

Department:	Aerospace	
Programs:	BSAE / MSAE	
College:	Engineering	
Program Website	BSAE: http://ae.sjsu.edu/academics/bsae MSAE: http://ae.sjsu.edu/academics/msae	
Link to Program Learning Outcomes (PLOs) on program website:	BSAE: http://ae.sjsu.edu/academics/bsae/bsae-program-outcomes MSAE: https://ae.sjsu.edu/msae-program-outcomes	
Program Accreditation (if any):	ABET (BSAE)	
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Part A

1. **List of Program Learning Outcomes (PLOs):** No changes

1A. - **BSAE Program Learning Outcomes** are specified by ABET. AE faculty have broken down each outcome into elements and proposed performance criteria for each outcome element.

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

Outcome Elements

A-1: Apply mathematics.

A-2: Apply physics.

A-3: Apply aerospace engineering principles.

A-4: Identify, formulate and solve aerospace engineering problems.

A-1: Ability to apply mathematics

Outcome Performance Criteria:

A-1.1: Apply calculus.

A-1.2: Derive and solve differential equations.

A-1.3: Use linear algebra.

A-2: Ability to apply physics

Outcome Performance Criteria:

A-2.1: Draw free-body diagrams.

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

A-3: Ability to apply engineering principles

Outcome Performance Criteria:

A-3.1: Apply aerospace structures principles.

- A-3.2: Apply aerospace dynamics principles.
- A-3.3: Apply aerodynamics principles.
- A-3.4: Apply flight mechanics principles.
- A-3.5: Apply aerospace propulsion principles.
- A-3.6: Apply stability and control principles.

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

- 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 (i.e., examine various issues, make appropriate assumptions, etc.).
- A-4.4: Develop a plan for the solution (i.e., select appropriate theories, principles, approaches).
- A-4.5: Implement their solution plan and check the accuracy of their calculations.
- A-4.6: Evaluate their results and reflect on their strengths and weaknesses in the process.

Outcome B: Ability to design and conduct water tunnel and wind tunnel experiments, as well as to analyze and interpret data from such experiments.

Outcome Elements

- B-1: Design water tunnel and wind tunnel experiments.
- B-2: Conduct water tunnel and wind tunnel experiments.
- B-3: Analyze data from water tunnel and wind tunnel experiments.
- B-4: Interpret data from water tunnel and wind tunnel experiments.

B-1: Ability to design experiments*Outcome Performance Criteria:*

- B-1.1: Define goals and objectives for the experiment.
- B-1.2: Research relevant theory and published data from similar experiments.
- B-1.3: Select the dependent and independent variables to be measured.
- B-1.4: Select appropriate methods for measuring/controlling each variable.
- B-1.5: Select a proper range for the independent variables.
- B-1.6: Determine an appropriate number of data points for each type of measurement.

B-2: Ability to conduct experiments.*Outcome Performance Criterion:*

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-3: Ability to analyze data from experiments.*Outcome Performance Criterion:*

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

B-4: Ability to interpret data from experiments.*Outcome Performance Criteria:*

- 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.

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.

Outcome Performance Criteria:

- 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 (ex. 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.

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

Outcome Performance Criteria:

- D-1: Participate in making decisions, negotiate with partners, and resolve conflicts arising during teamwork.
- D-2: Set goals related to team projects, generate timelines, organize and delegate work among team members, and coach each other as needed to ensure that all tasks are completed.
- D-3: Demonstrate leadership by taking responsibility for various tasks, motivating and disciplining others as needed.
- D-4: Demonstrate adequate understanding of other fields (ex. different branches of engineering / physical sciences, economics, management, etc.) to participate effectively on multidisciplinary projects.
- D-5: Communicate ideas relating to AE in terms that others outside the discipline can understand.

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

Outcome Elements

- E-1: Communicate in writing
- E-2: Communicate orally

E-1: Ability to communicate in writing

Outcome Performance Criteria:

- 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.

E-2: Ability to communicate orally*Outcome Performance Criteria:*

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.

Outcome F: Understanding of professional and ethical responsibility.

