 min lecture

Coordinator: Dr. Nikos J. Mourtos

Textbook: Anderson, J.D., *Fundamentals of Aerodynamics*, 6<sup>th</sup> ed., 2017.  
ISBN 978-1-259-12991-9

Other supplemental materials: *Instructor Notes*

Catalog description:

*Airfoil and wing theory. Modeling of inviscid flows around aerodynamic bodies using 2-D and 3-D potential flow theory. Problem solving, computer simulations, wind tunnel experiments and team project.*

Prerequisites: “C” or better in Math133A, AE160.

Co-requisite: Engr100W.

### **Required** course

Course Goals: Introduce students to...

- *Low speed airfoil theory.*
- *Low speed wing theory.*
- *Aerodynamic simulations.*
- *Aerodynamic design of airfoils and wings.*
- *Aerodynamic interference.*

Course Learning Outcomes:

Upon successful completion of this course, students will be able to...

1. *Define the vorticity of a flow field and distinguish between rotational and irrotational flows.*
2. *Define circulation and calculate it around various paths.*
3. *Define the stream function and the potential function for a flow and calculate each, if they exist.*
4. *Analyze the elementary flows (uniform, source/sink, doublet, vortex, corner) as well as combinations of them.*
5. *Explain Kelvin’s theorem and its implications for the vortex system of an airfoil.*
6. *Use and interpret airfoil nomenclature.*
7. *Describe the aerodynamic characteristics of an airfoil and their importance in airplane design.*
8. *Explain the design and the performance improvements of modern airfoils (LS, MS, and supercritical).*

9. Use experimental data, thin airfoil theory results, and computer programs to predict aerodynamic characteristics of airfoils (e.g. lift and drag at various angles of attack, pitching moment about various points, ac location, etc.)
10. Design and perform an experiment to study the performance of an airfoil, analyze and interpret the results from this experiment, compare with analytical/computational predictions and other published experimental data, and explain any discrepancies.
11. Use the Biot-Savart law to calculate induced velocities in the vicinity of line vortices.
12. Explain how rectangular, swept, and delta wings differ in terms of maximum lift, lift slope, stall angle of attack, induced drag, skin friction drag, L/D at low speeds, and L/D at high speeds.
13. Describe the horseshoe vortex model for a wing and its limitations.
14. Apply Prandtl's lifting-line theory to calculate the aerodynamic characteristics of airplane wings.
15. Use the method of images to discuss and calculate aerodynamic interference for (a) wings flying in the vicinity of each other (ie., wing/tail/canard combination, biplanes, etc.), (b) wind-tunnel boundaries, and (c) ground effects.
16. Work effectively in a team to (a) define and solve open-ended problems that combine aerodynamics and flight performance, (b) design and perform wind tunnel experiments, and (c) analyze and interpret experimental data.

#### Course Relationship to BSAE Program Outcomes

	A	B	C	D	E	F	G	H	I
<i>Learning Outcomes</i>									
1 – 9	++			O	O			O	O
10		+++							
11 – 15	++								
16	+++	+++							

- +: Skill level 1 or 2 in Bloom's Taxonomy  
 ++: Skill level 3 or 4 in Bloom's Taxonomy  
 +++: Skill level 5 or 6 in Bloom's Taxonomy  
 O Skill addressed but not assessed

#### Topics:

- *Introduction to potential flow theory.*
- *Vorticity. Rotational and irrotational flows.*
- *Velocity potential and stream function.*
- *Elementary flows: uniform, source/sink, doublet, vortex.*
- *Cylinder pressure distributions.*
- *Airfoils: Kutta condition, nomenclature, characteristics, design and performance.*
- *Airfoil pressure distributions. Modern airfoils for low and high speed.*
- *High lift devices. Airfoil lift & drag.*
- *Wings: Induced drag, Biot-Savart law & twist, horseshoe vortex model & for high speeds/ Airfoil high-lift devices.*
- *Prandtl's lifting-line theory; elliptical & general lift distribution.*
- *Aerodynamic interference; method of images.*
- *Wind tunnel corrections; ground effect.*



## **AE 164 – Aerothermodynamics**

Credit: 5 semester units  
Contact time: 6 hrs:15 min lecture

Coordinator: Dr. Fabrizio Vergine

Textbook: Anderson, J.D., *Fundamentals of Aerodynamics*, 6<sup>th</sup> ed., 2017.  
ISBN 978-1-259-12991-9

Other supplemental materials: Instructor Notes

### Catalog description:

*Thermodynamic laws. Shock and expansion waves with applications to supersonic airfoils and wings. Nozzle flow. Flow with heat addition and friction. Aerodynamic heating. Conduction, convection and radiation heat transfer.*

Prerequisite: “C” or better in Phys52, AE 160

### **Required** course

Course Goals: Introduce students to...

- Accounting for energy and determining the efficiency of thermodynamic processes.
- Modeling of internal and external high-speed flows.
- Estimation of the aerodynamic forces on super/hypersonic vehicles.
- Estimation of aerodynamic heating on super/hypersonic vehicles.
- Aerothermodynamic design principles for super/hypersonic vehicles.

### Course Learning Outcomes:

Upon successful completion of this course, students will be able to...

1. Use the 1<sup>st</sup> and 2<sup>nd</sup> laws of thermodynamics to calculate heat transfer, work done and entropy changes in a thermodynamic system.
2. Use the equation of state and the definition of enthalpy to calculate thermodynamic properties.
3. Calculate the isothermal and isentropic compressibility of a gas for given conditions.
4. Use thermodynamics and conservation equations to calculate flow parameters at various points of a flow field.
5. Calculate stagnation and critical conditions at various points of a flow field for isentropic flow, adiabatic flow, flow with heat addition and flow with friction.
6. Explain physically what happens to flow parameters when the flow (a) crosses a normal shock wave, (b) is heated or cooled and (c) is subjected to friction.
7. List the differences between a Mach wave and a shock wave.
8. Explain the conditions under which you get (a) a bow shock in front of a body or a compression corner, and (b) an oblique shock at the nose of a body or at a compression corner.

9. Explain the differences between the flow over a cone and the flow over a wedge.
10. Calculate the flow properties downstream of a Mach wave, an oblique shock wave, and a Prandtl-Meyer expansion wave.
11. Calculate the lift and drag on supersonic airfoils using shock-expansion theory.
12. Calculate the flow properties downstream of a reflected / refracted shock wave.
13. Explain mathematically and physically the relationship between flow cross-sectional area and local Mach (or flow speed).
14. Explain an (a) ideally expanded, (b) over-expanded and (c) under-expanded nozzle.
15. Calculate the flow properties at various locations of an (a) ideally expanded, (b) over-expanded and (c) under-expanded nozzle.
16. Calculate the location of a shock in a Laval nozzle (assuming there is one).
17. Design a supersonic / hypersonic wind tunnel (i.e. select the appropriate reservoir, throat and nozzle exit conditions to get the desirable test section conditions).
18. Identify when heat transfer occurs as conduction, convection, or radiation.
19. Setup and solve conduction problems using Fourier's Law.
20. Explain the difference between natural and forced convection, and the tradeoffs associated with them.
21. Setup and solve convection problems using Newton's Law of Cooling.
22. Estimate aerodynamic heating on supersonic and hypersonic vehicles.
23. Select appropriate nose shapes for different Mach numbers, and explain the tradeoffs associated with the different shapes.
24. Work effectively in a team to define and solve open-ended problems that combine compressible flow and jet / rocket engine performance.

#### Course Relationship to BSAE Program Outcomes

	A	B	C	D	E	F	G	H	I
<i>Learning Outcomes</i>									
1 – 24	++	O		O	O			O	O

+: Skill level 1 or 2 in Bloom's Taxonomy

++: Skill level 3 or 4 in Bloom's Taxonomy

+++: Skill level 5 or 6 in Bloom's Taxonomy

O Skill addressed but not assessed

#### Topics:

- Conservation laws. Energy and internal energy. Entropy. Equilibrium state.
- Time-reversible and time-irreversible process.
- Enthalpy. Real gas, perfect gas, thermally perfect gas, calorically perfect gas.
- Adiabatic and isentropic processes.
- Compressibility and compressible flow.
- Oblique and normal shock waves. Expansion waves. Mach waves.
- Flow over a wedge and flow over a cone.
- Ideally expanded, under-expanded and over-expanded nozzles.
- Supersonic and hypersonic wind tunnels.
- Aerodynamic heating; conduction, convection, radiation.
- Fourier's law. Natural and forced convection. Newton's law of cooling.
- Thermal boundary layers.

## **AE 165 – Flight Mechanics**

Credit: 3 semester units  
Contact time: 2 hrs:30 min lecture

Instructor: Dr. Sean Swei

Textbook: *J.D. Anderson, Introduction to Flight, McGraw Hill*

Other supplemental materials:

*R.E. Nelson, Flight Stability and Automatic Control, McGraw Hill*

*Jerry Jon Sellers, et al., Understanding Space: An Introduction to Astronautics, McGraw-Hill*

*Instructor Notes*

Catalog description:

*Trajectory dynamics of atmospheric flight (aircraft and missiles) and spaceflight (orbital mechanics). Influence of vehicle design on trajectory. Aircraft static performance, stability and control. Rocket launch and re-entry dynamics. Computer simulations*

Prerequisite: AE 138

Co-requisite: AE 162

### ***Required*** course

Course Goals: Introduce students to...

- *Aircraft performance analysis for range and endurance.*
- *Aircraft static stability*
- *Longitudinal and lateral stability and control derivatives*
- *Launch vehicles for space missions*
- *Kepler's laws and orbiting satellites*

Course Learning Outcomes:

Upon successful completion of this course, students will be able to...

1. *Calculate thrust and power required for level flight*
2. *Compute the range and endurance of battery-powered propeller-driven aircraft*
3. *Compute aerodynamic coefficients; lift and drag (lift-induced drag)*
4. *Derive basic aircraft stability derivatives*
5. *Analyze aircraft trim conditions*
6. *Identify each element of a space system*
7. *Find elliptical orbit parameters*
8. *Design a Hohmann orbit transfer and compute the total  $\Delta V$*
9. *Describe and discuss various design methodologies and their trade-offs.*

### Course Relationship to BSAE Program Outcomes

	A	B	C	D	E	F	G	H	I
<i>Learning Outcomes</i>									
1 – 9	++			O	O			O	O

+: Skill level 1 or 2 in Bloom's Taxonomy

++: Skill level 3 or 4 in Bloom's Taxonomy

+++: Skill level 5 or 6 in Bloom's Taxonomy

O Skill addressed but not assessed

#### Topics:

- *Introduction.*
- *Basic aerodynamics.*
- *Aircraft performance.*
- *Flight range and endurance.*
- *Power and thrust requirements.*
- *Take-off and landing performance.*
- *Aircraft static stability.*
- *Longitudinal stability/control derivatives.*
- *Lateral stability/control derivatives.*
- *Aircraft trim analysis.*
- *Orbital mechanics.*
- *Describing orbits.*
- *Orbital maneuvers and Hohmann transfer.*
- *Parabolic and hyperbolic orbits.*
- *Lifting re-entry.*

## AE 166 – Rocketry

Credit: 3 semester units  
 Contact time: 2 hrs:30 min lecture

Instructor: Jay Westerwelle

Textbook: Instructor Notes

### Catalog description:

*Introduction to rocketry through theory, computer simulations, and development / launch of an amateur level rocket. Topics include basic principles of aerodynamics, vehicle structures, rocket propulsion, flight mechanics, avionics, as well as past and current launch vehicle technologies.*

Prerequisite: AE 165

### **Elective** course

### Course Goal:

Introduce students to rocketry through hands-on design/build/launch projects.

### Course Learning Outcomes:

Upon successful completion of this course, students will be able to...

1. Explain the history and current purpose of launch vehicles in industry.
2. Explain Newton's laws and how they apply to launch vehicles.
3. Define and estimate the aerodynamic forces of a launch vehicle.
4. Define and calculate the center of gravity and the center of pressure of a launch vehicle.
5. Explain the in-flight dynamics and safety hazards of launch vehicles.
6. Determine the flight stability of a launch vehicle.
7. Define the chemical components of a solid and liquid rocket motor.
8. Describe average thrust vs. impulse and thrust plots.
9. Explain the solid rocket motor naming convention.
10. Explain how rocket altimeters and accelerometers work.
11. Define the components of a launch vehicle and explain their purpose.
12. Use a simulation tool to approximate the flight trajectory of a rocket.
13. Present, launch, and recover a fully developed amateur level rocket.

### Course Relationship to BSAE Program Outcomes

	A	B	C	D	E	F	G	H	I
<i>Learning Outcomes</i>									
1 – 13	++	O	O	O	O			O	O

- +: Skill level 1 or 2 in Bloom's Taxonomy
- ++: Skill level 3 or 4 in Bloom's Taxonomy
- +++: Skill level 5 or 6 in Bloom's Taxonomy
- O Skill addressed but not assessed

Topics:

- *A brief history of rocketry*
- *Definitions, components, certification rules, and safety*
- *Newton's laws, calculation of aerodynamic forces on rockets*
- *Center of gravity and center of pressure*
- *In-flight dynamics of rockets; equation of motion*
- *Avionics and recovery*
- *Rocket propulsion; rocket thrust equation*
- *Open Rocket and RAS Aero Simulators*
- *Tripoli Level 2 practice exam & simulators*
- *Review exam and amateur rocket due*
- *Launch day & launch day review*
- *Current & future rocket technologies*

## AE 167 – Aerospace Propulsion

Credit: 3 semester units  
 Contact time: 2 hrs:30 min lecture

Instructor: Alex Carlozzi

Textbook: J.D., Mattingly, *Elements of Propulsion: Gas Turbines and Rockets*  
 AIAA Education Series, 2006

Catalog description:

*Overall performance characteristics of propellers, ramjets, turbojets, turbofans, rockets. Performance analysis of inlets, exhaust nozzles, compressors, burners, and turbines. Rocket flight performance, single-/multi-stage chemical rockets, liquid/solid propellants and design problems.*

Prerequisite: “C” or better in AE 164

### **Required** course

Course Goal:

Introduce students to the basic principles and design of (a) air-breathing propulsion systems and (b) space propulsion systems.

Course Learning Outcomes:

Upon successful completion of this course, students will be able to...

1. Perform a thermodynamic analysis of turbojet and turbofan engines.
2. Analyze the performance of subsonic and supersonic inlets.
3. Analyze the performance of combustors, afterburners, and exhaust nozzles.
4. Analyze the performance of axial flow compressors and turbines.
5. Carry out flight performance calculations for rockets.
6. Analyze the performance of solid and liquid rockets.

### Course Relationship to BSAE Program Outcomes

	A	B	C	D	E	F	G	H	I
<i>Learning Outcomes</i>									
1 – 6	++			O	O			O	O

+: Skill level 1 or 2 in Bloom’s Taxonomy

++: Skill level 3 or 4 in Bloom’s Taxonomy

+++: Skill level 5 or 6 in Bloom’s Taxonomy

O Skill addressed but not assessed

Topics:

- Review of aerothermodynamics required in engine analysis
- Aircraft gas turbine engine
- Parametric cycle analysis of ideal engines
- Turbojets

- *Turbofans*
- *Subsonic inlets*
- *Supersonic inlets*
- *Compressors*
- *Turbines*
- *Combustors*
- *Nozzles (Jet and Rocket)*
- *Liquid rocket engines*
- *Thrust chambers*
- *Solid rocket engines*
- *Rocket vehicle performance, ascent trajectory analysis, attitude maneuvers*
- *Examples from the Apollo Program.*



## AE 168 – Aerospace Vehicle Dynamics & Control

Credit: 3 semester units  
Contact time: 2 hrs:30 min lecture

Instructor: Dr. Kamran Turkoglu

Textbook: Hunter: *Aerospace Vehicle Dynamics & Control Course Reader*  
(Maple Press)

Roskam: *Airplane Flight Dynamics and Automatic Flight Controls, Parts I & II*

### Catalog description:

*Aircraft / spacecraft dynamics, stability and control. Linearization and Euler transformations. Eigenvalues and eigenvectors. State space and transfer function analysis of dynamics of aerospace vehicles. Feedback control design and synthesis using advanced control techniques.*

Prerequisite: “C” or better in AE 140, AE157, AE165

### **Required** course

#### Course Goals:

1. Review aircraft static stability and develop the concepts of aircraft dynamic stability.
2. Learn the principles of automatic feedback control.
3. Gain an understanding of aircraft motion and develop the means to control that motion.
4. Derive spacecraft equations of motion.
5. Design passive and active control of spacecraft.

#### Course Learning Outcomes:

Upon successful completion of this course, students will be able to...

1. Represent vehicle orientation using Euler angle rotations.
2. Develop perturbation equations for aerospace vehicle six degree-of-freedom motion.
3. Estimate lateral and longitudinal stability derivatives from aircraft geometry.
4. Determine the natural frequencies and damping ratios of the short period and phugoid modes.
5. Evaluate the effect of compressibility on aircraft handling qualities.
6. Evaluate the effect of altitude on aircraft handling qualities.
7. Derive transfer functions and plot vehicle time response.
8. Use root locus and frequency response techniques to design closed-loop control systems: rate-damping, attitude control, altitude control.
9. Using frequency response (CIFER), identify the stability derivatives of a UAV.
10. With the identified derivatives, design an autopilot for the UAV, take data and demonstrate its effectiveness.
11. Derive the equations of a satellite using gravity-gradient passive control.

12. Design a satellite control law using a momentum wheel.  
 13. Design a control law for a spacecraft which is 3-axis controlled by cold-gas jets.  
 14. In collaboration with the senior design project (AE171A or AE172A), design a feedback control system which satisfies the project mission requirements.

Course Relationship to BSAE Program Outcomes

	A	B	C	D	E	F	G	H	I
<i>Learning Outcomes</i>									
1 – 9	++								O
10	++								O
11	+++								O
12	++	O		O	O			O	O
13	+++	O	O	O	O			O	O
14	++								O
15	+++							O	O
16	+++							O	O
17	+++		O	O	O			O	O

- +: Skill level 1 or 2 in Bloom's Taxonomy  
 ++: Skill level 3 or 4 in Bloom's Taxonomy  
 +++: Skill level 5 or 6 in Bloom's Taxonomy  
 O Skill addressed but not assessed

Topics:

- *Airplane static longitudinal stability*
- *Airplane static lateral / directional stability*
- *Rigid body equations of motion & linearization*
- *Perturbation equations: longitudinal & lateral / directional*
- *Longitudinal stability derivatives*
- *Lateral / directional stability derivatives*
- *Dimensional perturbation equations*
- *Longitudinal dynamic stability*
- *Closed loop control*
- *Attitude-hold & altitude-hold autopilot design*
- *Lateral / directional control*
- *Launch vehicle control*
- *Gravity gradient dynamics & passive control*
- *Spacecraft attitude dynamics & 3-axis control*
- *Thruster control*

## AE 169 – Computational Fluid Dynamics

Credit: 3 semester units  
 Contact time: 2 hrs:30 min lecture

Instructor: Dr. Periklis Papadopoulos

Textbook: *Fundamentals of Computational Fluid Dynamics*  
 Lomax, Pulliam and Zingg, Springer-Verlag, Berlin 2001  
 ISBN 3-540-41607-2

### Catalog description:

*Physical and mathematical foundations of computational fluid mechanics with emphasis on applications. Solution methods for advection, diffusion, Euler and Navier-Stokes equations. The finite-volume formulation of the equations. Classification of partial differential equations and solution techniques. Truncation errors and stability analysis.*

Prerequisite: “C” or better in Math 129A, AE 160

### Required course

#### Course goal:

*Introduce students to basic numerical methods for fluid dynamics as well as to the basics of grid generation.*

#### Course Learning Outcomes:

Upon successful completion of this course, students will be able to...

1. *Use numerical tools based on the Euler and Navier-Stokes equations to analyze inviscid and viscous flows.*
2. *Generate appropriate grids for various aerospace engineering flows.*
3. *Determine the accuracy of numerical methods.*
4. *Use linear theory to design a numerical algorithm for a specific application.*

#### Course Relationship to BSAE Program Outcomes

	A	B	C	D	E	F	G	H	I
<i>Learning Outcomes</i>									
1 – 4	O			O	O			O	+++

+: Skill level 1 or 2 in Bloom’s Taxonomy

++: Skill level 3 or 4 in Bloom’s Taxonomy

+++: Skill level 5 or 6 in Bloom’s Taxonomy

O Skill addressed but not assessed

#### Topics:

- *Introduction to computational fluid dynamics*
- *Partial differential equations*
- *Discretization methods; errors, stability and consistency*
- *Explicit time differencing methods*

- *Implicit time differencing methods*
- *Central, upwind and characteristics of spatial differencing techniques*
- *Classical relaxation methods*
- *Multigrid methods*
- *Numerical methods for inviscid flows*
- *Shock-capturing methods*
- *Numerical methods for boundary layer flows*
- *Numerical methods for the Navier-Stokes equations*
- *Modeling of 3-D aerodynamic flows*
- *Grid generation; algebraic, differential equation, and variational methods*
- *Grid generation; unstructured and adaptive grids*
- *Contemporary methods and codes*

## **AE 171A – Aircraft Design I**

Credit: 3 semester units  
Contact time: 2 hrs:30 min lecture

Instructor: Gonzalo Mendoza

Textbook: *J. Roskam: Airplane Design, Parts I-VIII, Roskam Aviation and Engineering Corp., Rt. 4, Box 274, Ottawa, Kansas, 66067*

### Catalog description:

*First course in a two-semester sequence, in which students work in teams to complete the conceptual and preliminary design of an aircraft. Students are challenged to consider the relationship of aerospace engineering to the broader community. Meets GE areas S and V when course is taken in combination with: AE 171B, Engr. 195A and Engr. 195B.*

Prerequisites: “C” or better in AE20, AE162, AE165, Engr.100W.  
Senior in good standing.

