ABET
Self-Study Report

for the

Aeronautical and Astronautical Engineering Program

at the

University of Washington

June 25, 2013

CONFIDENTIAL

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BACKGROUND INFORMATION

A. Contact Information

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B. Program History

The program began in October 1929 with the founding of the Department of Aeronautical Engineering in the newly-built Guggenheim Hall. It was one of the eight such programs enabled by the Guggenheim Foundation for the Advancement of Aeronautics. In 1946 a Master's degrees program was initiated, and 1959 saw the beginning of our PhD program. In 1962 the department's name was changed to Aeronautics & Astronautics, in recognition of the advancements being made in space exploration (the degree program's name was accordingly changed to Aeronautical & Astronautical Engineering). In November 2012, the department was named after William E. Boeing, founder of the Boeing Company, who through his generosity made possible the initiation of instruction in aeronautics at the University of Washington (UW) in 1917. Our program has been continuously accredited since 1936, and the last general review took place December 2-4, 2007.

Since the last ABET review there have been a number of changes. One faculty member left the department for a position in industry but two new faculty were added. Another faculty member changed his affiliation from tenure-track to research faculty status. Furthermore, two additional faculty, in the areas of controls and structural mechanics, were hired in spring 2013 and will join the department in mid-August. In addition, the new Dean of Engineering (Michael Bragg), who will start his tenure at the UW in July 2013, will become a member of our faculty. Following the arrival of these three new faculty, the department will have a total of 17 tenured or tenure track faculty and two research faculty by the time of the ABET site visit in Autumn 2013. Our undergraduate program's core curriculum has undergone some refinement, largely focused on the junior-level laboratory courses, in which writing has been made a key aspect, in response to the phasing out of technical writing courses that had been offered through the department of Human-Centered Design and Engineering (HCDE). Our graduate program developed a new

Master of Aerospace Engineering track in Composite Materials and Structures, and recently initiated a new, professional Master's degree program that will be taught in the evenings.

C. Options

The only options available in the undergraduate program relate to the student's choice of the senior capstone design course between the two that are offered: Airplane Design and Space Systems Design. Students select electives that best support the capstone design course of their choice.

D. Organizational Structure

The Aeronautical and Astronautical Engineering program resides in the William E. Boeing Department of Aeronautics & Astronautics, in the College of Engineering (COE) at the UW. In addition to the undergraduate program, the department offers a graduate program leading to the degrees of Master of Aeronautics & Astronautics, Master of Aerospace Engineering, and Doctor of Philosophy. The department is led by a Chair (currently Prof. James C. Hermanson) and is supported by an Associate Chair for Research (currently Prof. Uri Shumlak). The Chair is supported by a Chair's Assistant and a departmental Administrator. There are also three academic program managers/coordinators, five technical staff, and three fiscal staff.

The department has several committees that assist and advise the Chair and the faculty in various administrative areas, each chaired by a faculty member. Policy and curricular decisions are made by the faculty, on the basis of recommendations from the relevant committees. The two committees devoted to educational issues are the Undergraduate Program Committee (currently chaired by Prof. Adam P. Bruckner) and the Graduate Committee (currently chaired by Prof. Kristi Morgansen-Hill). Each of these committees is served by a full-time staff member. Accreditation issues are dealt with by the Undergraduate Program Committee.

The department is one of 10 academic departments in the COE, which is led by the Dean. The COE has four Associate Deans, who are responsible for the Offices of Academic Affairs, Advancement, Infrastructure, and Research and Graduate Studies. All but the Associate Dean for Advancement (who is a development officer) are faculty members in departments in the College. The Dean reports to the Provost, the chief academic officer of the Seattle campus. The Provost, in turn, reports to the President, the chief executive officer. The President reports to the Board of Regents, which is the University's governing body whose broad responsibilities are to supervise, coordinate, manage and regulate the University, as provided by state statute. There are 10 regents, who are appointed by the Governor for six-year terms.

E. Program Delivery Modes

The Aeronautical and Astronautical Engineering program requires students to be enrolled full-time on-campus. Courses are offered during daytime hours for all four quarters of the academic year (but with only two lower-division courses during summer quarter). The program is of the traditional lecture / laboratory / recitation type. One senior elective (AA 462, Rocket Propulsion) is also offered synchronously via distance learning.

F. Program Locations

The program is offered only at the University of Washington's Seattle Campus.

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

There were no shortcomings remaining after the most recent ABET Final Statement.

H. Joint Accreditation

The program is not jointly accredited nor is it seeking to be accredited by more than one commission.