Outcome Elements

F-1: Understanding of professional responsibility.

F-2: Understanding of ethical responsibility.

F-1: Understanding of professional responsibility.*Outcome Performance Criterion:*

Demonstrate professional excellence in performance, punctuality, collegiality, and service to the aerospace engineering profession.

F-2: Understanding of ethical responsibility.*Outcome Performance Criteria:*

F-2.1: Are aware of the various professional codes of ethics (e.g. NSPE, ASME).

F-2.2: Properly acknowledge the work of others by citing all their sources when writing reports.

F-2.3: Given a job-related scenario that requires a decision with ethical implications they can identify possible courses of action, discuss the pros and cons of each one, decide on the best course of action, and justify their decision.

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.

Outcome Performance Criteria:

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.

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

Outcome Elements

H-1: Recognition of the need for lifelong learning.

H-2: Ability to engage in lifelong learning.

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

H-1.1: 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-2: Ability to engage in lifelong learning.*Outcome Performance Criteria:*

- 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 (e.g. articles, books, experts, etc.) and learn new material on their own.

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

Outcome Performance Criteria:

- I-1: Access information effectively and efficiently from the internet.
- I-2: Use state-of-the-art software to write technical reports and give oral presentations.
- I-3: Use computer simulations to conduct parametric studies and 'what if' explorations.
- I-4: Use modern software to analyze aerospace systems.
- I-5: Use modern equipment and instrumentation in AE laboratories.
- I-6: Are aware of state-of-the-art tools and practices used in the aerospace industry through plant visits and presentations by practicing engineers.

GE Area S: Self, Society, and Equality in the US

- 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.

GE Area V: Culture, Civilization, & Global Understanding

- 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.

BSAE PLO performance targets are defined as follows:

The scores earned by all students, in the 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% to ensure working knowledge of the material.

1.B- AE faculty have proposed the following **MSAE Program Learning Outcomes** with input from the AE Advisory Board.

Outcome A: Ability to use graduate level mathematics to model and solve aerospace engineering problems.

Outcome B: Ability to apply aerospace engineering science (aerodynamics, propulsion, flight mechanics, stability & control, aerospace structures & materials, etc.) to perform an in-depth analysis and / or design of an aerospace engineering system taking into consideration economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability constraints.

Outcome C: Ability to use modern tools (computational or experimental).