Co-requisites: AE164, AE168, Engr.195A

### ***Required (senior design capstone) elective*** course

#### Course Goals:

1. Offer an opportunity for going beyond a paper product (design report) into actual manufacturing and flight-testing of model airplanes.
2. Develop students' creative abilities in solving open-ended, airplane design problems.
3. Develop an appreciation of the interrelationships between aerodynamics, propulsion, structures, flight mechanics, stability & control, manufacturing, maintenance, and cost in an integrated airplane design.
4. Develop students' engineering judgment as well as their confidence in making and accepting responsibility for design decisions.
5. Develop students' oral and written communication skills, necessary to describe the assumptions, methods, and results of engineering analysis, synthesis, and decision making associated with airplane design.
6. Make students aware of the importance of teamwork in the design of an airplane and provide them with an opportunity to develop team and leadership skills.
7. Make students aware of their professional and ethical responsibilities as practicing engineers.
8. Discuss the role of identity, equality, social actions, and culture in aerospace engineering practice. (Integration of Area S and Engineering.)

#### Course Learning Outcomes:

**GE Area S–LO1:** Describe how identities (i.e. religious, gender, ethnic, racial, class, sexual orientation, disability, and/or age) are shaped by cultural and societal influences within contexts of equality and inequality.

**GE Area S–LO2:** Describe historical, social, political, and economic processes producing diversity, equality, and structured inequalities in the U.S.

**GE Area S–LO3:** Describe social actions, which have led to greater equality and social justice in the U.S. (i.e. religious, gender, ethnic, racial, class, sexual orientation, disability, and/or age).

**GE Area S–LO4:** Recognize and appreciate constructive interactions between people from different cultural, racial, and ethnic groups within the U.S.

1. Define an appropriate set of mission requirements and sketch the mission profile of an airplane.
2. Define, calculate, and evaluate measures of merit (MOM) for an airplane.
3. Perform a literature search and collect data to show the need for a particular airplane.
4. Identify the critical mission requirements of an airplane.
5. Evaluate the configuration of airplanes and describe the connection between configuration choices (ex. high wing, tandem landing gear) and mission requirements.
6. Describe the pros and cons of the various conventional aircraft configurations.
7. Describe the pros and cons of unconventional aircraft configurations such as canards, 3-surface, swept-forward wings, flying wings, tailless, V/STOL, stealth, etc.
8. Select an appropriate configuration for an airplane with a specified mission.
9. Estimate the takeoff weight of an airplane based on the mission requirements using the weight fraction method.
10. Calculate the takeoff weight sensitivities of an airplane to changes of critical parameters such as L/D, sfc, etc.
11. Perform trade studies between range and payload.
12. Construct a matching graph based on specific performance constraints (stall speed, cruise speed, takeoff and landing distance, maneuverability requirements) and use it to predict the required thrust/power and wing area of an airplane.
13. Prepare CAD drawings of the cockpit and the fuselage of an airplane based on specific payload requirements.
14. Design the wing, high-lift system, and lateral controls of an airplane.
15. Design the empennage and the directional controls of an airplane.
16. Design the landing gear of an airplane using tip-over and ground clearance criteria and (for retractable landing gear) show the retraction feasibility with appropriate drawings.
17. Perform a weight and balance analysis for an airplane and draw the c.g. excursion diagram.
18. Perform static longitudinal and directional stability analysis for an airplane and draw the corresponding  $x -$  plots.
19. Perform a critical evaluation of the landing gear design, the empennage, the weight and balance, and the stability and control analysis to ensure that an airplane is not prone to tip-over problems, too much c.g. travel, too much or too little stability and / or a minimum control speed problem.
20. Estimate the drag polars of an airplane for the takeoff, cruise (low and high speed), and landing configurations.
21. Work harmoniously and effectively in a team to solve engineering problems related to the design of an airplane and to communicate the results in technical reports and oral briefings.

22. *Communicate effectively in a team environment, negotiate and resolve conflicts, motivate and coach others in your team, organize and delegate work as needed, develop a team vision and set team goals, and manage resources.*
23. *Evaluate your own performance as well as that of your teammates using specific criteria, such as the quality of their work, their commitment to the team / project, leadership skills, responsibility, abilities, communication skills, and personality.*
24. *Develop a milestone schedule (timeline) for an engineering project and follow it.*
25. *Identify possible courses of action, discuss the pros and cons of each one, and decide on the best one, given a job-related scenario that requires a decision with ethical implications.*
26. *Write high quality design reports (i.e., using correct language and terminology, correct technical information, and professionally prepared graphs and tables).*
27. *Give clear, informative, technically correct oral presentations using professionally prepared visual aids.*

#### Course Relationship to BSAE Program Outcomes

Course Learning Outcomes	BSAE Student Learning Outcomes								
	A	B	C	D	E	F	G	H	I
1 – 20	++		+++					+++	+++
21 – 24				+++	+++			+++	
25						+++		+++	
26 – 27					+++				
32 - 34							+++	+++	
GE Area S – LO1							+++	+++	
GE Area S – LO2							+++	+++	
GE Area S – LO3							+++	+++	
GE Area S – LO4				+++				+++	

- +: Skill level 1 or 2 in Bloom's Taxonomy  
 ++: Skill level 3 or 4 in Bloom's Taxonomy  
 +++: Skill level 5 or 6 in Bloom's Taxonomy  
 O Skill addressed but not assessed

#### Topics:

- *Design and the brain. The aircraft design process.*
- *Team building, the team process.*
- *Mission requirements, constraints, measures of merit.*
- *Configuration design: conventional / unconventional.*
- *Weight sizing; weight sensitivities. Performance sizing.*
- *Design of the fuselage, wing, high-lift system, and lateral controls.*
- *Design of the empennage, longitudinal, and directional controls.*
- *Weight and balance*
- *Landing gear design*
- *Stability and control*
- *Drag polars*
- *Historical, social, political, and economic processes and the role of airplanes in promoting diversity, equality, and structured inequalities in the U.S. and the world.*
- *Technological innovations in aircraft design and their role in promoting social justice in the U.S. and the world.*

## **AE 171B – Aircraft Design II**

Credit: 3 semester units  
Contact time: 2 hrs:30 min lecture

Instructor: Gonzalo Mendoza

Textbook: *J. Roskam: Airplane Design, Parts I-VIII, Roskam Aviation and Engineering Corp., Rt. 4, Box 274, Ottawa, Kansas, 66067*

### Catalog description:

*Second course in a two-semester sequence, in which students work in teams to complete the conceptual and preliminary design of an aircraft. Students are challenged to consider the relationship of aerospace engineering to the broader community. Meets GE areas S and V when course is taken in combination with: AE 171A, Engr. 195A and Engr. 195B.*

Prerequisites: “C” or better in AE164, AE168, AE171A  
Senior in good standing.

Co-requisites: AE167, AE169, Engr.195B

### ***Required (senior design capstone) elective*** course

#### Course Goals:

- 1. Offer an opportunity for going beyond a paper product (design report) into actual manufacturing and flight-testing of model airplanes.*
- 2. Develop students' creative abilities in solving open-ended, airplane design problems.*
- 3. Develop an appreciation of the interrelationships between aerodynamics, propulsion, structures, flight mechanics, stability & control, manufacturing, maintenance, and cost in an integrated airplane design.*
- 4. Develop students' engineering judgment as well as their confidence in making and accepting responsibility for design decisions.*
- 5. Develop students' oral and written communication skills, necessary to describe the assumptions, methods, and results of engineering analysis, synthesis, and decision making associated with airplane design.*
- 6. Make students aware of the importance of teamwork in the design of an airplane and provide them with an opportunity to develop team and leadership skills.*
- 7. Make students aware of their professional and ethical responsibilities as practicing engineers.*
- 8. Discuss the role of culture, civilization, and global understanding in aerospace engineering practice. (Integration of Area V and Engineering.)*



Course Learning Outcomes:

**GE Area V-LO1:** Compare systematically the ideas, values, images, cultural artifacts, economic structures, technological developments, and / or attitudes of people from more than one culture outside the U.S.

**GE Area V-LO2:** Identify the historical context of ideas and cultural traditions outside the U.S. and how they have influenced American culture.

**GE Area V-LO3:** Explain how a culture outside the U.S. has changed in response to internal and external pressures.

1. Procure, fabricate, and assemble the various parts of their airplane (UAV).
2. Evaluate their design through flight-testing and identify any modifications / improvements needed to meet the mission requirements.
3. Evaluate and describe accurately the environmental impact of their airplane.
4. Evaluate and describe accurately any health / safety issues related to their airplane.
5. Work harmoniously and effectively in a team to solve engineering problems related to the design of an airplane and to communicate the results in technical reports and oral briefings.
6. Communicate effectively in a team environment, negotiate and resolve conflicts, motivate and coach others in your team, organize and delegate work as needed, develop a team vision and set team goals, and manage resources.
7. Evaluate your own performance as well as that of your teammates using specific criteria, such as the quality of their work, their commitment to the team / project, leadership skills, responsibility, abilities, communication skills, and personality.
8. Develop a milestone schedule (timeline) for an engineering project and follow it.
9. Identify possible courses of action, discuss the pros and cons of each one, and decide on the best one, given a job-related scenario that requires a decision with ethical implications.
10. Write high quality design reports (i.e., using correct language and terminology, correct technical information, and professionally prepared graphs and tables).
11. Give clear, informative, technically correct oral presentations using professionally prepared visual aids.
12. Describe regional, national or global contemporary problems related to aircraft design (e.g. transportation, environmental and safety issues, energy conservation, etc.) and identify possible solutions as well as any limitations of these solutions.

Course Relationship to BSAE Program Outcomes

	BSAE Student Learning Outcomes								
	A	B	C	D	E	F	G	H	I
Course Learning Outcomes									
1 – 4		O	+++				+++	+++	+++
5 – 8				+++				+++	
9						+++		+++	
10 – 11					+++				
12, GE V-LO1, V-LO2, V-LO3					+++		+++	+++	

+: Skill level 1 or 2 in Bloom’s Taxonomy

++: Skill level 3 or 4 in Bloom’s Taxonomy

+++: Skill level 5 or 6 in Bloom’s Taxonomy

O Skill addressed but not assessed

Topics:

- *AIAA Design / Build / Fly Competition; SAE Aero Design Competition*
- *Outsourcing aerospace engineering: considering ideas, values, images, cultural artifacts, economic structures, and technological developments abroad while evaluating your decision to manufacture your airplane in other countries.*
- *Cultural and social factors, which led to the invention of aerospace technology outside the U.S.*
- *Effects of US aerospace technology around the world*
- *Case study on aircraft safety, ethics and liability issues: V-Tail Bonanza*
- *Case study on aircraft safety, ethics and liability issues: The Crash of AA191*
- *Case study on spacecraft safety, ethics & liability issues: Space Shuttle accidents*
- *Case study on spacecraft safety, ethics & liability issues: Apollo 13*

## AE 172A – Spacecraft Design I

Credit: 3 semester units  
Contact time: 2 hrs:30 min lecture

Instructor: Dr. Periklis Papadopoulos

Textbook: Instructor's Notes

### Catalog description:

*First course in a two-semester sequence, in which students work in teams to complete the conceptual and preliminary design of a spacecraft. Students are challenged to consider the relationship of aerospace engineering to the broader community. Meets GE areas S and V when course is taken in combination with: AE 172B, Engr. 195A and Engr. 195B.*

Prerequisites: "C" or better in AE20, AE162, AE165, Engr.100W.

Senior in good standing.

Co-requisites: AE164, AE168, Engr.195A

### ***Required (senior design capstone) elective*** course

#### Course Goals:

1. Offer an opportunity for going beyond a paper product (design report) into actual manufacturing and testing of space vehicle parts.
2. Develop students' creative abilities in solving open-ended, spacecraft design problems.
3. Develop an appreciation of the interrelationships between aerodynamics, propulsion, structures, flight mechanics, stability & control, manufacturing, maintenance, and cost in an integrated spacecraft design.
4. Develop students' engineering judgment as well as their confidence in making and accepting responsibility for design decisions.
5. Develop students' oral and written communication skills, necessary to describe the assumptions, methods, and results of engineering analysis, synthesis, and decision making associated with spacecraft design.
6. Make students aware of the importance of teamwork in the design of a spacecraft and provide them with an opportunity to develop team and leadership skills.
7. Make students aware of their professional and ethical responsibilities as practicing engineers.
8. Discuss the role of identity, equality, social actions, and culture in aerospace engineering practice. (Integration of Area S and Engineering.)

#### Course Learning Outcomes:

**GE Area S–LO1:** Describe how identities (i.e. religious, gender, ethnic, racial, class, sexual orientation, disability, and/or age) are shaped by cultural and societal influences within contexts of equality and inequality.

**GE Area S–LO2:** Describe historical, social, political, and economic processes producing diversity, equality, and structured inequalities in the U.S.

**GE Area S–LO3:** Describe social actions, which have led to greater equality and social justice in the U.S. (i.e. religious, gender, ethnic, racial, class, sexual orientation, disability, and/or age).

**GE Area S–LO4:** Recognize and appreciate constructive interactions between people from different cultural, racial, and ethnic groups within the U.S.

1. Define an appropriate set of mission requirements for a spacecraft.
2. Define, calculate, and evaluate measures of merit (MOM) for a spacecraft.
3. Perform a literature search and collect data to show the need for a particular spacecraft.
4. Design spacecraft hardware.
5. Apply the complete product development cycle: basic idea / societal need / market study / economic and budget analysis.
6. Create the baseline design of a spacecraft.
7. Establish the final design of a spacecraft.
8. Evaluate / analyze the operation of a spacecraft as well as any data relayed.
9. Work harmoniously and effectively in a team to solve engineering problems related to the design of a spacecraft and to communicate the results in technical reports and oral briefings.
10. Communicate effectively in a team environment, negotiate and resolve conflicts, motivate and coach others in your team, organize and delegate work as needed, develop a team vision and set team goals, and manage resources.
11. Evaluate your own performance as well as that of your teammates using specific criteria, such as the quality of their work, their commitment to the team / project, leadership skills, responsibility, abilities, communication skills, and personality.
12. Develop a milestone schedule (timeline) for an engineering project and follow it.
13. Identify possible courses of action, discuss the pros and cons of each one, and decide on the best one, given a job-related scenario that requires a decision with ethical implications.
14. Write high quality design reports (i.e., using correct language and terminology, correct technical information, and professionally prepared graphs and tables).
15. Give clear, informative, technically correct oral presentations using professionally prepared visual aids.

#### Course Relationship to BSAE Program Outcomes

	BSAE Student Learning Outcomes								
	A	B	C	D	E	F	G	H	I
<i>Course Learning Outcomes</i>									
1 – 8	++		+++	O				+++	+++
9 – 12				+++	+++			+++	
13				O		+++		+++	
GE Area S – LO1				O	O		+++	+++	
GE Area S – LO2				O	O		+++	+++	
GE Area S – LO3				O	O		+++	+++	
GE Area S – LO4				+++	O			+++	

- +: Skill level 1 or 2 in Bloom’s Taxonomy
- ++: Skill level 3 or 4 in Bloom’s Taxonomy
- +++ : Skill level 5 or 6 in Bloom’s Taxonomy
- O Skill addressed but not assessed

Topics:

- *Introduction to spacecraft design*
- *Mission requirements*
- *Systems specifications documentation*
- *System decomposition*
- *Subsystem design*
- *Subsystem specification documentation*
- *Subsystem design review*
- *System design and integration*
- *System / subsystems coupling*
- *Subsystems design review.*
- *Detailed design review.*
- *Final design review.*
- *Historical, social, political, and economic processes and the role of spacecraft in promoting diversity, equality, and structured inequalities in the U.S. and the world.*
- *Technological innovations in spacecraft design and their role in promoting social justice in the U.S. and the world.*

## **AE 172B – Spacecraft Design II**

Credit: 3 semester units  
Contact time: 2 hrs:30 min lecture

Instructor: Dr. Periklis Papadopoulos

Textbook: Instructor Notes

### Catalog description:

*Second course in a two-semester sequence, in which students work in teams to complete the conceptual and preliminary design of a spacecraft. Students are encouraged to participate in the International Planetary Probe Workshop and / or the AIAA Student Conference. Students are challenged to consider the relationship of aerospace engineering to the broader community. Meets GE areas S and V when course is taken in combination with: AE 172A, Engr. 195A and Engr. 195B.*

Prerequisites: “C” or better in AE164, AE168, AE171A  
Senior in good standing.

Co-requisites: AE167, AE169, Engr.195B

### **Required (senior design capstone) elective course**

#### Course Goals:

1. Offer an opportunity for going beyond a paper product (design report) into actual manufacturing and testing of space vehicle parts.
2. Develop students' creative abilities in solving open-ended, airplane design problems.
3. Develop an appreciation of the interrelationships between aerodynamics, propulsion, structures, flight mechanics, stability & control, manufacturing, maintenance, and cost in an integrated airplane design.
4. Develop students' engineering judgment as well as their confidence in making and accepting responsibility for design decisions.
5. Develop students' oral and written communication skills, necessary to describe the assumptions, methods, and results of engineering analysis, synthesis, and decision making associated with airplane design.
6. Make students aware of the importance of teamwork in the design of an airplane and provide them with an opportunity to develop team and leadership skills.
7. Make students aware of their professional and ethical responsibilities as practicing engineers.
8. Discuss the role of culture, civilization, and global understanding in aerospace engineering practice. (Integration of Area V and Engineering.)

Course Learning Outcomes:

**GE Area V-LO1:** Compare systematically the ideas, values, images, cultural artifacts, economic structures, technological developments, and / or attitudes of people from more than one culture outside the U.S.

**GE Area V-LO2:** Identify the historical context of ideas and cultural traditions outside the U.S. and how they have influenced American culture.

**GE Area V-LO3:** Explain how a culture outside the U.S. has changed in response to internal and external pressures.

1. Procure, fabricate, and assemble the various parts of a microsatellite.
2. Evaluate their design through testing and identify any modifications / improvements needed to meet the mission requirements.
3. Evaluate and describe accurately the environmental impact of their spacecraft.
4. Evaluate and describe accurately any health/safety issues related to their spacecraft.
5. Work harmoniously and effectively in a team to solve engineering problems related to the design of a spacecraft and communicate the results in technical reports and oral briefings.
6. Communicate effectively in a team environment, negotiate and resolve conflicts, motivate and coach others in your team, organize and delegate work as needed, develop a team vision and set team goals, and manage resources.
7. Evaluate your own performance as well as that of your teammates using specific criteria, such as the quality of their work, their commitment to the team / project, leadership skills, responsibility, abilities, communication skills, and personality.
8. Develop a milestone schedule (timeline) for an engineering project and follow it.
9. Identify possible courses of action, discuss the pros and cons of each one, and decide on the best one, given a job-related scenario that requires a decision with ethical implications.
10. Write high quality design reports (i.e., using correct language and terminology, correct technical information, and professionally prepared graphs and tables).
11. Give clear, informative, technically correct oral presentations using professionally prepared visual aids.
12. Describe regional, national or global contemporary problems related to spacecraft design (e.g. transportation, environmental and safety issues, energy conservation, etc.) and identify possible solutions as well as any limitations of these solutions.

Course Relationship to BSAE Program Outcomes

	BSAE Student Learning Outcomes								
	A	B	C	D	E	F	G	H	I
Course Learning Outcomes									
1 – 4		O	+++				+++	+++	+++
5 – 8				+++				+++	
9						+++		+++	
10 – 11					+++				
12, GE: V-LO1, V-LO2, V-LO3					+++		+++	+++	

- +: Skill level 1 or 2 in Bloom’s Taxonomy
- ++: Skill level 3 or 4 in Bloom’s Taxonomy
- +++ : Skill level 5 or 6 in Bloom’s Taxonomy
- O Skill addressed but not assessed

Topics:

- *Spacecraft subsystems design*
- *Spacecraft subsystem testing*
- *Preparation for International Planetary Probe Workshop*
- *Outsourcing aerospace engineering: considering ideas, values, images, cultural artifacts, economic structures, and technological developments abroad while evaluating your decision to manufacture your spacecraft in other countries.*
- *Cultural and social factors, which led to the invention of aerospace technology outside the U.S.*
- *Effects of US aerospace technology around the world*
- *Case study on aircraft safety, ethics and liability issues: V-Tail Bonanza*
- *Case study on aircraft safety, ethics and liability issues: The Crash of AA191*
- *Case study on spacecraft safety, ethics & liability issues: Space Shuttle accidents*
- *Case study on spacecraft safety, ethics & liability issues: Apollo 13*



## **AE 180 – Individual Studies**

Credit: *1 – 3 semester units*  
Contact time: *1 – 3 hrs of supervision*

Coordinator: *Dr. Nikos J. Mourtos*

Textbook: *Depends on the topic*

Catalog description:

*Individual work on special topics. Students work with faculty and/or industry mentors on design, research, lab development or other types of projects.*

Prerequisite: *Upper division standing or instructor consent*

***Elective*** course

Course Goals: *Develop design and / or research skills.*

Course Learning Outcomes:

*Learning objectives are specific to the topics of the course.*

## **AE 199 – Special Topics in Aerospace Engineering**

Credit: *1 – 4 semester units*

Contact time: *1 – 4 hrs of lecture*

Coordinator: *Dr. Nikos J. Mourtos*

Textbook: *Depends on the topic*

Catalog description:

*Special topics that are currently of interest to industry and academia.*

*Content varies from semester to semester.*

Prerequisite: *Upper division standing or instructor consent*

***Elective*** course

Course Goal:

*Introduce students to special topics, which are currently of interest to industry and academia.*

Course Learning Outcomes:

*Learning objectives are specific to the topics of the course.*

## APPENDIX B – FACULTY VITAE

### *B.1 Tenure-Line Faculty*

## **Nikos J. Mourtos**

### *1. Education*

- Ph.D., Aeronautical & Astronautical Engineering, Stanford University, 1987.
- ENGINEER, Aeronautical & Astronautical Engineering, Stanford University, 1983.
- M.S., Aeronautical & Astronautical Engineering, Stanford University, 1982.
- B.S., Mechanical Engineering, University of Patras, Greece, 1980.