GENERAL CRITERIA

CRITERION 1. STUDENTS

A. Student Admissions

Although direct freshman admission was initiated in 2011 and early admission at the sophomore level has been in place for more than a decade, the majority of students enter our program in their junior year. The junior year admission process gives students the opportunity to complete their prerequisites at a community college, and be able to apply for admission to our program as juniors. The admission process described below applies specifically to juniors but the same criteria are used with students who are admitted as sophomores.

The Undergraduate Advising Office coordinates the departmental undergraduate admissions effort. Admission to the department is highly competitive. Students apply to the program after completing a set of program prerequisites (see Table 1.1) and are evaluated based upon grades in prerequisite and general education courses, their application essays, and their potential to contribute to the field of aerospace engineering. An Admissions Committee, comprised of four faculty members, the chair of the Undergraduate Program Committee (faculty), and the manager of the Undergraduate Program (staff academic advisor) evaluate the applications. The committee makes all final decisions by consensus. All departmental admissions forms are on-line and students can complete the process remotely. Once the on-line applications are completed and submitted, students receive email confirmation of their application, and then receive notification from the department about 3 weeks after the application deadline (July 1 for Autumn admission).

Table 1.1 Prerequisites for admission to junior class standing

MATH 124, Calculus I	*CHEM 142, Chemistry I*	AMATH 301, Scientific Computing*
MATH 125, Calculus II	*PHYS 121, Mechanics & Lab*	AA 210, Statics
MATH 126, Calculus III	PHYS 122, Electricity & Magnetism & Lab	CEE 220, Mechanics of Materials
MATH 307, Differential Equations	PHYS 123, Waves & Lab	ME 230, Dynamics
MATH 308, Linear Analysis	*ENGL, Composition*	AA 260, Thermodynamics
MATH 324, Advanced Multivariable Calculus*		

*Must be taken prior to or not later than Autumn quarter of admission

Admission is competitive, and there are always more applicants than we have available space. Typically, we receive about 80 – 100 applications per year. Our target is 65 students in the junior class, and this number must include students who originally enrolled in the program as sophomores the previous year and freshmen who enrolled two years earlier. The acceptance rate to our offers of admission usually lies in the range of 80 - 85%.

Early Admission (sophomores): The Early Admissions application process is handled in the same manner as the Upper Division Admission process, although it requires fewer prerequisite courses to apply. The program prerequisites for Early Admission students are shown in Table 1.1 in *italics*. The review process by the department is handled in the same manner as the Upper Division Admission.

Freshman Admission: The direct freshman admission is handled somewhat differently, and at a much earlier time of year. The University of Washington's Office of Undergraduate Admissions notifies students of their offer of admission to the UW by March 31, and the students have until May 1 to accept this offer of admission. The offers from the department to enter our program as a freshman are made directly to the students prior to the May 1 deadline. The students do not apply to our program, but rather just indicate their departments of interest on their UW applications. Our program has access to those applications online. Our Undergraduate Program Manager prepares a summary of the student data and presents it to the Undergraduate Committee, which then determines which students are strong candidates for the program. A written notification is then sent to the freshmen accepted directly into the program, and response is requested by May 1st, which is also the UW's acceptance deadline.

Upper Division Admission: This process requires students to apply to the department using a web-based application process. For the resident UW students the courses are automatically downloaded to the application when they open it, but new transfer students must show, for any course that has not yet been formally evaluated by Admissions, how that course maps to those of the UW. The instructions on to how to map such courses to the UW's are provided by a link to the Washington State Technical and Community Colleges Guide for Equivalencies (http://admit.washington.edu/EquivalencyGuide). Additional details can be found in the Section titled Transfer Students and Transfer Courses.

Students may start the autumn-quarter, junior-year program after meeting the requirements and standards for upper-division admission. If a student has not completed the prerequisite requirements by the end of the summer quarter prior to the start of the junior year, he/she is dropped from the department.

Table 1.2 below shows the admissions statistics for sophomores and juniors for the most recent six-year period. Note that the students who apply and are enrolled for Early Admission affect the following year's junior class enrollment, and this fact should be kept in mind when comparing application statistics to the graduation statistics. The freshmen admitted affect the junior class enrollment numbers two years after being enrolled in the department. Freshmen are not included in Table 1.2.

Direct freshman admission was initiated two years ago, for the 2011-2012 academic year. A highly selective process was used to review high school seniors who had gained admission to the UW and had expressed a preference for our program. A total of 7 students were invited to enter the program, and 5 accepted. The following year, 10 high school seniors were invited and 4 accepted. This year (2013) 22 were invited and 11 accepted. The duration of our freshman admission program and the relatively small number of students who have joined to date make any kind of inference of trends difficult, other than to say that we are gradually increasing the number of freshmen we admit directly from high school.