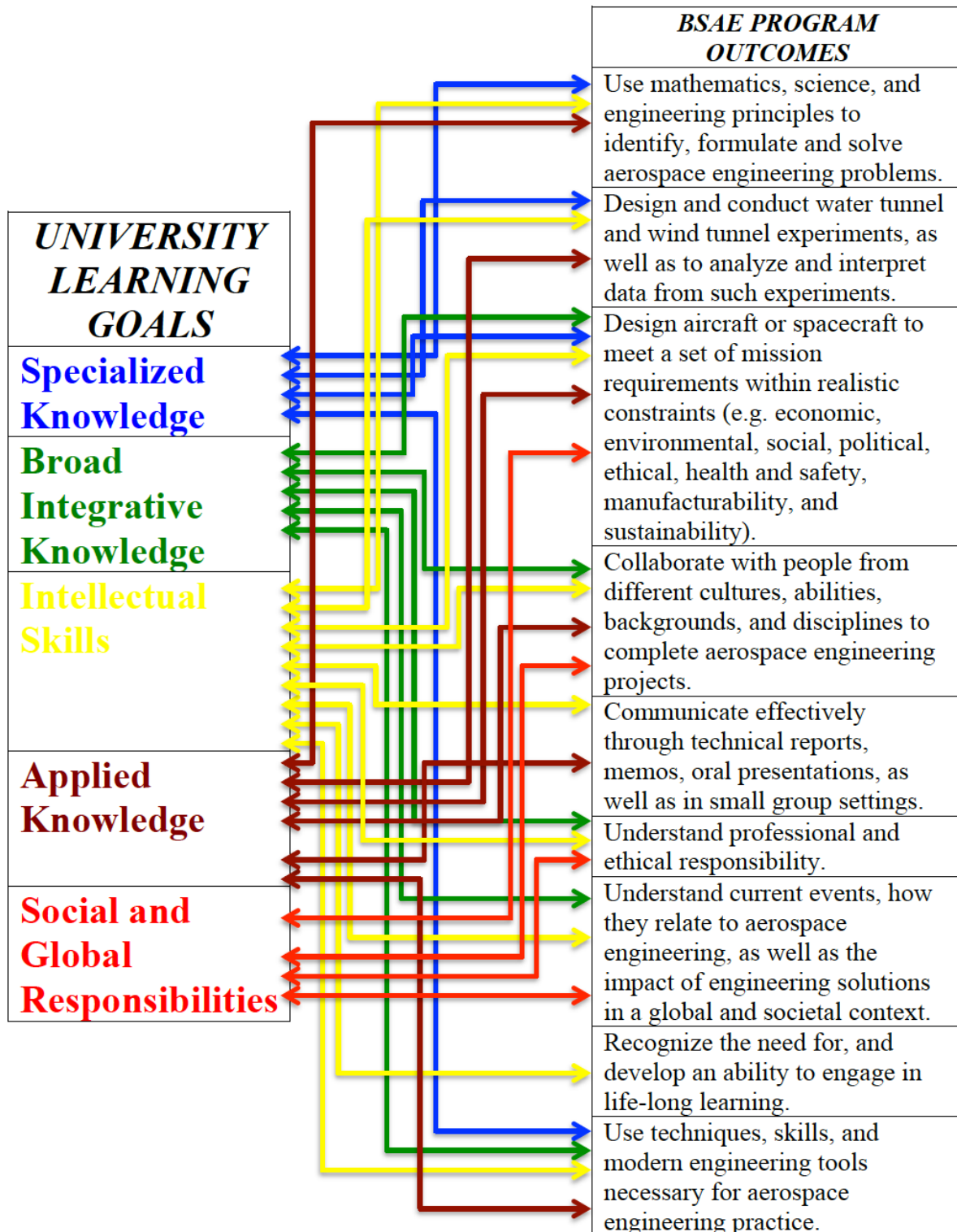
Outcome D: Ability to perform a literature search related to a given problem, cite the references in appropriate ways, and demonstrate an understanding of the cited literature.

Outcome E: Graduate level technical writing ability, including correct language and terminology, appropriate visuals, and summarizing key ideas.