### *2. Academic experience*

- Professor & Chair, AE Department, SJSU, 2016-present.
- Professor & AE Director, SJSU, 2012-2016.
- Prof. & AE Associate Chair, Dept. of Mech. & Aero. Engineering, SJSU, 2010-2011.
- Prof. & AE Coordinator, Dept. of Mechanical & Aerospace Engr. SJSU, 2004-2006.
- Associate Professor, Dept. of Mechanical & Aerospace Engr., SJSU, 1991-1999.
- Assistant Professor, Department of Aerospace Engineering, SJSU, 1988-1991.
- Lecturer, Departments of Mechanical and Aerospace Engineering, SJSU, 1985-1988.

### *3. Non-Academic Experience*

- NASA Ames RC, STOVL / Powered-Lift Technology Branch, ASEE Summer Faculty Fellow, 03Jun-16Aug 1991.
- NASA Ames RC, Fixed Wing Aerodynamics Branch, ASEE Summer Faculty Fellow, 08Jun-17Aug 1990.

### *4. Certifications or Professional Registrations*

- SNAME ABET Program Evaluator Training, San Francisco, California, 17Oct03
- Private Pilot, 1981.
- Licensed Mechanical Engineer, member of the Greek Technical Chamber, 1975.

### *5. Current Membership in Professional Organizations*

- Athens Institute for Education & Research (ATINER):
  - **Head:** Mechanical Engineering Research Unit (2016 – 2018)
  - Academic Member: Education Research Unit (2016 – 2018)
- Asia Pacific Alliance for Quality Assurance in Higher Education (APAQA), Member, Management Committee
- ASEE: American Society for Engineering Education (1988 – present)

### *6. Honors & Awards*

- 2017 Nominated, SJSU Distinguished Service Award; selected among top 3 finalists.
- 2014 Nominated, SJSU Student Organization Advisor of the Year Award by ΣΓΤ.
- 2008 Hon. Mention–Provost's Outstanding Scholarship of Teaching & Learning Award
- 2007&2008 ΣΓΤ Professor of the Year Award, voted by AE Students
- 2007 Provost's Assessment Award for Commitment to Program Excellence through Student Learning Assessment

### *7. Service Activities*

#### ***Service to the University***

- Ed.D. Leadership Program faculty member, 2009 – present.
  - Recruitment Committee for SJSU Asc. Dean for Graduate Studies, AY16-17.
  - Assistant Director, SJSU Center for Faculty Development & Support, 2006-2008.
  - Faculty-in-Residence for Innovative Pedagogy, ITL, SJSU, 1998-2002.
- Service to the College of Engineering***
- Recruitment Committee, International Engr. Graduate Student Advisor, AY16-17.
  - Chair, Recruiting Committee, Carolyn Guidry Professor of Engr. Educ., AY13-14.
  - Member, College of Engineering Strategic Planning Committee, AY13-14.
  - Faculty Instructional Development Coordinator, College of Engr., SJSU, 1996-2002.

## 8. *Publications & Presentations*

### ***Journal***

- Mourtos, N.J., Preparing engineers for the 21<sup>st</sup> century: How to teach engineering students process skills, ***Invited Paper***, International J. for Quality Assurance in Engineering & Technology Education, 4(4), 2015.
- Mourtos, N.J., Defining, teaching, and assessing engineering design skills, ***Invited Paper***, International J. for Quality Assurance in Engr. & Tech. Education, 2(1), 2012.
- Conference Proceedings – Education***
- Mourtos, N.J., Reflection as a way to develop engineering process skills, 1<sup>st</sup> ATINER Annual International Conference on Engineering Education & Teaching, June 2016.
- Mourtos, N.J., Integrating general education outcomes into a senior design capstone experience, Proc., World Engineering Education Forum, December 2014.
- Mourtos, N.J., Service Learning in Aerodynamics at SJSU, Proc., 2<sup>nd</sup> International Engineering and Technology Education Conference, November 2013.

### ***Conference Proceedings – Technical***

- Montgomery, S. & Mourtos, N.J., Design of a 5-kg solar-powered unmanned aircraft for perpetual solar endurance flight, Proc., 49<sup>th</sup> AIAA/ASEE Joint Propulsion Conf. 2013.
- Rajagopalan, A. S. & Mourtos, N.J., Design of a 4-seat, general aviation, electric aircraft, Proceedings, More Electric Aircraft Conference, November 2012.

### ***Presentations***

- 4-6Dec17 – Teaching & learning engineering in the 21<sup>st</sup> century: Are we dancing to the music? ***Invited keynote address***, Intern. Engr. & Tech. Educ. Conf., Hanoi, Vietnam.
- 16&17May17 – Critical thinking skills for the 21<sup>st</sup> century. One-day ***workshop***, Sultan Qaboos University, Muscat, Oman.
- 18May17 – Preparing effective practitioners and responsible citizens for the 21<sup>st</sup> century: Alternative teaching methods. One-day ***workshop***, Sultan Qaboos U., Muscat, Oman.
- Nov16 – Peer reviews of teaching effectiveness: Can they be used to steer faculty towards new pedagogies? World Engineering Education Forum, Seoul, Korea.
- 21Apr15 – Panelist: Teaching to learn, learning to teach, 4<sup>th</sup> Annual ASEE Engineering Education Colloquium, Stanford University, California, USA.

## 9. *Professional Development Activities*

- 07Jun17 Flipped Learning workshop, SJSU
- 03 – 05Feb16 UAV Design short course w. D. P. Raymer, UCLA.
- 16Oct15 CSU New Department Chairs 19<sup>th</sup> Annual Workshop, CSULB, CA.

## **Periklis E. Papadopoulos**

### *1. Education*

Ph.D. Aeronautics and Astronautics, Stanford University, 1992.

M.S. Aeronautics and Astronautics. Stanford University, 1987.

B.S. Mechanical Engineering, Illinois Institute of Technology, 1985.

### *2. Academic experience*

- Professor, Aerospace Engineering, San Jose State University, 2003 – Present
- Coordinator, Aerospace Engineering Program, SJSU, 2003 – 2004.
- Adjunct Professor, Aerospace Engineering, San Jose State University, 1999–2002.

### *3. Non-Academic Experience*

NASA-ARC– Aerothermodynamics Branch, Space Technologies Division, Senior Research Scientist 1989 – 2004.

- Program lead of the aerodynamic and aerothermodynamic analysis and validation team for Space Shuttle contingency abort scenarios.
- Developed the M-Orpheus shape morphing and grid generation launch vehicle design tool.
- Member of the NASA-ARC COBRA team for designing a next generation Mars Entry vehicle able to land heavy payload delivery systems.
- Performed de-orbit trajectory, CFD and systems level analysis for the Mars Science Laboratory.
- Analyzed hypersonic flow and aerothermodynamic environments about the Reusable Launch Vehicles X-33, X-34, X-38 and XCRV.
- Provided CFD simulations during atmospheric entry for planetary mission studies.
- Provided computational geometry expertise for the Space Launch Initiative (SLI) program.
- Development of a geometry engine (GeoGen) for automated vehicle geometry integration and surface triangulation.
- Automated the CAD to grid generation to CFD integration environment for hypersonic vehicle design as part of the NASA-ARC Integrated Design Systems (IDS) activities.
- Characterized the two-phase flow environment about the Galileo Nephelometer instrumentation during descent through Jovian clouds.
- Provided in-house grid generation expertise.
- Characterized the nozzle flow of the 16-Inch Shock-Tunnel at NASA-ARC.
- Performed trajectory and heating calculations for discovery mission concept studies.
- Provided CFD flow simulations of the DLR-HEG high enthalpy shock-tunnel facility as part of the Fourth European High Velocity Database Workshop.
- Modeled reentry environments along the descent trajectory of the Venus Composition Probe.
- Performed parametric studies of the flow at the back of the Gravitational Biology Facility to determine the effectiveness of the design at cooling the facility.
- Assessed the heat shield erosion due to dust particles on a Mars aerocapture vehicle.

- Determined the aerothermal environment and heat shield erosion on the Mars Environmental Survey/Mars Pathfinder vehicles during direct ballistic entries and evaluated the appropriate heat shield sizing.

4. *Certifications or Professional Registrations* – None

5. *Current Membership in Professional Organizations*

AIAA, 1988 – present

6. *Honors & Awards*

- 2008 Certificate of recognition for excellence in providing CFD support to the Mars Science Laboratory mission.
- 2005 Trajectory-based automatic grid generating tool for atmospheric entry CFD modeling recognized and published at PDC Corporation.
- 2002 Group Achievement Award in recognition of outstanding dedication to the improvement of Space Shuttle safety through the expansion of Space Shuttle abort capability, presented by NASA-HQ administrator, Sean O’Keefe.
- 2002 Invited speaker at the JANNAF Interagency Propulsion Committee, 2<sup>nd</sup> Modeling and Simulation Subcommittee Joint Meeting, “A Geometry-Centered Approach for Two-Stage-To-Orbit Vehicle Synthesis”, Destin, Florida.
- 2001 NASA Award for ‘Turning Goals into Reality’.
- 2001 NASA Group Achievement Award.
- 2001 Invited speaker at the 35th Thermophysics conference, “Simulations in Support of Shuttle Orbiter Contingence Abort Aerodynamic Database Enhancements”, AIAA.
- 2000 Certificate of appreciation in recognition of excellence in successfully completing the X-33 Task ARC-01 that contributed to the X-33 vehicle aerothermodynamics and verifications, NASA-X33-Program Office.
- 2000 Certificate of appreciation in recognition of excellence in successfully completing the X-33 Tasks ARC-19 and ARC-23 that contributed to the reusable launch vehicle environments analysis synthesis and design, NASA-X33-Program Office.

7. *Service Activities*

Service to the University

All Teacher Education Committee, 2008 – 2010

8. *Publications & Presentations*

V.D. Patel and P.E. Papadopoulos, Altitude control for high altitude balloons, IPPW-14, June 12–16, 2017, Hague, Netherlands.

9. *Professional Development Activities*

- 2016 Destination Venus: Science, Technology and Mission Architectures, Short-Course, 13<sup>th</sup> International Planetary Probe Workshop.
- 2015 Radio Flyers: Principles of Communications, Radio Science, Radar, Navigation, and Tracking, Short-Course, 13<sup>th</sup> International Planetary Probe Workshop.
- 2015 Launch-Space Education Services/United States Space Foundation, McLean, VA

## **Kamran Turkoglu**

### *1. Education*

- Ph.D. Control Science & Dynamical Systems (major), University of Minnesota, 2012.  
Aerospace Engineering & Mechanics, (minor), University of Minnesota, 2012.
- M.S., Aeronautics & Astronautics, Istanbul Technical University, Turkey 2007.
- B.S., Aeronautical Engineering, Istanbul Technical University, Turkey, 2006  
(double major)
- B.S., Aerospace Engineering, Istanbul Technical University, Turkey, 2005.

### *2. Academic Experience*

- Assistant Professor, Department of Aerospace Engineering, SJSU, 2013 – present.
- Research Assistant, Aerospace Engr. & Mechanics, U. of Minnesota, 2008-2012.
- Research Assistant, Mechanical Engineering, University of Connecticut, 2007-2008
- Research Fellow, Aerospace Engineering, Istanbul Technical U., Turkey 2005-2007

### *3. Non-Academic Experience*

- NASA Ames RC, Control System Design & Optimization, AFDD Research Fellow  
May-Aug 2014.
- Hitachi Global Storage Technologies, Senior Control Systems Engineer,  
September 2012 – July 2013.
- Seagate Technologies, Senior Control Systems Engineer, June – July 2012
- Seagate Technologies, Researcher, May – November 2011
- ETH Zurich (Swiss Federal Institute of Technology), Zurich, Switzerland, May-Aug  
2015
- University of Strathclyde, Glasgow, Scotland

### *4. Certifications or Professional Registrations – N/A*

### *5. Current Membership in Professional Organizations*

Member of ASME, AIAA, SIAM, IEEE

### *6. Honors & Awards*

- Outstanding Teaching Assistant Award, College of Science and Engineering Student  
Board, University of Minnesota, 2011
- Control Science & Dynamical Systems Department Fellowship Award, 2009.
- Aerospace Engineering Department Summer Scholarship Award, UMN, 2009-2010.
- Scientific & Technological Research Council of Turkey Fellowship Award, 2006-  
2007.

### *7. Service Activities*

#### *Service to the University*

- Member, University Undergraduate Studies Committee, 2013-2017

#### *Service to the College of Engineering*



- Member, College of Engineering Research Committee, 2014-2017
- Member, College of Engineering Undergraduate Studies Com., 2013, 2016, 2017

## 8. *Publications & Presentations*

### *Journal Articles*

- Fei Sun and Kamran Turkoglu. Distributed real-time non-linear receding horizon control methodology for multi-agent consensus problems. *Aerospace Science and Technology*, 63 (2017) 82-90. doi:10.1016/j.ast.2016.12.0182.
- Galvani, P.A., Sun, F. and Turkoglu, K., Aerodynamic modeling of NREL 5-MW wind turbine for nonlinear control system design: A case study based on real-time nonlinear receding horizon control. *Aerospace* 2016, 3(3), 27; doi:10.3390/aerospace3030027
- Kamran Turkoglu and Nejat Olgac, Robust control for multiple time delay MIMO systems with delay-decouplability concept, *Topics in Time Delay Systems, Lecture Notes in Control and Info. Sciences*, Vol 388/2009, pp.37-47, Springer-Verlag, 2009.

### *Papers in Conference Proceedings*

- Eric Wahl & Kamran Turkoglu, Wahba's problem: A combined binary search and bisection Approach, *AIAA Guidance, Navigation and Control Conference, AIAA Science & Technology Forum & Exposition 2017*.
- Fritz, S. & Turkoglu, K., Optimal trajectory determination for asteroid exploration via gravity assist maneuvers, *IEEE Aerospace Conference 2016*, March 5-12.11.
- Lu, L. K. & Turkoglu, K., H1 loop-shaping robust differential thrust control methodology for lateral/directional stability of an aircraft with a damaged vertical stabilizer, *AIAA Guidance, Navigation, & Control Conference, AIAA Science & Technology Forum & Exposition 2016*.
- Kamran Turkoglu, Real-time guidance strategies for optimizing aircraft performance in stochastic wind conditions, *American Control Conference (ACC) at the Portland, Oregon*, June 04-06, 2014.
- Kamran Turkoglu, Short-term turning in presence of wind as a trajectory optimization problem, 4<sup>th</sup> *IEEE Aerospace Conference, Yellowstone Conference Center, Big Sky, Montana*, March 01 - 08, 2014.

### *Presentations*

- Real-time guidance strategies for optimizing aircraft performance in stochastic wind conditions, *American Control Conference, Portland, Oregon*, June 04-06, 2014.
- Short-term turning in presence of wind as a trajectory optimization problem, *IEEE Aerospace Conf., Yellowstone Conference Center, Big Sky, Montana*, March 2014.

## 9. *Professional Development Activities*

- NSF CAREER Grant Writing Workshop, Summer 2016
- How to engineer engineering education, Summer 2017

## **Fabrizio Vergine**

### *1. Education*

Ph.D., Aerospace Engineering, The University of Texas at Arlington, 2014.

M.S., Astronautical Engineering, The University of Rome, “La Sapienza,” 2010.

B.S., Aerospace Engineering, The University of Rome, “La Sapienza,” 2006.

### *2. Academic Experience*

- Assistant Professor, AE Department, SJSU, 2017-present.
- Adjunct Professor, MAE Department, UT Arlington, 2014, 2015, 2017.
- Postdoctoral Fellow, MAE Department, UT Arlington, 2015-2017.
- Postdoctoral Scholar, MAE Department, UT Arlington, 2014-2015.
- Graduate Research Assistant & Graduate Teaching Assistant, MAE Department, UT Arlington, 2010-2014.

### *3. Non-Academic Experience – None*

### *4. Certifications or Professional Registrations – None*

### *5. Current Membership in Professional Organizations*

AIAA, Member, 2011–present.

### *6. Honors & Awards*

Phi Kappa Phi Honor Society, 2012.

### *7. Service Activities – None*

### *8. Publications & Presentations*

#### ***Journal Articles***

F. Vergine, C. Ground & L. Maddalena, Strut injectors for scramjets: Total pressure losses in two streamwise vortex interactions, AIAA J. of Propulsion and Power, published online, Feb. 2017.

F. Vergine, C. Ground & L. Maddalena, Turbulent kinetic energy decay in supersonic streamwise interacting vortices, J. of Fluid Mechanics, Cambridge University Press, N. 807, pp. 353-385, 2016.

F. Vergine & L. Maddalena, Study of two supersonic streamwise vortex interactions in a Mach 2.5 flow: merging and no merging configurations, Physics of Fluids, American Institute of Physics, N. 27, 2015.

F. Vergine, M. Crisanti, L. Maddalena, V. Miller & M. Gamba, Supersonic combustion of pylon injected hydrogen in high-enthalpy flow with imposed vortex dynamics, AIAA J. of Propulsion and Power, N. 31, pp. 89-103, 2014.

F. Vergine & L. Maddalena, Stereoscopic particle image velocimetry measurements of supersonic, turbulent, and interacting streamwise vortices: challenges and application, Progress in Aerospace Sciences, Elsevier, N. 66, pp. 1-16, 2014.

L. Maddalena, F. Vergine & M. Crisanti, Vortex dynamics studies in supersonic flow:

- merging of co-rotating streamwise vortices, *Physics of Fluids*, American Institute of Physics, N. 26, 2014.
- L. Maddalena & F. Vergine, *Vortex dynamic in supersonic mixing flows*, AccessScience/McGraw-Hill Education, 2016.
- C. Ground, F. Vergine & L. Maddalena, The effect of vortex merging and non-merging on the transfer of modal turbulent kinetic energy content, *Experiments in Fluids*, Springer, August 2016, 57:131.

### ***Conference Proceedings***

- F. Vergine, Cody Ground & L. Maddalena, Experimental study of strut injectors for scramjet combustors: Total pressure losses in a selected supersonic streamwise vortex interaction mode,” AIAA Paper 2015-3589.
- F. Vergine & L. Maddalena, Experimental study of strut injectors for scramjet Combustors, Invited AIAA Paper 2014-2803.
- C. Ground, F. Vergine, L. Maddalena & V. Viti, Experimental and numerical investigation of the flow characteristics of a strut injector for scramjets, AIAA Paper 2014-3217.
- M. Crisanti, F. Vergine & L. Maddalena, Filtered Rayleigh scattering measurements in Helium-air mixing experiments of selected streamwise vortex interactions in a Mach 2.5 Flow, AIAA Paper 2014-0984.
- F. Vergine, M. Crisanti & L. Maddalena, Investigation of the merging process and Dynamics of streamwise vortices generated by a flow-mixing device in a Mach 2.5 Flow, AIAA Paper 2013-0699.
- F. Vergine, L. Maddalena, V. Miller & M. Gamba, Supersonic combustion and flame-holding characteristics of pylon injected hydrogen in a Mach 2.4 high enthalpy flow, AIAA Paper 2012-333.
- F. Vergine & L. Maddalena, Evolution of large-scale structures generated by a strut injector in a Mach 2.5 flow, AIAA Paper 2012-332.

*9. Recent Professional Development Activities – None*

## **B.2          *Adjunct Faculty***

### **Arun K. Banerjee**

#### *1. Education*

- Ph.D., Engineering Mechanics, University of Florida, 1972
- Ph.D., Mechanical Engineering, Indian Institute of Technology, Kharagpur, 1969
- B.E., Mechanical Engineering, Calcutta University, India, 1962

#### *2. Academic Experience*

- Adjunct Faculty, San Jose State University, 1988-2017
- Adjunct Faculty, Santa Clara University, 1992-2016

#### *3. Non-Academic Experience*

- Northrop, Huntsville, Alabama, Research Engineer, 1973-1977
- Martin-Marietta, Denver, Colorado, Staff Engineer, 1977-1981
- Lockheed Missiles, Palo Alto, Principal Res. Scientist, 1981-2010

#### *4. Certifications or Professional Registrations – None*

#### *5. Current Membership in Professional Organizations*

Associate Fellow, AIAA.

#### *6. Honors & Awards*

- European Space Agency, State-of-the-Art Lecturer, Amsterdam, 1992
- AIAA Engineer-of-the-Year Award, San Francisco, 1990
- Invited Speaker, International Congress of Theoretical & Applied Mechanics, Warsaw, 2004 & Adelaide, 2008

#### *7. Service Activities*

Associate Editor, Journal of Guidance, Control, and Dynamics, 1995-2001

#### *8. Publications & Presentations*

Flexible Multibody Dynamics, Book, John Wiley & Sons, New York, 2016

#### *9. Professional Development Activities – None*

## **Robert J. Benzio**

### *1. Education*

M.S. Aerospace Engineering, San Jose State University, in-progress

B.S. Aerospace Engineering, San Jose State University, 2003

### *2. Academic Experience*

- Adjunct Faculty, Aerospace Engineering, SJSU, 2014-present.
- Adjunct Faculty, Design & Manufacturing Technologies, De Anza College 2008-present.

### *3. Non-Academic Experience*

- ATR/Orbotech, San Jose, CA, Engineer, Nov. 2016-present
- NASA Ames, Thermal Protection Branch OSSI NASA intern, June 2016 – August 2016
- NASA Ames, Howard and Houston Engineering, Engineer, August 2008 – October 2014
- NASA Ames, Education Associates, Engineering Intern on SOFIA, August 2005 – August 2008
- NASA Ames, Orbital Sciences Corporation, Engineer, August 2004 – April 2005
- NASA Ames, NASA/Ames Internship Program through FHDA, April 2004 – August 2005

## **Jeanine Hunter**

### *1. Education*

M.S. Aeronautical & Astronautical Engineering, Stanford University, 1981.  
B.S. Aeronautical Engineering, Purdue University, 1979.