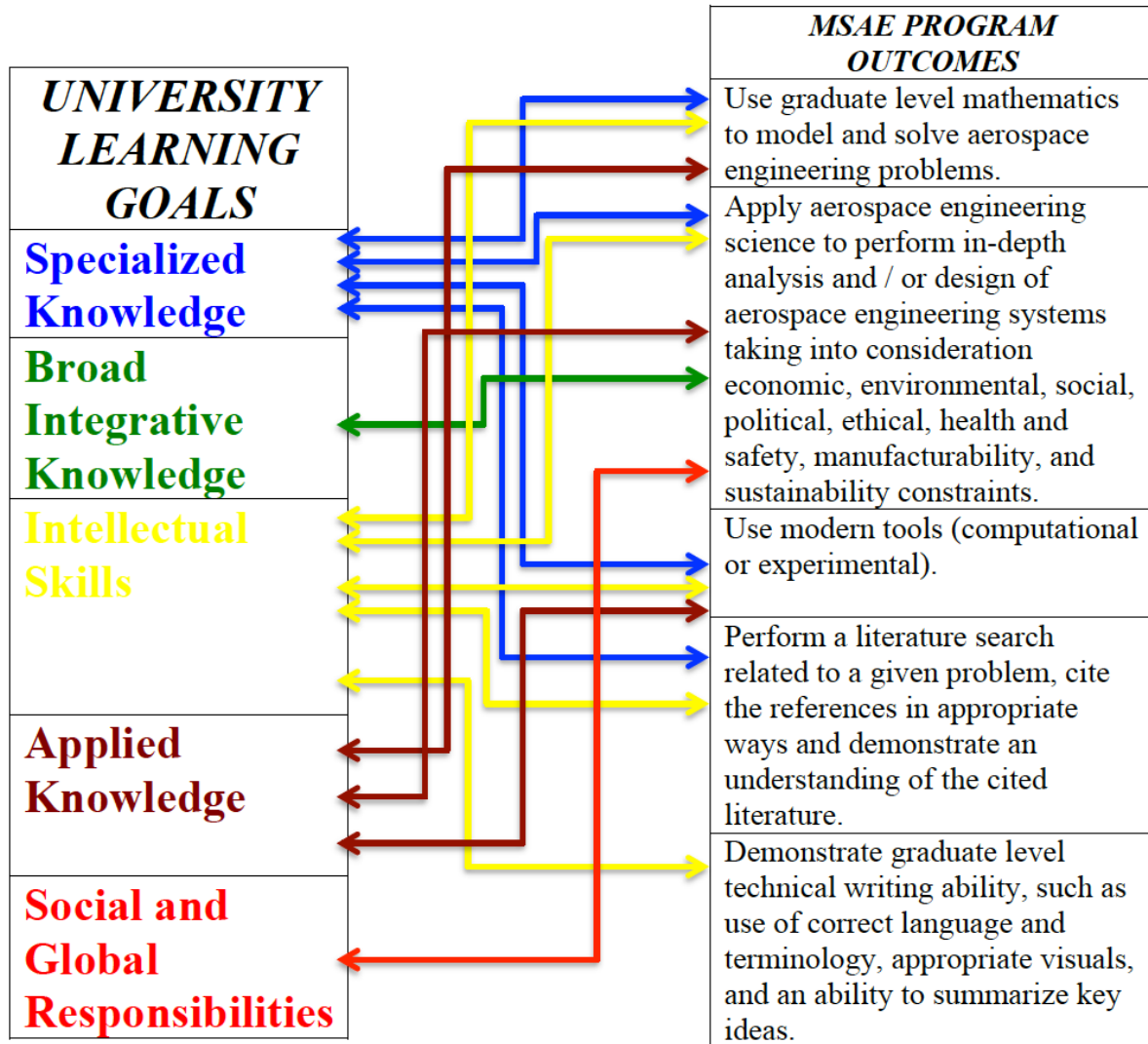
2. **Map of PLOs to [University Learning Goals \(ULGs\)](#)** No changes

The maps below are the product of several discussions in AE faculty meetings.

BSAE Program Outcomes / University Learning Goals Map



MSAE Program Outcomes / University Learning Goals Map



3. Alignment – Matrix of PLOs to Courses

BSAE Course / Outcome Mapping

<i>BSAE</i>	Student Outcomes								
	A	B	C	D	E	F	G	H	I
<i>Original ABET Outcomes</i>	(a), (e)	(b)	(c)	(d)	(g)	(f)	(h), (j)	(i)	(k)
Required Courses & Course Coordinators									
AE 112 - Jeanine	++	+		+					
AE 114 - Jeanine	++	+		+	+			+	
AE 138 - Jeanine	++			+	+			+	
AE 140 - Jeanine	++			+				+	
AE 157 - Kamran	++			+				+	+
AE 160 - Nikos	++	+	+	+	+			+	+++
AE 162 - Nikos	++	++	+	+	+		+	++	+++
AE 164 - Nikos	++	+	+	+	+		+	+	
AE 165 - Periklis	++		+	+	+		+	+	
AE 167 - Periklis	++	+	+	+	+		+	+	
AE 168 - Kamran	++	+		+				+	
AE 169 - Periklis	+			+				+	+++
AE 171 A, B - Nikos AE 172 A, B - Periklis	+	+	+++	+++	+++	+++	++	+++	+++
Extra Curriculum Activities: Student Club Activities		+	+	+	+	+		+	+

+: 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

The following changes have been made:

Outcome A-1.1 – ability to apply calculus: now assessed only in AE160

(old: AE140, AE160, AE162)

Outcome A-1.3 – ability to apply linear algebra: now assessed in AE157 (old: AE169)

Outcome A-2.1 – ability to draw free body diagrams: now assessed in AE112 (old: AE114)