### *2. Academic Experience*

Lecturer, Department of Aerospace Engineering, SJSU, 1989 - 1996  
Lecturer, Department of Mechanical and Aerospace Engineering, SJSU, 2009 – 2012  
Lecturer, Department of Aerospace Engineering, SJSU, 2013 - present

### *3. Non-Academic Experience*

- Manager, Guidance, Navigation and Control Section, TRW 1986 – 1989
- Engineer and Analyst: Systems Identification, Trajectory Reconstruction, TRW 1983 - 1990
- Project Engineer, Flight Dynamics & Controls Branch, NASA Ames Research Center 1979 - 1983

### *4. Certifications or Professional Registrations*

Private Pilot, 1976

### *5. Membership in Professional Organizations – None*

### *6. Honors and Awards*

2017	Nominated, SJSU Outstanding Lecturer
2014	SJSU College of Engineering <b>Outstanding Lecturer</b>
2008 – 2014	ΣΓΤ Professor of the Year Award, Voted by AE Students

### *7. Service Activities*

2013-present	Director, AE Learning Community Initiative
2013-present	Freshman Advisor, AE Department

### *8. Most important publications and presentations from the past five years*

#### *Papers in Conference Proceedings*

Low Cost Flight-Test Platform to Demonstrate Flight Dynamics Concepts using Frequency-Domain System Identification Methods, AIAA Atmospheric Flight Mechanics Conference, August 2013.

### *9. Most Recent Professional Development Activities – None*

## **Rachael V. Ishaya**

### *1. Education*

M.S. Mechanical & Aeronautical Engineering, University of California - Davis, 2004.  
B.S. Aerospace Engineering, San Jose State University, 1996.

### *2. Academic Experience*

Adjunct Professor, AE Department, San Jose State University, Fall 2016.  
Research Assistant, MAE Department, University of California - Davis, 1997 – 2004.

### *3. Non-Academic Experience*

- Pragmatic Professional Engineers, Inc., CEO/Owner, Jan 2015 – present.
- Bryza Wind Lab, Inc., President/Owner, Mar 2011 – present.
- International Accreditation Service, Inc., Technical Assessor, May 2011 – present.
- Otech Engineering, Inc., Chief Engineer, Jun 2005 – Feb 2011.
- NASA Ames Research Center, Planetary Aeolian Laboratory, Arizona SU,
- Academic Associate/Senior Staff Technician, Mar 1996 – Oct 1998.
- Orbitek Engineering, Inc., High Vacuum TIG Welder/Fabricator, Jan95 – Jan96.
- HTB, Inc., Aerospace/Ultra-High Vacuum TIG Welder/Fabricator, Jun.92– Jan95.
- United States Marine Corps, Aircraft Structures Tech/Welder, May 1988 – May 1992.

### *4. Certifications or Professional Registrations – None*

### *5. Current Membership in Professional Organizations*

AIAA, American Institute of Aeronautics and Astronautics (1996 – present)

### *6. Honors & Awards – None*

### *7. Service Activities – None*

### *8. Publications & Presentations*

Ishaya, R.V. (2014). Anemometer Calibration Requirements For Wind Energy Applications. American Meteorological Society (AMS) 17<sup>th</sup> Symposium on Meteorological Observations and Instrumentation, Westminster, Colorado.

Coquilla, R.V. (2012). Calibration Program For Wind Sensors In Wind Energy Applications. National Conference of Standards Laboratories International (NCSLI) Conference, Sacramento, California.

Coquilla, R.V. (2012). The Quality of Wind Tunnels Used for Calibrating Anemometers. American Wind Energy Association (AWEA) Wind Power Conference, Atlanta, Georgia.

Coquilla, R.V. (2012). Standard Practices for Air Speed Calibration Testing. Measurement Science Conference (MSC), Anaheim, California.

Coquilla, R.V. (2012). Quality of Air Speed Calibrations. Measurement Science Conference (MSC), Anaheim, California. Also published in CAL LAB: The International Journal of Metrology, Vol. 19, No. 3, pp 24-31.

### *2008 Recent Professional Development Activities – None*

## **Darryl W. Levasseur**

### *1. Education*

B.S. Aerospace Engineering, San Jose State University, 2012.

### *2. Academic Experience*

Adjunct Professor, Department of Aerospace Engineering, SJSU, Fall 2016.

-Systems Engineering Course

Guest Lecturer, Department of Aerospace Engineering, SJSU, 2013-2015.

-Spacecraft Design Courses

### *3. Non-Academic Experience*

- Metis Technology Solutions, PI, Phase I Small Business Innovative Research Grant for Small Form Factor RFID Free Flyer Payload, April 2017-Present
- Metis Technology Solutions, Chief Technologist, Aug 2013-Present
- NASA Ames RC, Systems Engineer II, Code RE Engineering Division, Metis Technology Solutions, Aug 2012-Present.
  - Laboratory and Safety Manager
  - Flight Hardware Test Engineering
  - Flight Hardware Assembly
  - Astrobee Free Flyer Robotics Engineer
  - Biosentinel Lunar CubeSat Mission Battery Group Lead
  - SPHERES Free Flyer Robotics Engineer
  - SPHERES Free Flyer Battery Group Lead
  - SPHERES Free Flyer CO2 Pressure Vessel Development Lead
- NASA Ames RC, Intern, Intelligent Robotic Group, University Space Research Association, Jun 2011-Aug 2012.

### *4. Certifications or Professional Registrations*

Soldering Certified, NASA-STD-8739.3 Soldered Electrical Connections

Soldering Certified, IPC J-STD-001S

ESD Certified, QS.0026/ANSI S.2020 Program Plan for NASA Ames Research Center Electrostatic Discharge (ESD) Control

Crimp/Cable Certified, NASA-STD-8739.4A Workmanship Standard For Crimping, Interconnecting Cables, Harnesses, and Wiring

Polymeric Certified, NASA-STD8739.1B, Workmanship Standard For Polymeric Application on Electronic Assemblies

### *5. Current Membership in Professional Organizations – None*

### *6. Honors & Awards*

2012 SJSU Outstanding Aerospace Engineering Award.

### *7. Service Activities – None*

### *8. Publications & Presentations – None*

### *9. Professional Development Activities – None*



## **Long K. Lu**

### *1. Education*

- Ph.D. Applied Mathematics & Statistics, U. of CA, Santa Cruz, expected June 2020.
- M.S. Aerospace Engineering, San Jose State University, December 2015.
- B.S. Aerospace Engineering, San Jose State University, May 2014.
- A.A. Mathematics, San Jose City College, May 2011.

### *2. Academic Experience*

- Adjunct Faculty, Dept. of Aerospace Engineering, SJSU, Spring 2016 – present.
- Graduate Research Assistant, Flight Control Systems & UAV Laboratory, Aerospace Engineering, SJSU, Spring 2014 – Fall 2015.
- Teaching Assistant, Aerospace Engineering, SJSU, Spring 2015 – Fall 2015.
- Workshop Facilitator, Aerospace Engineering, SJSU, Spring 2014.

### *3. Non-Academic Experience – None*

### *4. Certifications or Professional Registrations – None*

### *5. Current Membership in Professional Organizations – None*

### *6. Honors & Awards*

- 2016 University of California, Santa Cruz Graduate Fellowship.
- 2016 Best Session Presentation, AIAA Guidance, Navigation & Control Conference.
- 2015 California State University Sally Casanova Pre-Doctoral Scholarship.
- 2015 SJSU Charles W. Davidson College of Engineering Student Research Competition Winner.
- 2015 SJSU Sigma Gamma Tau Aerospace Engineering Honor Society Outstanding Research Award in Aeronautics.
- 2012 SJSU Charles W. Davidson College of Engineering Global Technology Initiative Scholar.
- 2011 National Science Foundation Engineering Leadership Pathway Scholarship.

### *7. Service Activities*

- Provides letters of recommendation to AE students at SJSU, Spring 2016-present.
- Promoted STEM Education at Third Street Community Center and San Jose High School, Fall 2012.

### *8. Publications & Presentations*

#### *Conference Papers*

- Lu, L. and Turkoglu, K., H-infinity Loop-Shaping Robust Differential Thrust Control Methodology for Lateral/Directional Stability of an Aircraft with a Damaged Vertical Stabilizer, AIAA SciTech 2016 Conference, San Diego, CA, 2016.
- Lu, L. and Turkoglu, K., Utilization of Differential Thrust to Regain Lateral/Directional

Stability of a Commercial Aircraft with a Damaged Vertical Stabilizer, IEEE Aerospace Conference, Big Sky, MT, 2015.

*Conference Presentations*

H-infinity Loop-Shaping Robust Differential Thrust Control Methodology for Lateral/Directional Stability of an Aircraft with a Damaged Vertical Stabilizer, AIAA SciTech 2016 Conference, San Diego, CA, 2016.

Utilization of Differential Thrust to Regain Lateral/Directional Stability of a Commercial Aircraft with a Damaged Vertical Stabilizer, IEEE Aerospace Conference, Big Sky, MT, 2015.

*9. Professional Development Activities*

Jan. 2016      AIAA SciTech 2016 Conference, San Diego, CA.

Jan. 2016      SJSU AE Department Engineering Course Design Workshop

Mar. 2015      IEEE Aerospace Conference, Big Sky, MT.

## **Gonzalo Eduardo Mendoza**

### *1. Education*

M.S. Aerospace Engineering, Wichita State University, 2008  
B.S. Aerospace Engineering, San José State University, 1998

### *2. Academic Experience*

SJSU, Lecturer, Department of Aerospace Engineering, 2010 – present, part-time.

### *3. Non-Academic Experience*

Textron Aviation, Inc. Manager, Loads, Acoustics, and Structural Dynamics Group. Manage a technical support group for advanced design, in production, and legacy airplanes focused on external loads development (static and dynamic), interior and exterior acoustics, landing gear dynamic design, as well as vibration and aeroelastic stability. 2013-present, full-time.

Cessna Aircraft Company. Engineer Specialist, Sr. Aerosciences. Development of simulation tools and analysis methods for the evaluation of aircraft response to ground and flight maneuvering and turbulence conditions. Analysis of interaction between systems and structures (control law and system failure mode effects). Development of load alleviation concepts. Mentoring and training of Aerosciences Engineers. Support loads analyses as required for legacy airplane models. Approval of external loads certification data for Part 23 and 25 aircraft under Cessna's Organization Designation Authorization (ODA). 2006-2013, full-time.

Cessna Aircraft Company. Aerodynamics Engineer. Stability and Control, Trajectory Analysis, and Wind Tunnel Testing. Preparation and documentation of wind tunnel test plans. Coordination of wind tunnel and model builder schedules. Collection and analysis of wind tunnel aerodynamic data. Preparation of wind tunnel pre- and post-test reports. Performance and stability and control analyses of advanced design configurations. 2002-2005, full-time.

Cessna Aircraft Company. Loads and Dynamics Engineer. Responsibilities included: Development of aircraft basic data. Analysis of empennage, wing, and control surface loads per 14 CFR Part 23 and 25. Reduction of wind tunnel aerodynamic data and preparation of loads aerodynamic models. 1998-2002, full-time.

### *4. Certifications or Professional Registrations*

- Private pilot, instrument rated.
- Current Textron Aviation ODA Unit Member, former FAA Designated Engineer
- Representative (DER) with approval authority for external loads analyses for Part 23 and 25 airplanes.

### *5. Current Membership in Professional Organizations*

- Sr. Member, American Institute of Aeronautics and Astronautics

- Member, Society of Automotive Engineers

6. *Honors & Awards*

Honors at graduation: Summa Cum Laude.

7. *Service Activities*

Member, SJSU Aerospace Engineering Advisory Board. 2011-2017.

8. *Publications & Presentations*

Woodrow, P., Tischler, M., Hagerott, S., Mendoza, G., and Hunter, J., Low Cost Flight-Test Platform to Demonstrate Flight Dynamics Concepts using Frequency-Domain System Identification Methods, AIAA Atmospheric Flight Mechanics (AFM) Conference, Guidance, Navigation, and Control and co-located Conferences, AIAA 2013-4739

9. *Professional Development Activities*

Developing Leadership Excellence, Textron U. leadership course, October, 2014.

## **Sean Montgomery**

### *1. Education*

M.S. Aerospace Engineering, San Jose State University, 2013.  
B.S. Aerospace Engineering, San Jose State University, 2008.

### *2. Academic Experience*

Adjunct Professor, AE Department, SJSU, 2013–present.

### *3. Non-Academic Experience*

NASA Ames RC, Cockpit Graphics Intern: Programmed software instrument displays for the Vertical Motion Simulator, 2008-2013.

### *4. Certifications or Professional Registrations – None*

### *5. Current Membership in Professional Organizations – None*

### *6. Honors & Awards*

2013 standing Research Award in Aeronautics, AE Department, SJSU.

### *7. Service Activities*

Faculty Advisor for MSAE projects

### *8. Publications & Presentations*

Montgomery, S. & Mourtos, N.J., Design of a 5-kg Solar-Powered UA for Perpetual Solar Endurance Flight, Proc., 49<sup>th</sup> AIAA/ASME/SAE/ASEE Joint Propulsion Conference 2013.

### *9. Professional Development Activities*

SJSU AE Department Engineering Course Design Workshop, 2015.

## **Davon John Mukhar**

### *1. Education*

M.S. Aerospace Engineering, San Jose State University, 2016.

B.S. Aerospace Engineering, University of California, Irvine, 2015.

### *2. Academic Experience*

Adjunct Professor, AE Department, SJSU, 2016-present.

SAE Project Lead, University of California, Irvine, 2014-2015.

### *3. Non-Academic Experience*

- Mechanical Aerospace Ground Equipment Engineer, Space Systems Loral, Jan17 – present.
- Structural Engineering Intern, Space Systems Loral, May 2016 – December 2016.
- Engineering Intern, Ellipse Technologies (NuVasive Spinal), April 2013 – June 2015.

### *4. Certifications or Professional Registrations – N/A*

### *5. Current Membership in Professional Organizations*

Society of Automotive Engineers, 2015 – present

### *6. Honors & Awards – None*

### *7. Service Activities – None*

### *8. Publications & Presentations*

#### *Technical Reports*

D.J. Mukhar. (2016). Additive manufacturing with 3D printing applied to low Reynolds number airfoils and wing design. MSAE Project Report, San Jose State University.

### *9. Professional Development Activities*

June 2016 – Communication Satellite Engineering, Space Systems Loral Internal Education

## **Marcus S. Murbach**

### *1. Education*

ENGINEER (Unfinished), Aeronautical & Astronautical Engineering, Stanford University, 1989-2006; Dissertation work on experimental flight systems, robotic Mars missions.

M.S. Mechanical Engineering, 1986.

B.S., Bio-Physics/Engineering, Harvey Mudd College, Claremont, CA, 1979.

### *2. Academic Experience*

Adjunct Professor, SJSU, 2008 – present.

### *3. Non-Academic Experience*

NASA Ames Research Center, 1987 – present.

Principal Investigator, TechEdSat-N Nanosat Flight Series (5 flown; 5 planned)

Principal Investigator, SOAREX-N Suborbital Flight Series (9 flown; 3 planned)

Associate Principal Investigator, NASA Hypersonic Flight Project, 2005-2007

Advanced Concepts Branch/ Mission Analysis Division (numerous LEO to Planetary studies)

Ames Design Lead for the X-34 Thermal Protection System Project

Ames Design Team Representative to the NASA Lunar Mars Mission Project Office 1991-1993

PASCAL Mars Network Mission, Chief Engineer, 1998-2002

Space Station Biological Research Project, System Engineer, 1989-1992

LifeSat/Re-usable Re-entry Vehicle(RRV) Thermal Engineer

Space Shuttle Orbiter Experiments (OEX), Thermal Engineer; testing in ballistic ranges, arc-jets, wind-tunnels.

### *4. Certifications or Professional Registrations*

Graduate of the International Space University summer session, 1992.

### *5. Current Membership in Professional Organizations*

AIAA American Institute of Aeronautics/Astronautics, member (1988 – present)

### *6. Honors and Awards*

2014 NASA Distinguished Engineering Medal (considered prestigious)

2014 Various NASA Group Achievement Awards

### *7. Service Activities*

*Service to the University*

Supervise MSAE projects

Supports AE student internships at NASA and other private industry organizations

### *8. Publications and Presentations*

*Conference Proceedings*

- Murbach, M., Drew, J., Cozumuta, I., Guarneros-Luna, A., Tanner, A., Wheless, J. Lavin, A., “A Review of De-orbit Techniques for the Advancement of On-Orbit Manufacturing, International Astronautical Congress, Adelaide, Australia, September 25-29.
- Murbach, M. S., Papadopoulos, P., Glass, C., Dwyer-Ciancolo, A., Powell, R., Dutta, S., Guarneros-Luna, A., Tanner, F., Wheless, J., Dono-Perez, A., “Modelling the Exo-Brake and the Development of Strategies for De-orbit Drag Modulation, International Planetary Probe Workshop, The Hague, Netherlands, June 11-16, 2017.
- Murbach, M. S., Papadopoulos, P., Glass, C., Dwyer-Ciancolo, A., Guarneros-Luna, A., Tanner, F. A., Wheless, J. Dono-Perez, A. “Exo-Brake Drag Modulation Flight Experiment Results, International Planetary Probe Workshop, The Hague, Netherlands, June 11-16, 2017.
- Murbach, Marcus S., Boronowsky, Kenny M., Benton, Joshua E., White, Bruce, Fritzler, Erin, “Options for Returning Payloads from the ISS after the Termination of STS Flights,” 40th International Conference on Environmental Systems, 2010, AIAA-2010-6223.
- Murbach, Marcus S., “The SCRAMP – The Development of an Advanced Planetary Probe from CFD to Re-entry Test Flight,” International Planetary Probe Workshop III, Anavysos, Greece, June28-July2, 2005.
- Allen, Daniel T., and Marcus S. Murbach, “Milliwatt Radioisotope Power Supply for the PASCAL Mars Surface Stations,” Space Technology and Application Forum, 18th Symposium on Space Nuclear Power and Propulsion, Albuquerque, New Mexico, February 11-15, 2001.
- Murbach, M., and R. Arno, “Artificial Gravity for Mars Missions: The Different Design and Development Options,” ICES-167, International Conference on Environmental Systems, Toulouse, France, August, 2000.
- Murbach, Marcus S., Keese, David L., and Jack Farmer, “Aeolus – A System Concept for Precise Delivery of Mars Scientific Instrumentation,” 11th AIAA/USU Conference on Small Satellites, paper SSC97-V-2, Salt Lake City, Utah, May 15-18, 1997.
- Murbach, Marcus S., “Ultra-light Entry Systems for Planetary Applications,” 34th Aerospace Sciences Meeting and Exhibit, AIAA paper 96-0512, Reno, Nevada, January 7-11, 1996.
- Murbach, Marcus S., Garin, Vladimir, “The Supermodule – A Design Departure from the Shuttle Payload Paradigm,” 28th Aerospace Sciences Meeting, Reno, Nevada, January 8-11, 1990, AIAA-90-1716.
- Pitts, W. C., and M. S. Murbach, “Thermal Response of an Aeroassisted Orbital-Transfer Vehicle with a Conical Drag Brake,” AIAA 19th Thermophysics Conference, Snowmass, Colorado, June 25-28, 1984.  
Also in Martin Summerfield (editor), *Thermal Design of Aeroassisted Orbital Transfer Vehicles*, Progress in Astronautics and Aeronautics, Martin Summerfield, Volume 96, 1985.

9. *Professional Development Activities*

2012 – 2016 International Planetary Probe Workshops



## **Jimmy Rico**

### *1. Education*

M.S. Aerospace Engineering, San Jose State University, 2016.

B.S., Aerospace Engineering, San Jose State University, 2014.

### *2. Academic Experience*

Adjunct Faculty, Department of Aerospace Engineering, SJSU, Fall 2016.

### *3. Non-Academic Experience*

- Aeronautical Engineer, Contractor, Aug.2016 – Dec.2016.

Designed 3D CAD models, analyzed and interpreted flight data, designed nonlinear and linear simulations, and performed flight testing.

### *4. Certifications or Professional Registrations – None*

### *5. Current Membership in Professional Organizations*

- The American Institute of Aeronautics and Astronautics (AIAA)
- Sigma Gamma Tau
- Tau Beta Pi

### *6. Honors & Awards*

- Outstanding Research Award in Aeronautics

### *7. Service Activities – None*

### *8. Publications & Presentations*

#### *Conference Proceedings*

Rico, J. and Turkoglu, K., Arduino-based low-cost experimental unmanned aerial flight system for attitude determination in autonomous flights, AIAA Modeling & Simulation Technologies Conference / AIAA Science and Technology Forum & Exposition, 2016.

### *9. Professional Development Activities*

- Course Development, AE 199 Special Topics: UAVs, SJSU, Fall 2016.
- SJSU AE Department Engineering Course Design Workshop, August 2016.

## **Dimitrios Soukeras**

### *1. Education*

- MBA(ER), Business Administration, Leicester University, UK, 2010.
- B.S., Military Studies, Greek Military Academy, Greece, 1990.

### *2. Academic Experience*

- Adjunct Professor, AE Department, SJSU, 2015-present.

### *3. Non-Academic Experience*

- Greek Army, Career Officer, Honorably retired as Lieutenant Colonel of Army Aviation, Helicopter Pilot, Instructor, Evaluator, Maintenance Test Pilot, 15Sep86 – 27Dec07.
- Greek AAIASB (Air Accident Investigation and Safety Board), external partner, accident investigator-technical advisor, March 2008-present.
- Organizational Diagnosis Ltd, CEO & Lead Consultant, Aviation Safety Consultancy & Training, April 2011 – present.

### *4. Certifications or Professional Registrations*

- CPL (H), Licensed Commercial Helicopter Pilot JAR-FCL Rights, 23 June 2010.
- Certified Air Accident Investigator, Civil Registered. Aircrafts, ISASI, 11 Aug 2005.