Outcome A-2.2 – ability to apply Newton's laws: now assessed in AE138 (old: AE140)

Outcome A-3.3 – ability to apply aerodynamic principles: now assessed in AE164 (old: AE160, AE162, AE164)

Outcome A-4 – ability to identify, formulate and solve aerospace engineering problems: now assessed only in AE162 (old: AE162 and AE165)

MSAE Course / Outcome Mapping

<i>MSAE</i>	Student Outcomes				
	A	B	C	D	E
Required Courses					
AE 200	+++		★		
AE 245 or AE 246	★	★	★		
AE 250	★	★	★		
AE 262 or AE 264	★	★	★	★	★
AE 267	★	★	★		
AE 269	★	★	★		★
AE 271		★	★	★	★
AE 295 A, B or AE 299	★	+++	+++	+++	+++

++: Skill level 3 or 4 in Bloom's Taxonomy

+++ : Skill level 5 or 6 in Bloom's Taxonomy

★ Skill addressed but not assessed

4. Planning – [Assessment Schedule](#)

No changes

Timeline for BSAE 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
AY 15-16	X				X				
AY 16-17		X				X			
AY 17-18			X				X		

Timeline for MSAE Outcome Assessment

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

Plans for Implementing Course and Curriculum Improvements and Re-Assessment

Any recommendations made as a result of assessing a particular outcome/performance criterion, are implemented in the following AY and the outcome/performance criterion is re-assessed. If, following implementation of improvements, the performance criterion is met, no further action is taken until the next time the particular outcome is due for assessment.

5. Student Experience:

No changes

PLOs and ULGs are:

- Posted on the BSAE and MSAE websites
- Included on course syllabi, linked to specific course learning objectives.
- Communicated to students on the first day of class and throughout the semester in relationship to specific topics and course assignments.

Part B

6. Assessment Data and Results

Following the timelines shown above, we assessed in AY15–16:

BSAE Program

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

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

Outcome Element A-1: Ability to apply mathematics.

Performance Criterion A-1.1: Ability to apply calculus

AE 160 – Fall 2015 – Prof. Mourtos

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

Course Activities

- Calculate aerodynamic forces and moments on bodies by integrating surface pressure and shear stress distributions.
- Use the integral form of 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.

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 2	Workout Problem 9	Lab Report 3
AE 160 – Fall 15 N=89; passed=72 (81%)	68 (94%)	65 (90%)	70 (97%)

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 Criterion A-1.1.

Recommendation: None

Implementation: N/A

Performance Criterion A-1.2: Ability to derive and solve differential equations

AE 140 – Spring 2016 – Prof. Hunter

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

Course Activities

- Derive the second order differential equations of particle motion over the surface of the rotating Earth. The equations are simplified and solved closed-form
- Intuitively predict the influence of Coriolis acceleration on ground track, and analytically confirm
- Derive rigid body rotational equations of motion (also second order ODEs)
- Predict the robustness of cylindrical body spin stability to disturbances
- 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 Criterion A-1.3: Ability to apply linear algebra

AE 157 – Spring 2016 – Prof. Turkoglu

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

Course Activities

- a. Describe transient response analysis in aircraft and satellites.
- b. Formulate basic control actions and frequency response of aerospace automatic control systems.
- c. Analyze stability and stability margins in aerospace vehicle motions.
- d. Outline the fundamentals of modern control theory as it is applied to aerospace vehicles
- e. Determine the natural frequencies and damping ratios of aerospace vehicle dynamics.
- f. Derive transfer functions and plot vehicle time and/or frequency response.
- g. Use frequency response design techniques to design closed-loop control systems: rate-damping, attitude control, altitude control.
- h. 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 along side 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 Criterion A-2.1: Ability to draw free-body diagrams.

AE 112 – Fall 2015 – Prof. Boylan-Ashraf

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

Course Activities

- Create free-body diagrams of structural members under various combinations of applied axial, torsion, and bending.
- 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%
Quiz 4	93%

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 – it helps 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.

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”.

Recommendations

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 Criterion A-2.2: Ability to apply Newton's laws / physics concepts (e.g. angular momentum, friction, etc.)

AE 138 – Fall 2015 – Prof. Hunter

Assessment Summary: The performance target is met for Performance Criterion A-2.2**Course Activities**

- Write position, velocity and acceleration vectors in Newtonian and non-Newtonian reference frames
- Relate reference frames and transform attitudes through a direction cosine matrix
- Predict the difference between inertial and relative motion and model this motion with Newton's Laws.
- 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**Outcome Element A-3: Ability to apply aerospace engineering principles.****Performance Criterion A-3.1: Ability to apply aerospace structures principles.**

AE 114 – Spring 2016 – Prof. Boylan-Ashraf

Assessment Summary: The performance target is met for Performance Criterion 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 Criterion A-3.2: Ability to apply aerospace dynamics principles.

AE 140 – Spring 2016 – Prof. Hunter

Assessment Summary: The performance target is met for Performance Criterion 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: Develop rigid body dynamics visualization tools as project topics.

Implementation: Spring 2017

Performance Criterion A-3.3: Ability to apply aerodynamics principles.

AE164 – Fall 2015 – Prof. Sean Montgomery

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

Course Activities

- a. Use the 1st and 2nd laws of thermodynamics to calculate heat transfer, work done and entropy changes in a thermodynamic system.

- b. Use thermodynamics and conservation equations to calculate flow parameters at various points of a flow field.
- c. 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.
- d. Calculate the flow properties downstream of a Mach wave, an oblique shock wave, a Prandtl-Meyer expansion wave, and a normal shock wave.
- e. Calculate the lift and drag coefficients on supersonic airfoils using shock - expansion theory.
- f. Calculate the flow properties downstream of a reflected / refracted shock wave.
- g. Calculate the flow properties at various locations of an (a) ideally expanded, (b) over-expanded and (c) under-expanded nozzle.
- h. 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>						
	Exam 1	Exam 2	Quiz 1	Exam 3	Exam 4	Exam 5	Test Average
AE 164 – Fall 15 N=59; passed=59 (100%)	53 (90%)	56 (95%)	39 (66%)	54 (92%)	54 (92%)	57 (97%)	59 (100%)

Analysis – 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 Criterion A-3.4: Ability to apply flight mechanics principles

AE 165 – Spring 2016 – Prof. Hunter

Assessment Summary: The performance target is met for Performance Criterion 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 Criterion A-3.5: Ability to apply aerospace propulsion principles

AE 167 – Spring 2016 – Prof. Carozzi

Assessment Summary: The performance target is met for Performance Criterion 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 spend 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: None.

Implementation: N/A.

Performance Criterion A-3.6: Ability to apply stability and control principles

AE 168 – Fall 2015 – Prof. Turkoglu

Assessment Summary: The performance target is not met for Performance Criterion 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

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 aerospace engineering problems [AE162 – Spring 2016 – Prof. Nikos J. Mourtos](#)

Assessment Summary: The performance target is not met for Performance Criterion A-4.

Outcome Performance Criteria:

- 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 (i.e., examine various issues, make appropriate assumptions, etc.).
- A-4.4: Develop a plan for the solution (i.e., select appropriate theories, principles, approaches).
- A-4.5: Implement their solution plan and check the accuracy of their calculations.

A-4.6: Evaluate their results and reflect on their strengths and weaknesses in the process.

Course Activities

Students propose a project that integrates theory and applications from AE162, AE165 and possibly other courses (e.g. AE114, AE157). A final report is due at the end of the semester. Students:

1. Select an airplane with a high AR wing.

2. Potential Flow Simulation

Use the Potential Flow Theory Program to simulate the flow around the fuselage of their selected airplane. They plot the streamlines around the fuselage and write the stream function and the velocity potential function.

3. Airfoil Study

a. Define criteria for selecting an airfoil for their airplane.

b. Based on these criteria, they find at least 10 potential airfoils and compare them using published data and software such as XFLR5.

c. Based on their criteria they select the best airfoil for their airplane wing.

d. Use thin airfoil theory to estimate the aerodynamic characteristics of their selected airfoil and compare with actual data.