### *5. Current Membership in Professional Organizations*

- International Society of Air Safety Investigators: Member (2005-Present)
- Greek Aviation Society: Since 2008
  - **Member of the Board: Mechanical Engineering Research Unit** (2014 – 2015)
  - **Chairman of the Board: 2016**
- Helicopter Association International (HAI): Helicopter Pilot Membership, (2009 – present)

### *6. Honors & Awards*

From Military Service:

- Medal of Military Merit III Class.
- Badge Golden Cross Order of Phoenix.
- Badge Golden Cross order of Merit.
- Decoration of Meritorious Command.

### *7. Service Activities*

- Organized 4<sup>th</sup> Greek Aviation Society Conference, Athens International Airport, May 2016.
- Offered TRIPOD Beta Accident Investigation Training for Greek AAIASB accident Investigators, December 5-9 2016, Athens, Greece.

## *8. Publications & Presentations*

### *Papers in Conference Proceedings*

- Dimitrios Soukeras, Theodoros Pitikaris, Nikolaos Kanellos, Nelson Carrera: The Financial System in the Post Crisis Era within the Banking Union Framework, 5<sup>th</sup> FEBS Conference Proceedings, Athens, December 2014.
- Dimitrios Soukeras, Theodoros Pitikaris, Nikos Kanellos, European Banking System, a normal accident in progress in TRIPOD interpretation, IIPPE, Lisbon 2016.
- Dimitrios Soukeras, TRIPOD: An in-depth Accident Analysis method or a Safety Management Booster? European Branch ISASI (ESASI) Annual Seminar Proceedings, Madrid 2013.

### *Presentations*

- Investigating Germanwings Accident beyond limits with TRIPOD, Greek AAIASB, Biannual safety meeting, Athens International Airport. 4<sup>th</sup> December 2016.
- Bow Tie Risk Assessment for an Aviation Environment. Two Days Workshop for Greek CAA and Greek AAIASB, Athens, Greece, 4, 5 September 2016.
- Bow Tie Cure against Ship Evacuation Fears. Invited keynote address, SNAME Greek Section, Technical meeting, Athens, Greece, 24 November 2015.

## *9. Professional Development Activities*

- 04 Oct 2016 – 05 Nov 17      Life Coaching & Mentoring Practitioner, University of the Aegean, Greece
- 06 March 17-5 July 2017      Executive Coaching, University of Ioannina, Greece.

## **Sean S.M. Swei**

### *1. Education*

- Ph.D., School of Aeronautics and Astronautics, Purdue University, 1993.
- M.S., Mechanical Engineering & Mechanics, Drexel University, 1986.
- B.S., Mechanical Engineering, National Taiwan University, Taiwan, 1983.

### *2. Academic Experience*

- Adjunct Professor, Aerospace Engineering, SJSU, 2006-present.
- Adjunct Professor, Mechanical Engineering, Santa Clara University, 2016.
- Assistant Prof., Mech. & Aero. Engr., Nanyang Technological U., Singapore, 1998-2001.
- Visiting Scholar, Mechanical Engr., Hong Kong U. of Science & Technology, 1995.
- Teaching/Research Assistant, School of Aero. & Astro., Purdue University, 1986-1993.
- Research Assistant, Mechanical Engineering & Mechanics, Drexel U., 1984-1986.

### *3. Non-Academic Experience*

- NASA Ames RC, Intelligent Systems Division, Senior Research Scientist, 2000-present.
- General Motors Corp., Senior Project Engineer, 1995-1998.
- Taiwan Technical Consultant, Inc., Taiwan, Senior Researcher, 1993-1995.

### *4. Certifications or Professional Registrations – None*

### *5. Professional Membership – AIAA, Senior Member, 2001-present*

### *6. Honors & Awards*

- 2015 Exceptional Engineering Achievement Medal, NASA Ames Research Center
- 2014 NASA Group Achievement Awards
- 2014 NASA Ames Honor Award
- 2010 SJSU Part-Time Faculty Award for Excellence in Teaching
- 2007 AIAA Aerospace Software Engineering Award
- 2003 & 2005 NASA Ames Contractor Excellence Award
- 2005 American Helicopter Society Outstanding Technical Support Award
- 2003 American Helicopter Society Schroers Award for Outstanding Rotorcraft Research
- 1989-1992 Purdue University David Ross Fellowship Award

### *7. Service Activities*

#### *Service to Professional Organizations*

- 2017 AIAA SPACE Conference, Track Chair
- 2016 AIAA SPACE Conference, Track Co-Chair.
- 2016-present: AIAA Intelligent Systems Technical Committee, Secretary.
- 2012-present: Asian American Pacific Islander Advisory Group, Chair, NASA Ames RC.
- 2009-2012 Asian American Pacific Islander Advisory Group, Secretary, NASA Ames RC.

## 8. Publications & Presentations

### **Journal**

- Al-Jiboory, G. Zhu, S.S. Swei, W. Su, N. Nguyen, "LPV Modeling of a Flexible Wing Aircraft Using Modal Alignment and Adaptive Gridding Methods," *Aerospace Science & Technology*, 2017.
- S.M. Swei, N. Nguyen, "Adaptive Estimation of Disturbance Torque for Orbiting Spacecraft Using Recursive Least-Squares Method," *AIAA Journal of Aerospace Information Systems*, 2016.
- S.M. Swei, J. Fusco, R. Nakamura, "Design of Sun Safe Controllers for Lunar Atmosphere and Dust Environment Explorer," *AIAA Journal of Guidance, Control & Dynamics*, 2016.
- W. Su, S.M. Swei, G. Zhu, "Optimum Wing Shape Determination of Highly Flexible Morphing Aircraft for Improved Flight Performance," *AIAA J. of Aircraft*, 2016.
- Jenett, S. Calisch, D. Cellucci, N. Cramer, N. Gershenfeld, S.M. Swei, K.C. Cheung, "Digital Morphing Wing: Active Wing Shaping Concept Using Composite Lattice-based Cellular Structures," *Journal of Soft Robotics (SoRo)*, 2016.
- N. Cramer, S.M. Swei, K. Cheung, M. Teodorescu, "Extended Discrete-Time Transfer Matrix Approach to Modeling and Decentralized Control of Lattice-based Structures," *International J. of Structural Control and Health Monitoring*, 2016.

### **Conference Proceedings**

- N. Cramer, S.M. Swei, K. Cheung, D. Cellucci, B. Jenett, M. Teodorescu, "Lattice-based Discrete Structure Modeling and Control for Large Flexible Space Structure Applications," *AIAA SciTech*, 2017.
- N. Nguyen, E. Ting, D. Chaparro, M. Drew, S.M. Swei, "Multi-Objective Flight Control for Drag Minimization and Load Alleviation of High-Aspect Ratio Flexible Wing Aircraft," *AIAA SciTech*, 2017.
- Al-jiboory, G. Zhu, S.M. Swei, W. Su, N. Nguyen, "LPV Modeling of a Flexible Wing Aircraft Using Adaptive Model Gridding and Alignment Methods," *AIAA SciTech*, 2017.
- S.M. Swei, A.J. Westfall, "Attitude Control System Design for CubeSats Configured with Exo-Brake Parachute," *AIAA SPACE 2016*, Long Beach, CA.
- Chakrabarty, S. Swei, "Tree Based Trajectory Planning for Mars Aerocapture," *AIAA SciTech*, 2016, San Diego, CA.

### **Presentations**

- Robust Adaptive Estimation of Disturbance Torque Using Recursive Least-Squares Method, Department of Mechanical Engineering, Santa Clara University, 2016.
- Some Advances in Aeroelastic Aircraft and Flexible Spacecraft Controls," Department of Computing Engineering, University of California at Santa Cruz, 2015.

## 9. Recent Professional Development Activities – N/A

## **Jay Westerwelle**

### *1. Education*

B.S., Aerospace Engineering, San Jose State University, 2014.

### *2. Academic Experience*

Adjunct Faculty, San Jose State University, Fall 2014-present.

### *3. Non-Academic Experience*

- Flight Engineer, SSL, Palo Alto, California, 2014-present.
- Satellite Controller Intern, Skybox, Inc., Palo Alto, CA, Jan.-Jun. 2014
- Senior CAD Technician, Hexagon Transportation Consultants, Inc., San Jose, CA, Jun. 2008 – Feb. 2010
- Senior CAD Technician, CPH Engineers, Jacksonville, FL, Feb.2003 – Jun.2008

### *4. Certifications or Professional Registrations*

- Certified Flight Engineer, SSL
- Certified Satellite Controller, Skybox, Inc.
- Level 2 Certification, Tripoli Rocketry Association

### *5. Current Membership in Professional Organizations*

American Institute for Aeronautics & Astronautics (AIAA)

### *6. Honors & Awards*

- Outstanding Senior Award: Western Region 2014
- Member of Sigma Gamma Tau National Honor Society
- Scott T. Axeline Award for Excellence in Service, Charles W. Davidson College of Engineering, SJSU

### *7. Service Activities – None*

### *8. Publications & Presentations – None*

### *9. Professional Development Activities – None*

## Cecilia Larrosa Wilson

### 1. Education

Ph.D. Aeronautics and Astronautics, Stanford University, 2013  
M.S. Aeronautics and Astronautics, Stanford University, 2008  
B.S. Aerospace Engineering, San Diego State University, 2007

### 2. Academic Experience

2012 – present	Advanced Aerospace Structures and Materials (AE250), Mechanical and Aerospace Engineering, San Jose State U. Part time faculty.
9/2012 – 12/2012	Analysis of Structures (AA 240A), Aero/Astro Department, Stanford U. Teaching assistant; Prof. Fu-Kuo Chang
1/2012 – 3/2012	Mechanics of Composites (AA256), Aero/Astro Department, Stanford U. Teaching assistant; Prof. Fu-Kuo Chang
1/2012 – 3/2012	Structures: Why things don't (and sometimes do) fall down (AA113 Freshmen Intro Seminar), Aero/Astro Department, Stanford U. Course assistant; Prof. George Springer

### 3. Non-Academic Experience

2016 - present	Consultant Structural Integrity Associates, Inc. San Jose, Ca
2013-2016	Senior Engineer Mechanical Engineering Practice, Exponent Inc. Menlo Park, Ca.
2008-2013	Doctoral research: <i>Structural health monitoring and management for composite structures</i> , Structures and Composites Laboratory, Aero/Astro Department, Stanford U.

### 4. Certifications or Professional Registrations

Licensed Mechanical Engineer, California, #38109.

### 5. Current Membership in Professional Organizations

American Society of Mechanical Engineers—ASME  
American Institute of Aeronautics and Astronautics—AIAA  
Prognostics and Health Management Society—PHM

### 6. Honors & Awards

2011-2013	<i>Diversifying Academia, Recruiting Excellence (DARE) Fellowship</i> Competitive 2-year fellowship from the Office of the Vice Provost for Graduate Education, Stanford U.
2010, 2011	<i>Zonta International, Amelia Earhart Fellow</i> Competitive international one year award of \$10,000 (received twice)

### 7. Service Activities

9/2011 - present	Graduate and Professional Peer Advising (GP2A), an Engineering Diversity Program; undergrad and grad advisor
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9/2010 - present	Stanford Young Astronauts (YA) program member; teach science and engineering to 3 <sup>rd</sup> grade classrooms in local elementary schools.
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## 8. Publications & Presentations

### *Journal Publications*

Wilson, C. L., and Chang F-K. Monitoring fatigue induced transverse matrix cracks in laminated composites using built-in acousto-ultrasonic techniques. *Structural Health Monitoring*, 2016, Vol. 15(3), 335-350. DOI: 10.1177/1475921716636333

Larrosa C, Lonkar K and Chang F-K. In situ damage classification for composite laminates using Gaussian discriminant analysis. *Structural Health Monitoring*, 2014, Vol. 13(2), 190-204. DOI: 10.1177/1475921713517288

### *Book Chapters*

Wilson, C.L., Lonkar, K., Roy, S., Kopsaftopoulos, F. and Chang, F-K. *Structural Health Monitoring of Composites*, In Reference Module in Materials Science and Materials Engineering, Elsevier, 2017, Current as of 18 May 2017, ISBN 9780128035818, <https://doi.org/10.1016/B978-0-12-803581-8.10039-6>.

Lau D, Larrosa C. Case study 1: Health management system for a next generation UAV. In: *Product and Systems Development: A Value Approach*, First Edition. Weiss SI, John Wiley and Sons, pp. 173–188, 2013.

### *Conference Publications*

C.L. Wilson, E. Currens and J. F. Rakow. Void content in out-of-autoclave manufacturing processes. *Proc. Microscopy and Microanalysis Conference 2016*, P10: Microscopy and characterization of ceramics, polymers and composites. Columbus, Ohio, July 2016.

A. D. Nguyen, C. Page and C. L. Wilson. A new strategy toward internet of things: structural health monitoring using a combined fiber optic and acoustic emission wireless sensor platform. *Proc. SPIE 9803, Sensors and Smart Structures Technologies for Civil, Mechanical, and Aerospace Systems 2016*, 98031M (April 20, 2016); DOI:10.1117/12.2235637

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## 9. Professional Development Activities

May 2017 – Keynote presentation; Failure Analysis of Composites, ASM/SAMPE Silicon Valley meeting





Reynolds Number (per foot):  $1.4 \times 10^6$  /foot

### Components

- Data Acquisition System(DAS), Display and Control System (DAC)
- National Instruments hardware and LabView software
- Capable of monitoring: force/moment balance output, pressures, model angle of attack
- Dell desktop computer
- 3-component force / moment sting balance
- Drag model set: teardrop, backward cup, forward cup, circular flat plate, and sphere
- Pressure cylinder
- Clark Y-14 airfoil
- Pressure wing
- Wake rake
- Wing with adjustable slat and flaps
- 1:48 scale F-16 model
- Pitot-static probe
- Yaw probe
- Boundary layer flat plate and 10-tap total pressure probe
- Turbulence sphere
- Multi-column manometer
- Pressure transducer array

### **Subsonic Wind Tunnel Experiments**

#### ***AE160 – Aerodynamics I***

1. Study of aerodynamic drag as a function of shape (teardrop, backward cup, forward cup, circular flat plate, sphere, etc.) and Reynolds number.
2. Study of airfoil drag as a function of angle-of-attack and Reynolds number using wake traverses (momentum theorem).
3. Boundary layer study on a flat plate: laminar vs. turbulent boundary layer, boundary layer transition, boundary layer thickness, boundary layer velocity profiles.

#### ***AE162 – Aerodynamics II***

4. Study of the pressure distribution on a circular cylinder.
5. Study of the pressure distribution on an airfoil as a function of angle-of-attack and Reynolds number. Calculation of airfoil lift by integrating the surface pressure distribution.
6. Study of airfoil lift and drag as a function of angle-of-attack and Reynolds number using direct measurements (force balance system).
7. Study of airfoil aerodynamic characteristics with high lift devices (leading edge slats and split flaps).

#### ***AE168 – Aerospace Vehicle Dynamics & Control***

8. Study of the static longitudinal and directional stability characteristics of an F-16

model.

### ***AE171B – Aircraft Design II***

3D Printer for creating models for wind tunnel testing and/or parts for projects.

#### **C.1.1.2 Rolling Hills Research Corporation Water Tunnel Model 0710**



#### Performance Specifications

Size: L=112in, W=46in, H=47in  
Capacity: 105 gallons  
Test Section: W=7in, H=10in, L=18in  
Down Stream Window: 7in x 9.5in  
Flow Velocity: 2 to 5 in./sec.  
Turbulence Intensity: <0.5% RMS

#### Components

Centrifugal pump: 1.5hp 115VAC 60Hz 16A (stainless steel)  
Dye injection system (pressurized, 3-color), control panel  
Models: 2D airfoil, conical body, delta-wing aircraft

### **Water Tunnel Experiments**

#### ***AE160 – Aerodynamics I***

1. Flow visualization studies on airfoil, conical body, and delta wing aircraft. Attached / separated flow, steady / unsteady flow, 2-D / 3-D flow, observation of vortex formation and bursting.

***AE262 – Advanced Aerodynamics***

2. Flow visualization studies of high angle-of-attack hydro/aerodynamics on conical bodies and delta wing aircraft. Vortex formation and bursting as a function of body shape and angle-of-attack.

***New Experiments Planned for the Wind Tunnel***

1. Hot wire anemometer
2. Laser velocimeter

**C.1.2 – Supersonic Aerodynamics Lab**

Purpose

Provide students with experiments in supersonic flow and familiarity with instrumentation and data acquisition software (LabVIEW), schlieren / shadowgraph techniques for shock and expansion waves visualization, nozzle flow characterization, intrusive pressure and temperature measurements for free-stream flow characterization, measurement of aerodynamic forces acting on bodies submerged in supersonic flows and comparison with theoretical models.

Supported Courses

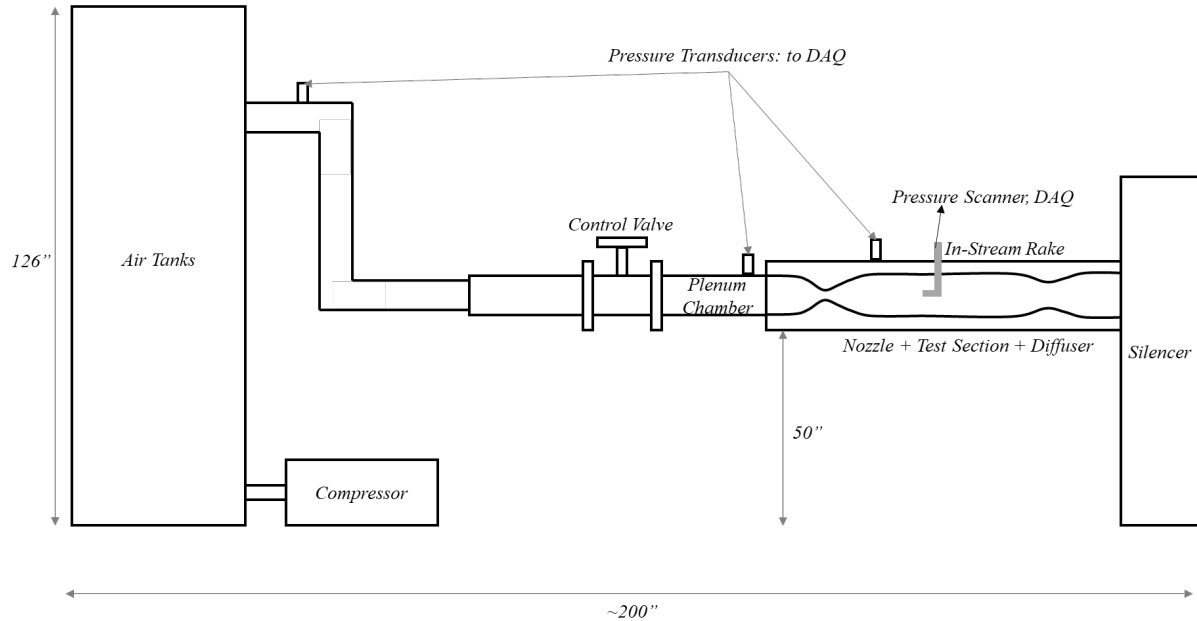
AE 164	Aerothermodynamics
AE 172B	Spacecraft Design II
AE 264	Advanced Compressible Flow
AE 280	Hypersonics

Enrollment

~ 60 students / year
~ 30 students / year
~ 30 students / 3 semesters
~ 30 students / year

Existing Stations & Major Equipment

**C.1.2.1      Supersonic Wind Tunnel Facility**



### Performance Specifications

Free-jet and closed test section modes.

Operation at different Mach numbers by exchanging nozzle sections.

Mach Number Range (free-jet mode) – 2 to 3.

Mach Number Range (closed test section mode) – 2 to 4.

Reynolds Number per Unit Length Range (free-jet mode) –  $3.1 \times 10^7/\text{foot}$  to  $8.9 \times 10^7/\text{foot}$ .

### Components

- Air compressor.
- Two high-pressure air receivers (max operating pressure: 550psi).
- Control Valve for steady state operation of the facility.
- Pressure transducers for the measurement of tank, plenum and test section pressure.
- Thermocouples for the measurement of plenum and in-stream temperatures.
- Pressure scanner for the simultaneous measurement of the pressure along the length of the nozzle or from the in-stream rake.
- National Instruments Data Acquisition System and LabView software for the operation of the wind tunnel control valve and for monitoring pressures and temperatures.
- Z-type schlieren system for the visualization of shock and expansion waves and local Mach number evaluation.
- Rake for pressure and temperature probes.
- Wind tunnel models: wedges, cones, diamond-shaped airfoils.

### **Supersonic Wind Tunnel Experiments**

#### ***AE 164 – Aerothermodynamics***

1. Visualize the flow around sharp and blunt bodies using a Schlieren system. CLO-1:

Compare the shock wave pattern on sharp wedges with the solution of the oblique shock wave equation; CLO-2: Compare the shock wave around cones at zero angle of attack with the Taylor-Maccoll solution; CLO-3: Visualize the formation of the shock around blunt bodies and understand the complexity of the flow downstream of the bow shock.

2. Characterize a nozzle flow at different exit Mach numbers in the free-jet configuration using the Schlieren system and the pressure scanner. CLO-1: Observe and quantify the underexpanded, perfectly expanded and overexpanded nozzle states; CLO-2: Observe expansion and shock wave patterns in the three cases; CLO-3: Estimate the local Mach number through analysis of Schlieren data images.
3. Design, build and validate of supersonic in-stream pressure and temperature probes through flow characterization. CLO-1: Describe and quantify the basic design constraints for supersonic flow probes (size, geometry, response time); CLO-2: Understand the measurement lag due to the use of small-sized tubing and finite-size thermocouple wires; CLO-3: Characterize the free-stream flow.
4. Evaluate the drag and lift coefficients on diamond-shaped airfoils submerged in supersonic flows and compare with available models: CLO-1: Measure the static pressure on the surface of the models using a pressure scanner; CLO-2: Compare experimental results with shock/expansion theory.

## **C.2 – Propulsion Lab**

Location: E-107

Square Footage: 1,357 ft<sup>2</sup>

Director: Dr. Fabrizio Vergine

### Purpose

Provide students with experiments in thermodynamic and flowdynamic analysis of jet engines.