4. Wing Study

a. Perform a parametric study to determine the best combination of sweep angle, thickness ratio and taper ratio. They use wing weight as their figure-of-merit. They use the WingDesign software of Desktop Aeronautics or any other piece of software they see fit.

b. Calculate the lift and drag characteristics of their wing using the monoplane equation.

c. Estimate the maximum lift coefficient of their wing, using the WingDesign software of Desktop Aeronautics.

5. Drag Polars

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

6. Estimate the takeoff and the landing performance of their airplane; compare your results with actual performance data.

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

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

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

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

11. From planform geometry and aerodynamic data, calculate the stability derivatives

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

Student Performance Results (AE162 only)

	Students who scored 70% or higher							
	Potential Flow Modeling	Airfoil Comparison	Thin Airfoil Theory Analysis	Wing Parametric Study	Wing Weight	Wing Aerodynamic Characteristics	Airplane Drag Polars	Total Project Score
N=78; passed=72	63 (88%)	60 (83%)	64 (89%)	50 (69%)	51 (71%)	67 (93%)	24 (33%)	63 (88%)

(92%)								
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Analysis

A-4.1 – As 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 – 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 – 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 – 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 AE160 (a prerequisite for AE162), and was also 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 and did not seem to know what drag polars were or how to estimate them.

A-4.5: 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: Students evaluated their results and reflected on their strengths and weaknesses, while carrying out the various parts of this project.

Recommendations

1. Case studies will be presented and discussed in class to demonstrate the different requirements of airfoils designed for different airplanes.
2. Several parametric studies will be presented in class involving wing parameters to illustrate how such studies can be used to optimize wing design.
3. 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

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

AE171A – Fall 2015 – Prof. Gonzalo E. Mendoza

AE172A – Fall 2015 – Prof. Marcus S. Murbach

AE171B – Spring 2016 – Prof. Gonzalo E. Mendoza

AE172B – Spring 2016 – Prof. Marcus S. Murbach

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

Outcome Element E-1: Ability to communicate in writing

Outcome Performance Criteria

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 Criteria E-1.1, E-1.2, E-1.3, and E-1.4.

Course Activities (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

Course Activities (AE172A)

- 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

Course Activities (AE171B)

- 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.

Course Activities (AE172B)

- 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: Technical reports, test article documentation, and individual papers.

Student Performance Results

	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 2016	22 (81%)	27 (100%)	25 (93%)*	N/A	N/A	N/A
AE172B – Spring 2016	N/A	N/A	N/A	34 (100%)	34 (100%)	34 (100%)

*Individual ethics assignment.

AE171A – 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.

AE171B – 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

Recommendation:

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.

Implementation: AY 2016 – 2017

AE172A – 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, and 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.

AE172B – 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 course concepts. The use of the weekly QUAD charts and ensuing discussion helped to keep the teams focused and is highly recommended. Lastly, various movies and videos describing the evolution of the Apollo and Shuttle programs (video from experts involved in their development) was very well received by students.

Recommendation

- All students will produce a 3D printed part related to the overall system/project through rapid prototyping

Implementation: AY 2016 - 2017

Outcome Element E-2: Ability to communicate orally

Outcome Performance Criteria:

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 Criteria 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.

Course Activities (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).

Course Activities (AE171B)

- 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.
- Prepare a final design review outlining the entire project development journey, including final performance results and recommendations for future projects.
- Prepare and take part on an individual discussion regarding an aerospace engineering ethics, safety, and/or liability topic of the student's choosing.

Course Activities (AE172B)

- 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.
- Present the final project hardware/software as a functional system (as appropriate).
- Prepare and take part on an individual discussion regarding an Aerospace Engineering ethics and societal implications.
- 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%)

AE171A – 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.

AE171B – 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 areas 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.

Recommendation: 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.

Implementation: AY 2016 – 2017

AE172A – 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.

AE172B – 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. 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 was crisper and more concise.

Recommendation: None.