### Supported Courses

AE 167 Aerospace Propulsion

### Enrollment

60 students / year

### Existing Stations & Major Equipment

#### **C.2.1 Mini-Lab Gas Turbine**



### Performance Specifications

- Design Maximum Thrust: 40 lbf (178 N)
- Fuels: Jet A, A-1, B; JP-4, 5, 8; kerosene, diesel, fuel oil #1 or #2
- Exhaust Gas Temperature: 1328° F (720° C)
- Mass Flow: 1.1 lbs/s (0.5 kg/s)
- Compressor Type: Single Stage Centrifugal (Radial Outflow)
- Turbine Type: Single Stage Axial Flow
- Design Maximum RPM: 87,000
- Engine Compression Ratio: 3.4
- Engine Pressure Ratio: 30.0
- Specific Fuel Consumption: 1.2
- Engine Diameter: 6.8 inches (17 cm)
- Engine Length: 10.8 inches (27 cm)

### Components

- SR-30 Gas Turbine with engine sensors and hush-kit
- Power system control panel
- Data acquisition computer

## Gas Turbine Experiments

### *AE167 – Aerospace Propulsion*

Study of jet engine characteristics: Measurement of compressor inlet temperature and pressure, turbine inlet temperature and pressure, turbine exit temperature and pressure, fuel flow and inlet and exit areas to be used in...

- Brayton cycle analysis – mass flow rate, inlet and exit velocity, station temperature and pressures, combustion and thermal efficiency, specific fuel consumption and power / thrust developed.
- Compressor analysis – compressor pressure ratio, power required, rotational speed and compressor efficiency.
- Turbine Analysis – work and power developed, expansion ratio and turbine efficiency
- Combustion analysis – excess air and fuel-air ratio.
- Diffuser and nozzle performance.

## C.3 – Aerospace Structures Lab

Location: E-164A

Square Footage: 285 ft<sup>2</sup>

Director: Prof. Jeanine M. Hunter

### Purpose

Demonstrate strength of materials concepts as applied to aerospace structures. The experiments include strain measurement & prediction, determination of Poisson's ratio on a cantilever beam, calculation of the thickness of a hollow torsional beam, theoretical & experimental determination of the shear center of a C-channel beam, the effect of lightening holes on the actual stress/strain of a Beechcraft 99 horizontal tail section, and calculation of the stress & shear center of a composite Alouette helicopter rotor blade. Future plans include structural dynamics characterization of the helicopter rotor blade section.

### Supported Courses

AE 112	Aerospace Structural Analysis I
AE 114	Aerospace Structural Analysis II
AE 250	Advanced Structures & Materials

### Enrollment

~ 90 students / year
~ 90 students / year
~ 45 students / year

### Existing Stations & Major Equipment

### *AE 112 – Aerospace Structural Analysis I*

#### 1. Strain Gage Seminar

Fundamentals of strain gage technology  
Strain gage attachment in groups of two students  
Small cantilever beam, Aluminum T6061-T6  
Measurement of strain under point load



Prediction of stress using bending moment curve  
Error reconciliation (should be < 5%)

2. Experimental Determination of Poisson's Ratio

Cantilever beam, steel alloy,  $E = 28.5 \times 10^6$  psi

Two-element rosettes on top and bottom of beam

Strain measurements taken with Vishay Wheatstone bridge circuit

Error reconciliation

3. Thickness of Torsional Beam

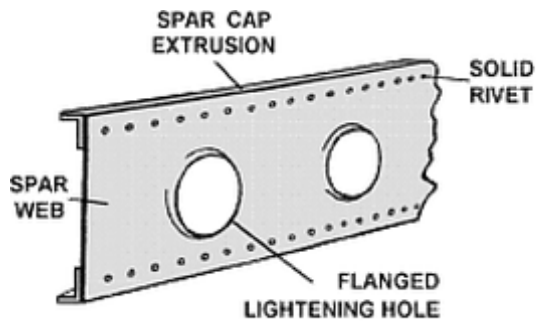
Direction cosine matrix to resolve torsional strain measurement

Modeling of torsional beam as hollow or solid

Determination of beam thickness

## AE 114 – Aerospace Structural Analysis II

### 4. Effect of Flanged Lightening Holes on Bending Strain



[http://www.zenair640.info/uploads/8/1/4/3/8143775/5522443\\_orig.gif?1](http://www.zenair640.info/uploads/8/1/4/3/8143775/5522443_orig.gif?1)

Beech 99 horizontal tail section experimental strain determination

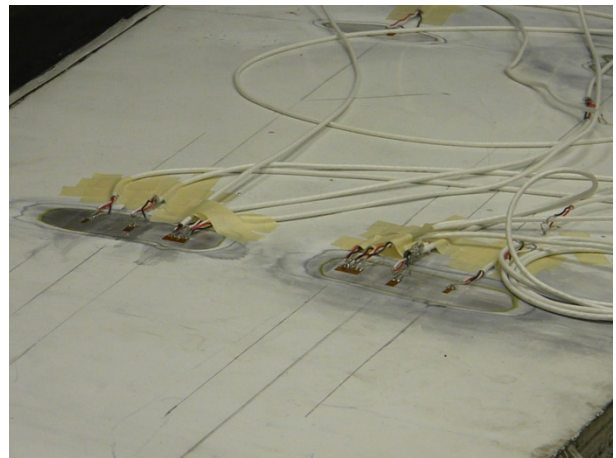
Calculation of section moment of inertia (stringer areas) at span station 21

Cantilever loading (simple point load)

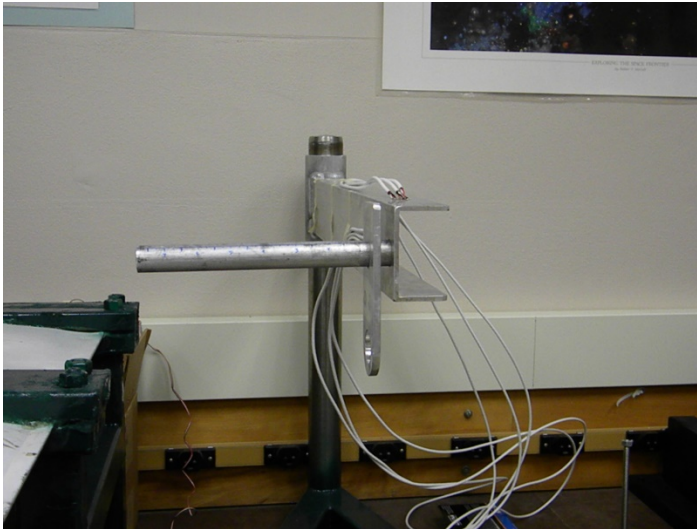
Experimental strain measurement

Theoretical calculation of bending stress with Euler's formula,  $\sigma = \frac{My}{I}$

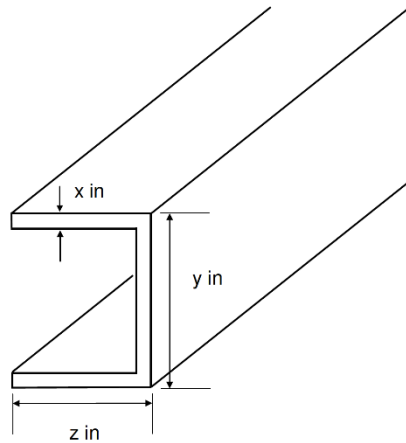
Find K such that:  $\sigma_{\text{experimental}} = K \sigma_{\text{theoretical}}$



## 5. Shear Center of a C-Channel Cantilever Beam

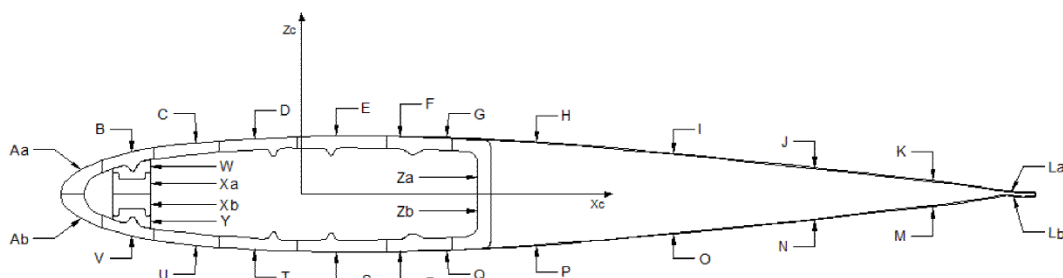


- Measure beam flange widths
- Calculate theoretical shear center of section
- Experimentally determine shear center of instrumented section
- Load applied creating torsional moment and shear flow in section
- Torsional strain is measured with the strain rosette



## 6. Bending Stress & Shear Center in Alouette Rotor Blade

- Calculate the moment of inertia of the composite (steel/aluminum) section
- Load helicopter rotor blade in bending; measure bending strain at five span stations
- Calculate theoretical bending stress at these stations and reconcile experimental error
- Experimentally determine shear center of the section instrumented with the strain rosette





### Existing Stations & Major Equipment

#### 1. System Identification of Aircraft

Experiment: This is a set-up which is used for system identification and parameter identification of aircraft. It provides experimental data for existing and newly built aircrafts, which further compliments aircraft stability and control design mission. This setup will serve for AE 168 and AE 246 classes.

#### 2. Ultrastick Unmanned Aerial Vehicle

Experiment: This multifunctional unmanned aerial vehicle/aircraft is used as the driving horse of the control theory applications, research topics and hands on projects/thesis.



Ultrastick UAV

#### 3. 3-Degree of Freedom Helicopter

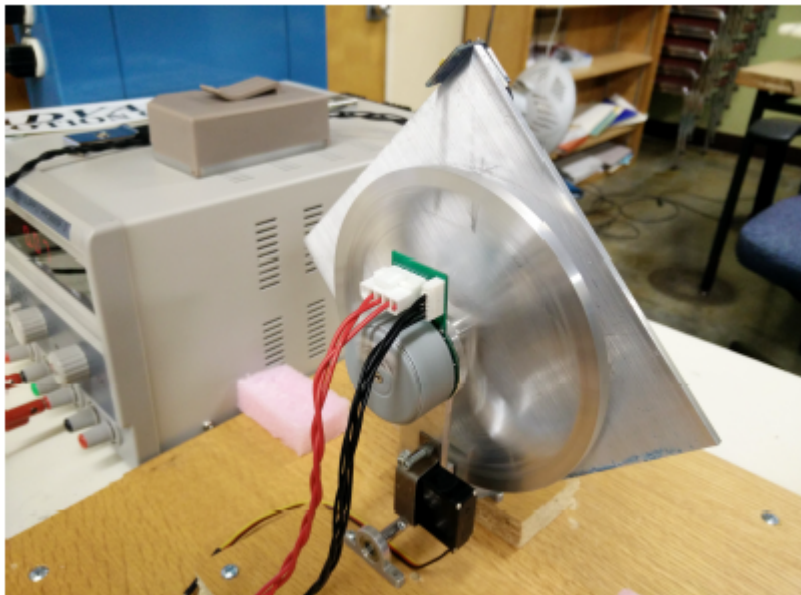
Experiment: The 3 DOF Helicopter model is used in this laboratory is analogous to a tandem rotor helicopter such as the Boeing HC-1B Chinook helicopter. This is used extensively in in-class control theory applications, as well as research and hands on projects/thesis. This set-up supports AE 157, AE 168 and AE 246 classes.



3DOF helicopter set-up

#### 4. 1DOF Cubli Experiment

Experiment: 1DOF cubli set-up is a very simple inverted pendulum experiment based on momentum wheel and the conservation of angular momentum principles. This simple, but yet powerful spacecraft dynamics demonstration is used extensively in in-class applications for AE 168 and AE 245, as well as research and projects/thesis.

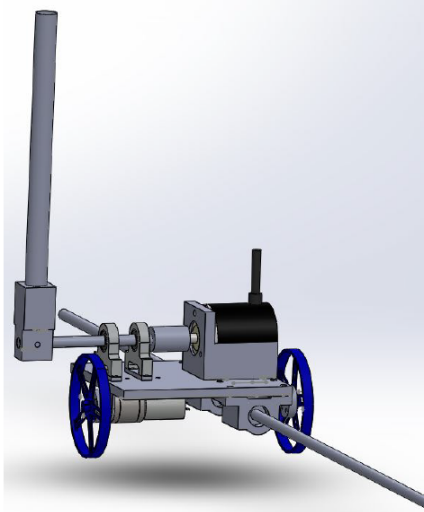


1DOF Cubli setup

#### 4. Self-Erecting Inverted Pendulum set-up

Experiment: This self-erecting inverted pendulum problem is a mechanical set-up which we developed within Fall 2016 semester, and is going to be used extensively in AE 157

and automatic control theory applications. It will provide a unique opportunity for students to test and implement theoretical controllers on a physical set-up.



Inverted Pendulum set-up

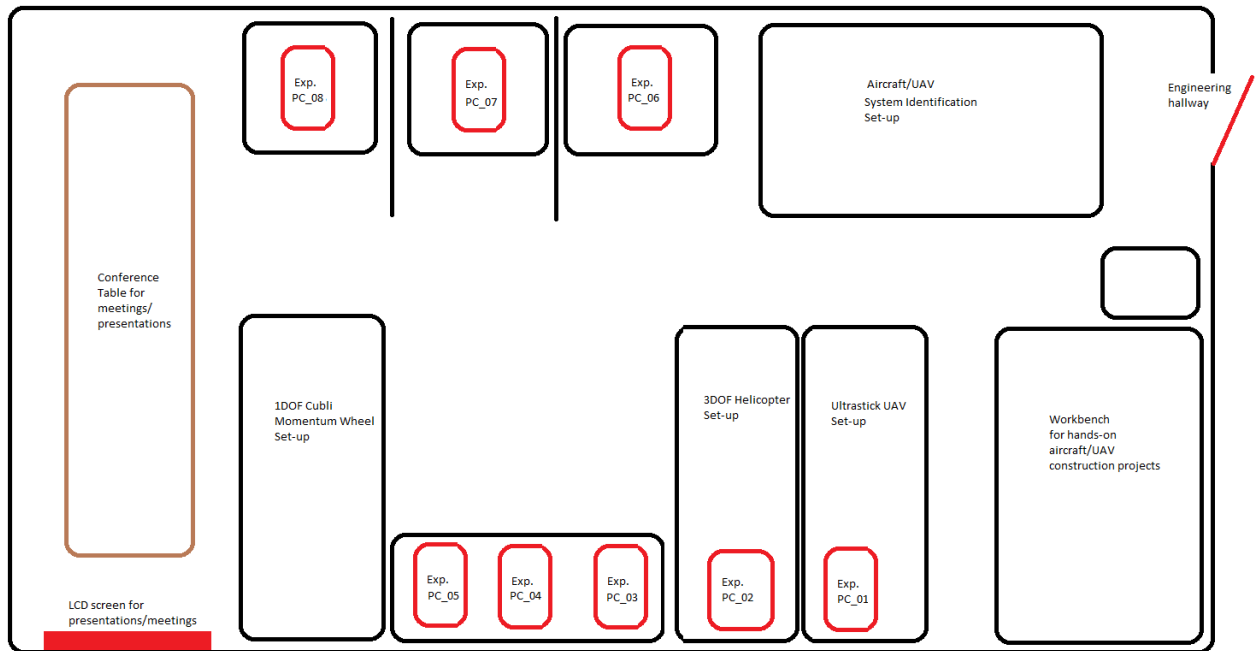
#### 5. Quadruple Tank System (will be added in 2017-2018 AY)

Experiment: This is a set-up which will aid to implement advanced control system designs (such as optimal and/or robust control theories), where the set-up itself (due to its non-minimum phase nature) is a challenging control problem. This will serve AE 157, AE 168 and AE 246 classes.



Quadruple tank setup

### Laboratory Layout





## APPENDIX D – Institutional Summary

### *1. The Institution*

Name and address of the institution:

San Jose State University  
One Washington Square  
San Jose, CA 95192

Name and title of the chief executive officer of the institution:

Dr. Mary A. Papazian  
President, San Jose State University

Name and title of the person submitting the Self-Study Report:

Dr. Nikos J. Mourtos  
Professor & Chair  
Aerospace Engineering Department  
San Jose State University

Name the organizations by which the institution is now accredited, and the dates of the initial and most recent accreditation evaluations:

The university is accredited by the WASC Senior College and University Commission (WSCUC), formerly known as the Western Association of Senior Colleges (WASC). Initial accreditation was in 1962, and the most recent accreditation was in July, 2015.

### *2. Type of Control*

The public higher education system in the State of California is comprised of three systems: the University of California (UC), the California State University (CSU), and California Community Colleges (CCC). San Jose State University (SJSU) is one of the 23 campuses of the CSU system, and is the oldest public higher education institution on the west coast.

Responsibilities for the California State University system are vested in the Board of Trustees, consisting of ex-officio members; alumni, faculty and student representatives; and members appointed by the Governor. The trustees appoint the Chancellor of the University system. The President of San Jose State University is the chief executive officer of the campus, and reports to the Chancellor.

### ***3. Educational Unit***

The Aerospace Engineering Program is housed with the Aerospace Engineering Department within the College of Engineering. The Department Chair is Dr. Nikos J. Mourtos. The Chair has administrative and budgetary responsibility for the programs in the department, and reports directly to the Dean of Engineering, Dr. Sheryl Ehamn. The Dean in turn reports to the Provost and Vice President for Academic Affairs, Dr. Andy Feinstein. The Provost reports to the president of the University, Dr. Mary Papazian.

### ***4. Academic Support Units***

The Chairs of each department teaching required courses are listed here:

#### ***College of Engineering***

Dr. Guna Selvaduray, Chair, Department of Biomedical, Chemical and Materials Engineering

Dr. Ray Chen, Chair, Department of Electrical Engineering

**Currently vacant**, Director, General Engineering Program

#### ***College of Science***

Dr. Karen Singmaster, Chair, Chemistry Department

Dr. Maria Cayco-Gajic, Chair, Mathematics and Statistics Department

Dr. Michael Kaufman, Chair, Physics Department

**General Education** courses are taught by a wide variety of departments across the campus.

The Deans of the relevant Colleges are listed here:

Dr. Lisa Vollendorf, Dean, College of Humanities and the Arts

Dr. Walter Jacobs, Dean, College of Social Sciences

Dr. Michael Parrish, Dean, College of Science

Dr. Mary Schutten, Dean, College of Applied Arts and Sciences

Dr. **Marlene Thomas**, **Interim** Dean, College of Business

Dr. Elaine Chin, Dean, College of Education

### ***5. Non-academic Support Units***

#### ***Units Within the College of Engineering:***

Lee Andersen, Director, Engineering Computing Systems

Neil Peters, Building Coordinator and Safety Specialist

Sarah Johnson, Director, Engineering Student Success Center

#### ***University-wide Units***

Martin Luther King, Jr. Library: Tracy Elliot, Ph.D.

Associate Vice President for IT Services and Chief Information Officer: Terry Vahey

Interim Associate Vice President for Student Academic Success Services, Dr. Stacy Gleixner

Director, Career Center: Catherine Voss Plaxton

Director, Academic Advising & Retention Services, Cindy Kato

Associate Vice President, Facilities Development & Operations: **vacant**

Director and Associate Vice President, Equal Opportunity Program: Debra Griffith, Ph.D.

Director, Accessible Education Center: Cindy Marota

Director, Counseling and Psychological Services: Kell Fujimoto

## 6. Credit Unit

- One semester unit represents one class hour (50 contact minutes) or three laboratory hours per week.
- One academic year represents 30 weeks of classes, exclusive of final examinations.

The university's credit hour policy appears on every syllabus, and reads:

*SJSU classes are designed such that in order to be successful, it is expected that students will spend a minimum of forty-five hours for each unit of credit (normally three hours per unit per week), including preparing for class, participating in course activities, completing assignments, and so on. More details about student workload can be found in [University Policy S12-3](http://www.sjsu.edu/senate/docs/S12-3.pdf) at <http://www.sjsu.edu/senate/docs/S12-3.pdf>.*

## 7. Tables

**Table D-1. Program Enrollment and Degree Data**

### Aerospace Engineering Program

Current Year	Academic Year		Enrollment Year					Total Undergrad	Total Grad	Degrees Awarded			
			1st	2nd	3rd	4th	5th			Associates	Bachelors	Masters	Doctorates
16-17	FT	61	64	42	50	58	275	48					
	PT	4	8	6	7	14	39	19					
1	15-16	FT	80	50	37	44	70	281	35		53		
	PT	3	7	11	10	16	47	31			18		
2	14-15	FT	79	44	30	34	61	248	37		39		
	PT	10	5	4	7	12	38	22			25		

3	13-14	FT	75	33	38	31	56	233	26		37	14	
		PT	4	1	5	6	12	28	29				
4	12-13	FT	44	35	24	28	41	172	18		25	13	
		PT	6	5	4	6	10	31	25				

These are official fall term enrollment figures (head count) for the current and preceding four academic years and undergraduate and graduate degrees conferred during each of those years.