Implementation: N/A

MSAE Program

Outcome E – Graduate level technical writing ability, including correct language and terminology, appropriate visuals, and summarizing key ideas

AE295A,B/AE299 – Fall 2015 – Prof. Nikos J. Mourtos

AE295A,B/AE299 – Spring 2016 – Prof. Kamran Turkoglu

Performance Criteria

E-1: Ability to use correct language and terminology

E-2: Appropriate use of graphs and tables

Assessment Summary: The performance target is met for both performance criteria and hence for Outcome E.

Assessment Tools: Project and theses reports of all (18) students who graduated in Fall 2015 and Spring 2016.

Student Performance Results

Student reports are evaluated in regards to each and every program outcome by the project/thesis advisor and additional faculty members/industry mentors, as needed. The table below summarizes student scores for Outcome E for the 18 reports evaluated, on a scale from 0-20 (E-1) and 0-10 (E-2).

	% students who scored 70% or higher	
	Fall 2015	Spring 2016
Correct language & terminology	100%	100%
Appropriate use of graphs and tables	92%	100%

Analysis: In general, students writing ability is very good, as reflected in their final reports. Two students published their papers in AIAA conference proceedings. A minor area of concern is students' use of graphs and tables from various pieces of software, which does not allow them to properly label their axes. Although the use of software is highly encouraged, students are still expected to produce appropriately labeled graphs in their technical reports.

Recommendation: Draft reports will be specifically checked for appropriate labeling of graphs and tables and returned to students with corrections before their final deadline every semester.

Implementation: AY 2016-2017

7. Analysis

BSAE Program

Analysis: With a few exceptions (e.g. linear algebra, stability and control) AE students in general do well in applying mathematics and aerospace engineering science to the solution of aerospace engineering problems, although minor improvements are needed in relationship to several more performance criteria. AE students are also very competent in written and oral communication, as indicated by their reports in the senior level aircraft and spacecraft design courses.

Recommendations: See above under each performance criterion.

MSAE Program

Analysis: see above.

Recommendation: see above.

8. Proposed changes and goals (if any)

Proposed improvements, as necessary, are listed above under each performance criterion and summarized in Part C below.

Part C

(This table should be reviewed and updated each year, ultimately providing a cycle-long record of your efforts to improve student outcome as a result of your assessment efforts. Each row should represent a single proposed change or goal. Each proposed change should be reviewed and updated yearly so as to create a record of your department's efforts. Please add rows to the table as needed.)

Proposed Changes and Goals for AY 2015-2016	Status Update
BSAE- Performance Criterion A-1.3 (Linear Algebra) <ul style="list-style-type: none"> ▪ Perform diagnostic assessment in the beginning of the semester to test students' skills in linear algebra. ▪ Meet with Math129A Coordinator to share our experience of ill-prepared students. ▪ Create reference material (e.g. notes, videos, etc.) as a review of fundamental linear algebra concepts to bring lagging students up to speed. 	
BSAE- Performance Criterion A-2.1 (free-body diagrams) Reflection will be used as a pedagogy to teach students how to draw free-body diagrams.	
BSAE- Performance Criterion A-3.2 (rigid body dynamics) Develop rigid body dynamics visualization tools as project topics.	
BSAE- Performance Criterion A-3.6 (stability & control) <ul style="list-style-type: none"> ▪ More example problems will be solved. ▪ Better student mentoring will be provided. ▪ More problems will be solved in problem solving sessions outside of class. ▪ Collaborative learning will be encouraged to enhance students' analytical skills. 	
BSAE-Performance Criterion A-4 (open-ended problem solving) <ul style="list-style-type: none"> ▪ Case studies will be presented and discussed in class to demonstrate the different requirements of airfoils designed for different airplanes. ▪ 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. 	
BSAE-Outcome E-1 (report writing) <ul style="list-style-type: none"> ▪ 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 Excel & Matlab. ▪ AE172: All students will produce a 3D printed part related to the overall system/project through rapid prototyping. 	
BSAE- Outcome E-2 (oral presentations) AE171: Increase the proportion of the presentation grade allotted to individual performance.	
MSAE-Outcome D (literature review) Goal: Develop a rubric to guide students in performing their literature review as well as to allow for a more accurate assessment of Outcome D.	