FT – full time

PT – part time

## Table D-2. Personnel

### Aerospace Engineering Department

Year<sup>1</sup>: 2016-2017

	HEAD COUNT		FTE <sup>2</sup>
	FT	PT	
Administrative <sup>2</sup>	1		0.4
Faculty (tenure-track) <sup>3</sup>	3		3.6
Other Faculty (excluding student Assistants)		10	2.9
Student Teaching Assistants <sup>4</sup>		19	N/A
Technicians / Specialists			
Office / Clerical Employees	1		
Others <sup>5</sup>			

## APPENDIX E – BSAE Advising Course Log

Name:  
Student ID #:

Entered SJSU (Semester and Year): Fall 2016

Entered as: Freshman / Transfer  
Transferred from:

Required Math & Science Courses (33 units)				
COURSE	Units	SJSU	OTHER	Grade
Math 30	3			
Math 31	4			
Math 32	3			
Math 129A	3			
Math 133A	3			
Chem 1A	5			
Phys 50	4			
Phys 51	4			
Phys 52	4			

Technical Communication (6 units)				
COURSE	Units	SJSU	OTHER	Grade
English 1B*	3			
Engr. 100W	3			

\*Not required for students completing  
Humanities Honors

Engineering Core Courses (16 units)				
COURSE	Units	SJSU	OTHER	Grade
Engr 10	3			
AE 15	1		<i>(Recommended)</i>	
AE 20	2			
AE 30	2			
EE 98	3			
MatE 25	3			

AE Core Courses (39 units)				
COURSE	Units	SJSU	OTHER	Grade
AE 112	4			
AE 114	3			
AE 138	3			
AE 140	3			
AE 157	3			
AE 160	3			
AE 162	3			
AE 164	5			
AE 165	3			
AE 167	3			
AE 168	3			
AE 169	3			

Capstone Course (8 units minimum)				
COURSE	Units	SJSU	OTHER	Grade
AE 17? A	3			
Engr. 195A	1			
AE 17? B	3			
Engr. 195B	1			

Technical Elective (3 units)				
COURSE	Units	SJSU	OTHER	Grade
	3			

Advisor's Notes:				

Course equivalences: assist.org

Transcript Evaluation: eval@sjsu.edu


## General Education Courses

- I am on the following GE track:
- I. Core GE classes
  - II. American Studies
  - III. Humanities Honors

### Core GE classes

*For a selection of courses in each area see the SJSU Catalogue and the Schedule of classes*

Area	Course	Units	SJSU	Other	Grade
A1/Oral Comm.		3			
A2/Written Comm. I	English 1A	3			
C1/Arts		3			
C2/Letters		3			
D1/Human Behavior		3			
D2/Comp. Systems	Pair 1:	3			
D3/Soc. Issues	Pair 2:	3			
E/Human Under & Development	Engr10 or ?	3			
US1					
US2					
US3					

### American Studies

Course	Units	SJSU	Other School	Grade
AMS 1A	6			
AMS 1B	6			
A1/Oral Communication	3			
A2/English 1A	3			
E/Engr10 or ?	3			

### Humanities Honors

Course	Units	SJSU	Other School	Grade
HUM 1A	6			
HUM 1B	6			
HUM 2A	6			
HUM 2B	6			
D1/Human Behavior	3			
E/ Engr10 or ?	3			

## APPENDIX F – Aerospace Engineering Advisory Board

**Kenny Boronowski**

Manager, Thermal Protection Systems

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Special Programs

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**George Fahmy**

Lead Flight Test Engineer

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**Brian Ha**

Flight Operations Engineer

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3825 Fabian Way, Palo Alto, CA 94303  
jay11west11@gmail.com



## APPENDIX G – Course Design Workshop for AE Faculty

### New AE Faculty Workshop

A full-day workshop with a focus on the process of course design, delivery, and assessment process.

Presented by Nikos J. Mourtos, Ph.D.

*Professor & Chair, Aerospace Engineering*

AE Conference Room, E272 – 19 August 2016

#### **9:00 – 9:30 Introduction**

Components of education. Process skills. Driving forces. Traditional vs. alternative teaching and learning methods.

#### **9:30 – 11:00 Part 1 – Course Learning Objectives**

Where do I want to take my students?

What are instructional objectives? Why do we need them? Taxonomy of instructional objectives. Cognitive and affective domains. Importance in course design.

***Task 1: Development and evaluation of your course learning objectives.***

#### **11:00 – 12:00 pm Part 2 – Assessment**

How do I know they (my students) have arrived?

Why assess? Diagnostic, formative, and summative assessment. Rubrics.

***Task 2: Design of proper instruments for assessment of your course learning objectives.***

#### ***12 – 1:30 pm Lunch***

### **Part 3 – Design of Learning Activities – Elements of Learning Theory**

#### **1:30 – 3:00 pm Conditions of Learning**

What does it take for people to learn something new?

***Task: Design learning activities for your course that meet the conditions of learning.***

#### **3:00 – 4:30 pm Teaching & Learning Styles**

***Task: Design learning activities for your course that meet the learning needs of all your students.***

#### **4:30 – 5:30 pm Conclusion**

Moving forward. Creating a community of learners / support network (for faculty and students).

#### ***6:00 pm Dinner***

## APPENDIX H – AE Instrument for Peer Evaluation of Teaching

**Professor's Name:**

**Date:**

**Title / Name of Evaluator:**

**Course No. & Title:**

**Number of students present:**

**Type of Class:**

### **PART A: TO BE COMPLETED BEFORE CLASS VISIT**

*Please review the course syllabus before visiting the class!*

*Leave blank any items that you cannot evaluate or simply make suggestions.*

<b>1. Course design:</b>	<b>Comments / Suggestions:</b>
1a. Appropriate course content (e.g. consistent w. department, college, university, accreditation agency expectations / criteria).	
1b. Clear goals.	
1c. Clear & measurable learning objectives.	
1d. Well-planned activities (in-class problems, hw, projects) tied to the learning objectives.	
1e. Appropriate methods to evaluate student learning throughout the course (hw, exams, reports tied to the learning objectives).	
1f. Attempts for continuous improvement (content updates, new instructional materials & methods, use of technology).	
1g. High expectations (e.g. clearly stated high standards of quality, no late assignments accepted, coming to class on time, rigorous & structured grading).	

**PART B: TO BE COMPLETED DURING CLASS VISIT**

*Please arrive early and stay for the entire class period!*

*Leave blank any items that you cannot evaluate or simply make suggestions.*

<b>2. Evidence of Student Learning in Class</b>	<b>Comments / Suggestions:</b>
<b>During Lecture / Laboratory The Students:</b>	
2a. Are attentive (e.g. they are facing the board, taking notes, participating in class activities, not sleeping / daydreaming, not reading newspapers, not doing homework).	
2b. Ask questions.	
2c. Answer questions.	
2d. Solve problems.	
2e. Present material.	
2f. Summarize key ideas.	
2g. Tackle open-ended problems.	
<b>3. In-Class Teaching Style &amp; Methods</b>	
<b>The Professor:</b>	
3a. Knows the subject / feels comfortable w. the material.	
3b. Is enthusiastic about the subject matter.	

<p>3c. Communicates high expectations (e.g. coming to class on time, coming to class prepared).</p>	
<p>3d. Creates a comfortable learning environment (e.g. shows respect for students, has good rapport w. students, knows student names, listens carefully to students' comments / questions &amp; answers, responds constructively, treats all students in a courteous and equitable manner).</p>	
<p>3e. Presents clear and well-organized lectures (e.g. clear learning objectives, review of previous material, coherent &amp; logical sequence of presentation, summary of key ideas).</p>	
<p>3f. Communicates clearly (speaking, writing, visuals, explanations, answering questions etc.).</p>	
<p>3g. Interacts w. students (e.g. questions students, provides appropriate and prompt feedback).</p>	
<p>3h. Expects students to prepare before they come to class.</p>	
<p>3i. Encourages student participation (e.g. small group problem-solving, students present material / summarize ideas, etc.).</p>	
<p>3j. Provides constructive and prompt feedback on assignments.</p>	

3k. Teaches students how to think / approach problems (e.g. through examples, presenting different ways to solve a problem, coaching students when they solve problems in class).	
3l. Addresses a variety of learning styles.	
3m. Assesses student learning throughout the class period.	
3n. Adapts teaching to in-class assessment.	
3o. Addresses level of instruction to average student (not the lowest or the highest)	
3p. Demonstrates good teaching ethics (shows up on time, uses class time effectively).	

**PART C: TO BE COMPLETED AFTER CLASS VISIT**

**Summary Evaluation of Teaching Effectiveness**

**Areas of Strength**

**Suggestions for Improvement**

## APPENDIX I – AE Faculty Petition for Department

The petition below was signed by all the AE faculty. Only a few of the signatures are showing here.

September 28, 2015

To: Dean Andrew Hsu

From: Aerospace Engineering Faculty

Re: Request to Form an Aerospace Engineering Department

The AE faculty request that the AE Program be given the official status of Aerospace Engineering Department. Our Program has grown to 400+ majors and 150+ FTES with four full-time, tenure-track faculty members. The split of our Program from Mechanical Engineering has allowed for a more dedicated and proper advising of AE students, which has resulted, among other things, in an increase of our:

- Six-year graduation rate for first-time-freshmen:
  - from 33.3% (F'07 cohort) to **42.4%** (F'08 cohort).
- Three-year graduation rate for transfer students:
  - from 37.5% (F'10 cohort) to **57.9%** (F'11 cohort)
- MSAE graduation rate for first-time graduate students:
  - from 41.7% (F'10 cohort) to **62.5%** (F'11 cohort)<sup>28</sup>

Our current program size already *exceeds the average AE program size in the U.S.* Our recent growth in headcount from 184 in Fall 2010 to 400+ majors in Fall 2015, as well as in FTES (from 35 in Fall 2010 to 150+ in Fall 2015) is due, among other things, to the national and international recognition of our Program, the established employment track-record of our graduates, as well as an increased interest in commercial “new space” ventures, green aviation initiatives, and autonomous aircraft.

In addition:

1. The AE Program is *uniquely located in close proximity to major aerospace companies and research facilities*, such as NASA Ames RC, Lockheed-Martin, Space Systems Loral, BAE Systems, Google (Skybox) and several smaller companies, which hire aerospace engineers. As such, it has tremendous potential for growth and excellence. One example of this potential, is the TechEdSat project<sup>29</sup>, in which AE students design, build, test, launch and deploy microsattellites from the International Space Station under the guidance of NASA engineers and AE faculty. The AE Program now plays a key role in state-of-the-art microsatellite research at NASA Ames RC.
2. The AE Program enjoys *national and international reputation*. A few examples of this reputation are:

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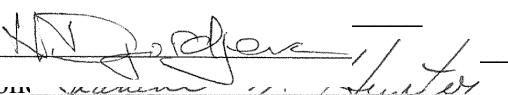
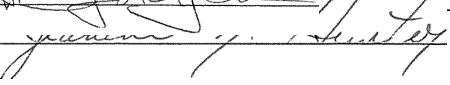

<sup>28</sup> Traditional approach

<sup>29</sup> Technical Educational Satellite, URL: < <http://techedsat.co/team.html>>

- The International Planetary Probe Workshop<sup>30</sup> (IPPW, Summer 2013), organized in collaboration with NASA Ames RC, which brought together engineers, technologists, scientists, mission designers, space agency leaders, and students from around the world for a compelling, week-long collaboration focused on exploring solar system destinations via in-situ missions. AE students presented papers at the conference.
- The ***ongoing success of aircraft design students*** in the highly competitive, international, AIAA Design, Build, Fly competition<sup>31</sup> (1<sup>st</sup> Place in 2012, 5<sup>th</sup> Place in 2013, 3<sup>rd</sup> Place in 2014) under the guidance of Mr. Mendoza, Manager of Loads, Acoustics, and Structural Dynamics at Cessna Aircraft Company. Mr. Mendoza is also a graduate of our Program (BSAE'97).
- ***Established collaborations with universities overseas***, among them four Mexican universities, the University of the Aegean in Greece, King Abdul Aziz University (KAU) in Saudi Arabia, Sultan Qaboos University in Oman, and Central Queensland University in Australia.
- ***There is currently no public university in the area, which offers an undergraduate degree in AE.*** This was true in 1987, when the AE Department was founded and continues to be the case today. Furthermore, although many engineering schools offer programs titled aerospace, few offer curricula with sufficient representation of astronautics. Our AE Program ***integrates modern applications of aeronautics and astronautics, including a distinct spacecraft design course.*** Approximately 90% of our graduates are employed in local industry. Since much of this industry is involved with the manufacturing of spacecraft and their components, the AE Program has received enthusiastic industrial support, technical and financial, for its innovative curriculum content.

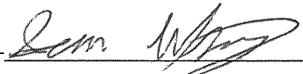
The establishment of the AE Department will foster the necessary stability and allow the Program to maintain its excellence. At the same time it will facilitate the continued growth of the Program to its full potential. Last but not least, the AE Department will provide ***the necessary status*** for AE Faculty to leverage their position in negotiations for funding from public and private institutions.

***The Aerospace Engineering Faculty:***


1. Mr. Robert Benzio, Lecturer, Engineer, NASA 
2. Dr. Peggy Boylan-Ashraf, Assistant Professor \_\_\_\_\_
3. Mr. Nik Djordjevic, Lecturer, Design Manager (ret.), Lockheed-Martin Space Systems Company \_\_\_\_\_
4. Ms. Jeanine Hunter, Lecturer, 
5. Dr. Cecilia Larrosa, Lecturer, Exp. 
6. Mr. Gonzalo Mendoza, Lecturer, Cessna Aircraft \_\_\_\_\_ 

<sup>30</sup> International Planetary Probe Workshop, URL: <[International Planetary Probe Workshop 10 \(IPPW-10\)](http://www.aiaadbf.org/ippw-10)>

<sup>31</sup> American Institute of Aeronautics and Astronautics Design/Build/Fly Competition, URL: <<http://www.aiaadbf.org>>

7. Mr. Sean Montgomery, Lecturer 

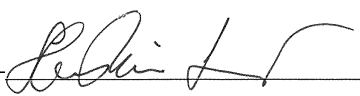
8. Dr. Nikos J. Mourtos, Professor & Director \_\_\_\_\_

9. Mr. Marc Murbach, Lecturer, Principal Investigator, SOAREX Flight Series, NASA Ames RC 


10. Mr. Ben Nikaido, Lecturer, NASA Ames RC \_\_\_\_\_

11. Dr. Periklis Papadopoulos, Professor \_\_\_\_\_

12. Mr. Dimitrios Soukeras, Lecturer, Safety Consultant/Air Safety Investigator \_\_\_\_\_

13. Dr. Sean Swei, Lecturer, Guidance, Navigation & Control Lead Analyst, NASA Ames RC 

14. Dr. Kamran Turkoglu, Assistant Professor \_\_\_\_\_

15. Mr. Jay Westerwelle, Lecturer, Flight Engineer, Space Systems Loral 



## APPENDIX J – AE Student Papers Presented at the IPPW

M. Feher, T. Renteria , J. Rodriguez , P. Wu , P. Papadopoulos. **Interplanetary Navigation Mission Support System**, *14th International Planetary Probe Workshop (IPPW-14)*, June 12–16, 2017/ The Hague, The Netherlands.

R. Rosila , S. Torres , L. Murray, I. Supelana, and J. Austring, P. Papadopoulos. **Cold Gas Thruster Attitude Control System to Augment the Exo-Brake Passive Deorbit**. *14th International Planetary Probe Workshop (IPPW-14)*, June 12–16, 2017/ The Hague, The Netherlands.

V.D.Patel and P.E.Papadopoulos. **Altitude Control for High Altitude Balloons**. *14th International Planetary Probe Workshop (IPPW-14)*, June 12–16, 2017/ The Hague, The Netherlands.

Eric Huynh, Myles Oldroyd, KoKo San, Julio Serafin, Richard Sok, Periklis Papadopoulos, Marcus Murbach. **On the Development and Design for an Affordable Two-Wheeled Mars Rover, MARVIN**. *14th International Planetary Probe Workshop (IPPW-14)*, June 12–16, 2017/ The Hague, The Netherlands.

M. Murbach, A. Guarneros-Luna, P. Papadopoulos, R. Alenaa , A. Dono Perezb , A. Tannerb , J. Whelessb , S. Smith, A.Salas, C. Priscalc J. Pleaterc , A. Dwyer Cianciolod , R. Powell d. **Exo-Brake Drag Modulation Flight Experiment Results**. *14th International Planetary Probe Workshop (IPPW-14)*, June 12–16, 2017/ The Hague, The Netherlands.

R. Rosila, S. Torres, L. Murray, J. Untalan, L. Freitas, J. Carpio, J. Esquivel, C. Espinoza, E. Lopez, R. Blanco, T. Soares, E. Marchen, I. Quintero, Z. Hughes, B. Tesfamichael, A. Gonzales, E. Reyes, P. Papadopoulos. **Autonomous Mars Robotic Agro-Life Support System**. *14th International Planetary Probe Workshop (IPPW-14)*, June 12–16, 2017/ The Hague, The Netherlands.

M. Murbach, P. Papadopoulos, A. Guerneros Luna. **ATROMOS: Using Nano-Satellite Technology to Explore the Mars Surface**. *Interplanetary Small Satellite Conference*, 1-2 May 2017, San Jose State University, San Jose, California.

M. S. Murbach, P. Papadopoulos, C. Glass, A. Dwyer-Ciancolo, R.W. Powell, S. Dutta, A. Guarneros-Luna, F. A. Tanner, A. Dono. **Modeling the Exo-Brake And The Development Of Strategies For De-orbit Drag Modulation**. *13th International Planetary Probe Workshop (IPPW-13)*, Johns Hopkins University-Applied Physics Laboratory, Laurel, Maryland, 13-17 June 2016.

- M.S. Murbach, P. Papadopoulos, D. Atkinson. **An Overview of the SOAREX and TechEdSat Flight Series: Missions To Advance Re-entry Experimentation, Planetary Mission Design, and Flight Technology.** *12th International Planetary Probe Workshop (IPPW-12)*, Cologne, Germany, 15-19 June 2015.
- M. Murbach, P. Papadopoulos, A. Guarneros-Luna, G. Pearhill, M. Bodmer, J. Mojica, A. Reuter, D. Atkinson, M. Scales, K. Sok, J. Cortez, Benton, T. Shu, J. Punzalan, G. Nakashiki, J. Drew, J. Swenson, A. Tabrizi, J. Wheless, R. Shimmin. **The Exo-Brake As A De-Orbit Mechanism: Analysis and Recent Flight Experience.** *12th International Planetary Probe Workshop (IPPW-12)*, Cologne, Germany, 15-19 June 2015.
- M. Murbach, P. Papadopoulos, A. Reuther, J. Mojica, A. Guarneros-Luna, M. Scales, G. Pearhill, M. Bodmer, D. Atkinson, K. Sok, J. Cortez, Benton, T. Shu, J. Punzalan, G. Nakashiki, J. Drew, J. Swenson, A. Tabrizi, J. Wheless, R. Shimmin, R. Alena. **The TechEdSat NanoSatellites and Exo-Brake De-orbit Mechanisms: Recent Flight Experience.** *11th International Planetary Probe Workshop (IPPW-11)*, Pasadena, 16-20 June 2014.
- Liz Hyde, Periklis Papadopoulos, James Grady, Marcus Murbach. **Combining Laser Communications and Power Beaming for use on Planetary Probes.** *10th International Planetary Probe Workshop (IPPW-10)*, San Jose, 17-21 June 2013.
- Liz Hyde, Periklis Papadopoulos. **Combining Laser Communications and Power Beaming for use on Planetary Probes.** *10th International Planetary Probe Workshop (IPPW-10)*, San Jose, 17-21 June 2013.
- Marcus Murbach, Periklis Papadopoulos. **The Small Payload Quick Return System (SPQR) As A Testbed for Future Planetary Probe Missions.** *9th International Planetary Probe Workshop (IPPW-9)*, Toulouse, France, 18-22 June 2012.

## APPENDIX K – Annual Assessment Reports for GE Areas S & V

Course Number/Title: AE171A – Aircraft Design I – *Fall 2015*  
 GE Area **S** in conjunction with Engr.195A

Results reported for AY 2015-2016 # of sections: 1 # of instructors: 1  
 Course Coordinator: *Nikos J. Mourtos* E-mail: nikos.mourtos@sjsu.edu  
 Department Chair: *Nikos J. Mourtos* College: Engineering

**Part 1 – Completed by the Course Coordinator:**

(1) What SLO(s) were assessed for the course during the AY?

*All SLOs were assessed in AE171A (one section offered).*

(2) What were the results of the assessment of this course?

*The assignments for each SLO are described below. Assignments were graded by a student assistant supervised by the Course Coordinator, using a 4-point scale rubric developed by Dr. Pat Backer, which takes into consideration the thesis statement, the organization of the paper, the mechanics of the paper (grammar, spelling, and punctuation), and the content of the paper.*

*Scores of 1 and 2: indicate that the student failed the assignment and did not meet the SLO.*

*Score of 3: indicates that the student passed the assignment and met the SLO.*

*Score of 4: indicates that the student passed the assignment and exceeded the expectations for meeting the SLO.*

In all assignments, if students do not meet the minimum expectation for the SLO (a score of 3), they are given one more opportunity to re-write and re-submit their paper, following specific recommendations on their paper.

SLO-1: Describe how identities (i.e. religious, gender, ethnic, racial, class, sexual orientation, disability, and/or age) are shaped by cultural and societal influences within contexts of equality and inequality.

- *Reflection Paper 1 (250 – 500 words): Based upon your response to Engr195A Testimony 1, consider your identity as a future aerospace engineer. How is your identity shaped by cultural and societal influences within contexts of equality and inequality?*

<b><i>Number of students in the course</i></b>	<b>29</b>
<i>Students who did not meet SLO-1</i>	<i>1 (3%)</i>
<i>Students who met SLO-1</i>	<i>20 (69%)</i>
<i>Students who exceeded the expectations for SLO-1</i>	<i>7 (24%)</i>
<i>Students who did not submit assignment</i>	<i>1 (3%)</i>

SLO-2: Describe historical, social, political, and economic processes producing diversity, equality, and structured inequalities in the U.S.

- *Reflection Paper 2 (500 – 750 words): Using the case studies provided in Engr195A, describe how airplanes in general and your project in particular, fit into the historical, social, political, and economic processes producing diversity, equality, and structured inequalities in the U.S.*

<b>Number of students in the course</b>	<b>29</b>
<i>Students who did not meet SLO-2</i>	<i>10 (34%)</i>
<i>Students who met SLO-2</i>	<i>14 (48%)</i>
<i>Students who exceeded the expectations for SLO-2</i>	<i>4 (14%)</i>
<i>Students who did not submit assignment</i>	<i>1 (3%)</i>

SLO-3: Describe social actions which have led to greater equality and social justice in the U.S. (i.e. religious, gender, ethnic, racial, class, sexual orientation, disability, and/or age).

- *Reflection Paper 3 (250-500 words): Consider the technological innovations in aerospace engineering in general and aircraft design in particular, describe a historical example and indicate how it has increased social justice in the U.S. and the world.*

<b>Number of students in the course</b>	<b>29</b>
<i>Students who did not meet SLO-3</i>	<i>4 (14%)</i>
<i>Students who met SLO-3</i>	<i>18 (62%)</i>
<i>Students who exceeded the expectations for SLO-2</i>	<i>6 (21%)</i>
<i>Students who did not submit assignment</i>	<i>1 (3%)</i>

SLO-4: Recognize and appreciate constructive interactions between people from different cultural, racial, and ethnic groups within the U.S.

- *Reflection Paper 4 (500 words): Consider a negative side effect of aerospace technology: noise. Read the following articles and research the procedures regarding airplane noise in your own town or region. What civic organizations promote the reduction of airplane noise in your community? Either visit one of these groups' websites or visit the group in person and describe the interactions between this group and the larger community. Your paper must cite your sources, including the ones listed below.*

Articles:

Swift, H. (2010, July). *A review of the literature related to potential health effects of aircraft noise. Partner Project 19 Final Report. Partnership for Air Transportation Noise and Emissions Reduction: an FAA / NASA / Transport Canada – sponsored Center-of-Excellence.*

Morrison, S.A., Watson, T. & Winston, C. (1998, September). *Fundamental Flaws of Social Regulation: The Case of Airplane Noise*. AEI-Brookings Joint Center, Available: <http://www.brookings.edu/research/papers/1998/09/airplane-winston>  
 FAA Advisory Circulars, *Noise Standards: Aircraft Type and Airworthiness Certification*, Available: [http://www.faa.gov/regulations\\_policies/advisory\\_circulars/index.cfm/go/document.list/parentTopicID/112](http://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.list/parentTopicID/112)  
 ICAO, *Environmental Protection, Aircraft Noise*, Available: <http://www.icao.int/environmental-protection/Pages/noise.aspx>

<b>Number of students in the course</b>	<b>29</b>
<i>Students who did not meet SLO-3</i>	<i>2 (7%)</i>
<i>Students who met SLO-3</i>	<i>20 (69%)</i>
<i>Students who exceeded the expectations for SLO-2</i>	<i>6 (21%)</i>
<i>Students who did not submit assignment</i>	<i>1 (3%)</i>

The **overall scores** of the students, determined by the average in all four assignments is as follows:

<b>Number of students in the course</b>	<b>29</b>
<i>Students who did not meet SLOs</i>	<i>1 (3%)</i>
<i>Students who met SLO-3</i>	<i>23 (79%)</i>
<i>Students who exceeded the expectations for SLO-2</i>	<i>4 (14%)</i>
<i>Students who did not submit assignments</i>	<i>1 (3%)</i>

(3) What were the lessons learned from the assessment?

*In general, students performed well in their reflections. Reflection 2 was the one most students had difficulty with, as they tend to consider equality as being synonymous with social justice. Following the recommendations from the previous assessment report, specific examples were given in class to distinguish between equality and social justice. Although the percentage of students who did not meet SLO-2 is still high (34%), overall, individual student scores were better this time than in AY 2014-2015. Students also performed better this time in Reflection 4. When taking into consideration all four assignments, only two students (6%) did not perform satisfactorily in Area S.*

(4) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

- *Provide articles addressing equality and social justice on CANVAS to help students distinguish between the two.*
- *Establish 500 as the minimum number of words for each reflection to ensure that students can develop good arguments in their reflections.*

## **Part 2 – Completed by the Department Chair**

- (4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

*Yes, they are. No actions are necessary.*

- (5) If this course is in a GE Area with a stated enrollment limit (Areas A1, A2, A3, C2, D1, R, S, V, & Z), please indicate how oral presentations will be evaluated with larger sections (Area A1), or how practice and revisions in writing will be addressed with larger sections, particularly how students are receiving thorough feedback on the writing which accounts for the minimum word count in this GE category (Areas A2, A3, C2, D1, R, S, V, & Z) and, for the writing intensive courses (A2, A3, and Z), documentation that the students are meeting the GE SLOs for writing.

*AE171A is a first semester senior design capstone experience, which typically draws an enrollment between 25 and 35 students. The AE Program does not anticipate larger enrolment in this course.*

Course Number/Title: AE172A – Spacecraft Design I – **Fall 2015**  
GE Area **S** in conjunction with Engr.195A

Results reported for AY 2015-2016 # of sections: 1 # of instructors: 1  
Course Coordinator: **Nikos J. Mourtos** E-mail: nikos.mourtos@sjsu.edu  
Department Chair: **Nikos J. Mourtos** College: Engineering

### **Part 1 – Completed by the Course Coordinator:**

- (1) What SLO(s) were assessed for the course during the AY?

*All SLOs were assessed in AE172A (one section offered).*

- (2) What were the results of the assessment of this course?

*The assignments for each SLO are described below. Assignments were graded by a student assistant supervised by the Course Coordinator, using a 4-point scale rubric developed by Dr. Pat Backer, which takes into consideration the thesis statement, the organization of the paper, the mechanics of the paper (grammar, spelling, and punctuation), and the content of the paper.*

*Scores of 1 and 2: indicate that the student failed the assignment and did not meet the SLO.*

*Score of 3: indicates that the student passed the assignment and met the SLO.*

*Score of 4: indicates that the student passed the assignment and exceeded the expectations for meeting the SLO.*

In all assignments, if students do not meet the minimum expectation for the SLO (a score of 3), they are given one more opportunity to re-write and re-submit their paper, following specific recommendations on their paper.

SLO-1: Describe how identities (i.e. religious, gender, ethnic, racial, class, sexual orientation, disability, and/or age) are shaped by cultural and societal influences within contexts of equality and inequality.

- *Reflection Paper 1 (250 – 500 words): Based upon your response to Engr195A Testimony 1, consider your identity as a future aerospace engineer. How is your identity shaped by cultural and societal influences within contexts of equality and inequality?*

<b>Number of students in the course</b>	<b>33</b>
Students who did not meet SLO-1	0
Students who met SLO-1	30 (91%)
Students who exceeded the expectations for SLO-1	3 (9%)
Students who did not submit assignment	0

SLO-2: Describe historical, social, political, and economic processes producing diversity, equality, and structured inequalities in the U.S.

- *Reflection Paper 2 (500 – 750 words): Using the case studies provided in Engr195A, describe how spacecraft in general and your project in particular, fit into the historical, social, political, and economic processes producing diversity, equality, and structured inequalities in the U.S.*

<b>Number of students in the course</b>	<b>33</b>
Students who did not meet SLO-2	0
Students who met SLO-2	21 (64%)
Students who exceeded the expectations for SLO-2	12 (36%)
Students who did not submit assignment	0

SLO-3: Describe social actions which have led to greater equality and social justice in the U.S. (i.e. religious, gender, ethnic, racial, class, sexual orientation, disability, and/or age).

- *Reflection Paper 3 (250-500 words): Consider the technological innovations in aerospace engineering in general and spacecraft design in particular, describe a historical example and indicate how it has increased social justice in the U.S. and the world.*

<b>Number of students in the course</b>	<b>33</b>
Students who did not meet SLO-3	0
Students who met SLO-3	16 (48%)
Students who exceeded the expectations for SLO-2	17 (52%)
Students who did not submit assignment	0

SLO-4: Recognize and appreciate constructive interactions between people from different cultural, racial, and ethnic groups within the U.S.

- *Reflection Paper 4 (500 words): Consider a negative side effect of aerospace technology: noise. Read the following articles and research the procedures regarding airplane noise in your own town or region. What civic organizations promote the reduction of airplane noise in your community? Either visit one of these groups' websites or visit the group in person and describe the interactions between this group and the larger community. Your paper must cite your sources, including the ones listed below.*

Articles:

Swift, H. (2010, July). *A review of the literature related to potential health effects of aircraft noise. Partner Project 19 Final Report. Partnership for Air Transportation Noise and Emissions Reduction: an FAA / NASA / Transport Canada – sponsored Center-of-Excellence.*

Morrison, S.A., Watson, T. & Winston, C. (1998, September). *Fundamental Flaws of Social Regulation: The Case of Airplane Noise. AEI-Brookings Joint Center, Available: <http://www.brookings.edu/research/papers/1998/09/airplane-winston>*

*FAA Advisory Circulars, Noise Standards: Aircraft Type and Airworthiness Certification, Available:*

*[http://www.faa.gov/regulations\\_policies/advisory\\_circulars/index.cfm/go/document.list/parentTopicID/112](http://www.faa.gov/regulations_policies/advisory_circulars/index.cfm/go/document.list/parentTopicID/112)*

*ICAO, Environmental Protection, Aircraft Noise, Available:*

*<http://www.icao.int/environmental-protection/Pages/noise.aspx>*

<b>Number of students in the course</b>	<b>33</b>
<i>Students who did not meet SLO-3</i>	<i>0</i>
<i>Students who met SLO-3</i>	<i>27 (82%)</i>
<i>Students who exceeded the expectations for SLO-2</i>	<i>6 (18%)</i>
<i>Students who did not submit assignment</i>	<i>0</i>

The **overall scores** of the students, determined by the average in all four assignments is as follows:

<b>Number of students in the course</b>	<b>33</b>
<i>Students who did not meet SLOs</i>	<i>0</i>
<i>Students who met SLO-3</i>	<i>25 (76%)</i>
<i>Students who exceeded the expectations for SLO-2</i>	<i>8 (24%)</i>
<i>Students who did not submit assignments</i>	<i>0</i>

- (3) What were the lessons learned from the assessment?

*In general, students performed well in their reflections. Reflection 2 was the one most students had difficulty with, as they tend to consider equality as being synonymous with social justice. Following the recommendations from the previous assessment report,*



*specific examples were given in class to distinguish between equality and social justice. Overall, individual student scores were better this time than in AY 2014-2015. Students also performed better this time in Reflection 4. When taking into consideration all four assignments, all students performed satisfactorily in Area S.*

- (4) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)
- *Provide articles addressing equality and social justice on CANVAS to help students distinguish between the two.*
  - *Establish 500 as the minimum number of words for each reflection to ensure that students can develop good arguments in their reflections.*

## **Part 2 – Completed by the Department Chair**

- (4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

*Yes, they are. No actions are necessary.*

- (5) If this course is in a GE Area with a stated enrollment limit (Areas A1, A2, A3, C2, D1, R, S, V, & Z), please indicate how oral presentations will be evaluated with larger sections (Area A1), or how practice and revisions in writing will be addressed with larger sections, particularly how students are receiving thorough feedback on the writing which accounts for the minimum word count in this GE category (Areas A2, A3, C2, D1, R, S, V, & Z) and, for the writing intensive courses (A2, A3, and Z), documentation that the students are meeting the GE SLOs for writing.

*AE172A is a first semester senior design capstone experience, which typically draws an enrollment between 25 and 35 students. The AE Program does not anticipate larger enrolment in this course.*

Course Number/Title: AE171B – Aircraft Design II – *Spring 2016*  
 GE Area **V** in conjunction with Engr.195B

Results reported for AY 2015-2016 # of sections: 1 # of instructors: 1  
 Course Coordinator: *Nikos J. Mourtos* E-mail: nikos.mourtos@sjsu.edu  
 Department Chair: *Nikos J. Mourtos* College: Engineering

**Part 1 – Completed by the Course Coordinator:**

(1) What SLO(s) were assessed for the course during the AY?

*All SLOs were assessed in AE171B (one section offered).*

(2) What were the results of the assessment of this course?

*The assignments for each SLO are described below. Assignments were graded by a student assistant supervised by the Course Coordinator, using a 4-point scale rubric developed by Dr. Pat Backer, which takes into consideration the thesis statement, the organization of the paper, the mechanics of the paper (grammar, spelling, and punctuation), and the content of the paper.*

*Scores of 1 and 2: indicate that the student failed the assignment and did not meet the SLO.*

*Score of 3: indicates that the student passed the assignment and met the SLO.*

*Score of 4: indicates that the student passed the assignment and exceeded the expectations for meeting the SLO.*

In all assignments, if students do not meet the minimum expectation for the SLO (a score of 3), they are given one more opportunity to re-write and re-submit their paper, following specific recommendations on their paper.

SLO-1: Compare systematically the ideas, values, images, cultural artifacts, economic structures, technological developments, and/or attitudes of people from more than one culture outside the U.S.

- *Reflection Paper 1 (750 words): Assume that your airplane will go into production. Using the studies provided in Engr195B as a background, write about how you will take into account at least two aspects (e.g. ideas, values, images, cultural artifacts, economic structures, or technological developments) while evaluating your decision to manufacture your airplane in two other countries.*

<b><i>Number of students in the course</i></b>	<b>27</b>
<i>Students who did not meet SLO-1</i>	2 (7%)
<i>Students who met SLO-1</i>	8 (30%)
<i>Students who exceeded the expectations for SLO-1</i>	17 (63%)

<i>Students who did not submit assignment</i>	<i>0</i>
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SLO-2: Identify the historical context of ideas and cultural traditions outside the U.S. and how they have influenced American culture.

- *Reflection Paper 2 (500 words): Consider an aerospace engineering technology invented outside of the U.S. (a) Describe the cultural and social factors that led to the invention of this technology. (b) Describe how this invention has evolved and influenced the culture in the U.S.*

<b><i>Number of students in the course</i></b>	<b><i>27</i></b>
<i>Students who did not meet SLO-2</i>	<i>2 (7%)</i>
<i>Students who met SLO-2</i>	<i>7 (26%)</i>
<i>Students who exceeded the expectations for SLO-2</i>	<i>18 (67%)</i>
<i>Students who did not submit assignment</i>	<i>0</i>

SLO-3: Explain how a culture outside the U.S. has changed in response to internal and external pressures.

- *Reflection Paper 3 (500 words): Using the social and cultural processes introduced in Engr195A&B, describe how non-US farmers have responded to the pressure from US farmers' enhanced ability in growing food using advances in aerospace engineering technology (UAVs, GPS).*
- *Reflection Paper 4 (750 words): Assume your airplane will go into production in the US. Describe how your product will put pressure on a culture outside the US. (choose a specific country.) Use the social and cultural processes introduced in Engr195A&B to guide your answer.*

<b><i>Number of students in the course</i></b>	<b><i>27</i></b>
<i>Students who did not meet SLO-3</i>	<i>0</i>
<i>Students who met SLO-3</i>	<i>8 (30%)</i>
<i>Students who exceeded the expectations for SLO-2</i>	<i>19 (70%)</i>
<i>Students who did not submit assignment</i>	<i>0</i>

The **overall scores** of the students, determined by the average in all four assignments is as follows:

<b><i>Number of students in the course</i></b>	<b><i>27</i></b>
<i>Students who did not meet SLOs</i>	<i>0</i>
<i>Students who met SLO-3</i>	<i>7 (26%)</i>
<i>Students who exceeded the expectations for SLO-2</i>	<i>20 (74%)</i>
<i>Students who did not submit assignments</i>	<i>0</i>

- (3) What were the lessons learned from the assessment?

*Students perform much better in Area V assignments, as they were better able to make the connection between Area V concepts and aerospace engineering.*

- (4) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

*No modifications are necessary.*

## **Part 2 – Completed by the Department Chair**

- (4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

*Yes, they are. No actions are necessary.*

- (5) If this course is in a GE Area with a stated enrollment limit (Areas A1, A2, A3, C2, D1, R, S, V, & Z), please indicate how oral presentations will be evaluated with larger sections (Area A1), or how practice and revisions in writing will be addressed with larger sections, particularly how students are receiving thorough feedback on the writing which accounts for the minimum word count in this GE category (Areas A2, A3, C2, D1, R, S, V, & Z) and, for the writing intensive courses (A2, A3, and Z), documentation that the students are meeting the GE SLOs for writing.

*AE171B is a second semester senior design capstone experience, which typically draws an enrollment between 25 and 35 students. The AE Program does not anticipate larger enrolment in this course.*

Course Number/Title: AE172B – Spacecraft Design II – **Spring 2016**  
GE Area **V** in conjunction with Engr.195B

Results reported for AY 2015-2016 # of sections: 1 # of instructors: 1  
Course Coordinator: **Nikos J. Mourtos** E-mail: nikos.mourtos@sjsu.edu  
Department Chair: **Nikos J. Mourtos** College: Engineering

## **Part 1 – Completed by the Course Coordinator:**

- (1) What SLO(s) were assessed for the course during the AY?

*All SLOs were assessed in AE172B (one section offered).*

- (2) What were the results of the assessment of this course?

*The assignments for each SLO are described below. Assignments were graded by a student assistant supervised by the Course Coordinator, using a 4-point scale rubric*

developed by Dr. Pat Backer, which takes into consideration the thesis statement, the organization of the paper, the mechanics of the paper (grammar, spelling, and punctuation), and the content of the paper.

Scores of 1 and 2: indicate that the student failed the assignment and did not meet the SLO.

Score of 3: indicates that the student passed the assignment and met the SLO.

Score of 4: indicates that the student passed the assignment and exceeded the expectations for meeting the SLO.

In all assignments, if students do not meet the minimum expectation for the SLO (a score of 3), they are given one more opportunity to re-write and re-submit their paper, following specific recommendations on their paper.

SLO-1: Compare systematically the ideas, values, images, cultural artifacts, economic structures, technological developments, and/or attitudes of people from more than one culture outside the U.S.

- *Reflection Paper 1 (750 words): Assume that your spacecraft will go into production. Using the studies provided in Engr195B as a background, write about how you will take into account at least two aspects (e.g. ideas, values, images, cultural artifacts, economic structures, or technological developments) while evaluating your decision to manufacture your airplane in two other countries.*

<b>Number of students in the course</b>	<b>33</b>
<i>Students who did not meet SLO-1</i>	<i>3 (9%)</i>
<i>Students who met SLO-1</i>	<i>15 (45%)</i>
<i>Students who exceeded the expectations for SLO-1</i>	<i>15 (45%)</i>
<i>Students who did not submit assignment</i>	<i>0</i>

SLO-2: Identify the historical context of ideas and cultural traditions outside the U.S. and how they have influenced American culture.

- *Reflection Paper 2 (500 words): Consider an aerospace engineering technology invented outside of the U.S. (a) Describe the cultural and social factors that led to the invention of this technology. (b) Describe how this invention has evolved and influenced the culture in the U.S.*

<b>Number of students in the course</b>	<b>33</b>
<i>Students who did not meet SLO-2</i>	<i>2 (6%)</i>
<i>Students who met SLO-2</i>	<i>11 (33%)</i>
<i>Students who exceeded the expectations for SLO-2</i>	<i>20 (61%)</i>
<i>Students who did not submit assignment</i>	<i>0</i>

SLO-3: Explain how a culture outside the U.S. has changed in response to internal and external pressures.

- *Reflection Paper 3 (500 words): Using the social and cultural processes introduced in Engr195A&B, describe how non-US farmers have responded to the pressure from US farmers' enhanced ability in growing food using advances in aerospace engineering technology (UAVs, GPS).*
- *Reflection Paper 4 (750 words): Assume your airplane will go into production in the US. Describe how your product will put pressure on a culture outside the US. (choose a specific country.) Use the social and cultural processes introduced in Engr195A&B to guide your answer.*

<b>Number of students in the course</b>	<b>33</b>
<i>Students who did not meet SLO-3</i>	<i>0</i>
<i>Students who met SLO-3</i>	<i>12 (36%)</i>
<i>Students who exceeded the expectations for SLO-2</i>	<i>21 (64%)</i>
<i>Students who did not submit assignment</i>	<i>0</i>

The **overall scores** of the students, determined by the average in all four assignments is as follows:

<b>Number of students in the course</b>	<b>33</b>
<i>Students who did not meet SLOs</i>	<i>0</i>
<i>Students who met SLO-3</i>	<i>14 (42%)</i>
<i>Students who exceeded the expectations for SLO-2</i>	<i>19 (58%)</i>
<i>Students who did not submit assignments</i>	<i>0</i>

- (3) What were the lessons learned from the assessment?

*Students perform much better in Area V assignments, as they are better able to make the connection between Area V concepts and aerospace engineering.*

- (4) What modifications to the course, or its assessment activities or schedule, are planned for the upcoming year? (If no modifications are planned, the course coordinator should indicate this.)

*No modifications are necessary.*

## **Part 2 – Completed by the Department Chair**

- (4) Are all sections of the course still aligned with the area Goals, Student Learning Objectives (SLOs), Content, Support, and Assessment? If they are not, what actions are planned?

*Yes, they are. No actions are necessary.*

- (5) If this course is in a GE Area with a stated enrollment limit (Areas A1, A2, A3, C2, D1, R, S, V, & Z), please indicate how oral presentations will be evaluated with larger sections (Area A1), or how practice and revisions in writing will be addressed

with larger sections, particularly how students are receiving thorough feedback on the writing which accounts for the minimum word count in this GE category (Areas A2, A3, C2, D1, R, S, V, & Z) and, for the writing intensive courses (A2, A3, and Z), documentation that the students are meeting the GE SLOs for writing.

*AE172B is a second semester senior design capstone experience, which typically draws an enrollment between 25 and 35 students. The AE Program does not anticipate larger enrolment in this course.*

## Signature Attesting to Compliance

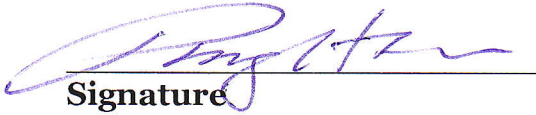
By signing below, I attest to the following:

That the Bachelor of Science in Aerospace Engineering program has conducted an honest assessment of compliance and has provided a complete and accurate disclosure of timely information regarding compliance with ABET's *Criteria for Accrediting Engineering Programs* to include the General Criteria and any applicable Program Criteria, and the ABET *Accreditation Policy and Procedure Manual*.

Ping Hsu

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**Dean's Name (As indicated on the RFE)**

  
Signature

6/23/17  
Date