Table 1.2 Admission statistics

Academic Year	Early Appl.	Upper Appl.	Total Appl..	Early Offered	Upper Offered	Total Offered	Early Offered Enrolled	Upper Offered Enrolled	Total Offered Enrolled *
2007-2008	31	46	77	15	39	54	12	25	37
2008-2009	45	50	95	20	44	64	15	40	55
2009-2010	47	54	101	21	41	62	17	32	49
2010-2011	31	80	111	14	54	68	12	42	54
2011-2012	49	61	110	21	49	70	14	45	59
2012-2013	46	76	122	17	51	68	10	43	53

Junior Class =	Direct Freshman, Advanced Admission, and Early Admission from prior years, minus any students who delay the start of the junior year program classes, or change majors before entering the junior year, plus upper division admission.

Four years ago the College of Engineering initiated an experimental process, called Advance Admission, to recruit high school students to the UW. They offered highly qualified incoming high school students an opportunity to be able to declare a major of their choice at the end of their freshmen year as long as they maintained certain standards. We started receiving students from this process in the Autumn of 2010 with two students. This number increased to 6 students in 2011, but after that the program was discontinued. (These students were not required to apply to a program or be reviewed, they simply entered the program of their choice.) This contributes to the difference among the Applicant, Offer and Admission Enrollment numbers, which reflect the competitive applicants and the total number of students in the entering class. The Advance Admissions students are included in the Entering Junior class numbers, but not in the Total Offered Enrollment numbers in Table 1.2.

It can be seen that generally there has been a steady increase in the number of applications and the enrollment. However, the maximum enrollment we can allow in the junior class is 65, which is dictated by classroom capacity issues (it is the maximum capacity of the largest classroom in Guggenheim Hall, the home of the program). While there is a number of larger classrooms on the UW campus, some with a significantly greater number of seats, they typically have long-standing priorities for other programs that have larger class sizes than we do.

B. Evaluating Student Performance

Evaluating student performance and progress is performed on a quarterly basis after a student enters the program. Student rankings within the department both by major courses and overall cumulative grade point average ensure that those students are meeting program objectives and making satisfactory progress toward the degree. To stay in the program students must maintain an overall cumulative grade point average of 2.00 or better, a minimum quarterly grade point average of 2.00, and a minimum grade of 1.7 in any 300-level or 400-level program course required for the aeronautical and astronautical engineering degree (two sophomore-level prerequisite program courses - AA 210, Statics, and AA 260, Thermodynamics - require minimum grades of 2.0). All other course requirements are subject to the University's minimum grade policy of 0.7. The student's courses are recorded on a B.S.A.A.E.[*] worksheet in each student's file. This worksheet also records specific circumstances, concerns, or problems a student might have. Periodic meetings of the academic staff advisor (i.e., the Undergraduate Program Manager) with students continue throughout the academic year about academic choices and requirements.

Once they have been admitted to the program, students are required to be registered for all the junior level courses offered each and every quarter. The program requirements are reviewed during the New Student Orientation at the beginning of the junior year. The registration system is also designed to monitor and restrict students from dropping any required courses without permission, and prevents students not admitted to the program from registering for our courses. Students must meet the prerequisite course requirements or they cannot register though the on-line registration system, which ensures that all courses that are required are completed each quarter. In order to ensure that any prerequisite grade requirements are met, the system checks the grade prerequisite requirements after pre-registration, but before the quarter begins, and will drop a student from the course for which he/she did not meet the minimum grade requirement. The student must then seek out the academic advisor in order to petition for permission to register for the class or find out what alternatives are possible. The system also restricts students from dropping all their classes without notification to the academic advisor. The exception to this restriction is if a student withdraws from the University, in which case he/she can drop all courses at the Registrar's Office.

At the end of each quarter, the academic staff advisor reviews students' grade reports to assure compliance with the policy of satisfactory progress (which is called the Continuation Policy). Any student determined to be out of compliance with the policy is required to meet with the advisor, who recommends corrective action. Students out of compliance with the program are placed on probation. Subject to confirmation by the advisor, students on probation for two academic quarters are transferred out of the program. Such transfers occur rarely and only after several attempts to remedy the situation have been made.

Graduation applications are filed for the senior class in the Autumn quarter of the Senior year, i.e., two quarters prior to graduation to ensure that students are aware of unfulfilled requirements.

Communications concerning career options and employment opportunities are provided to our students periodically throughout the year. Juniors in the department attend a meeting in spring quarter that outlines the senior-level requirements, department elective courses, and remaining requirements to ensure graduation eligibility. The academic staff advisor maintains an e-mail list

[*] Bachelor of Science in Aeronautical and Astronautical Engineering

of departmentally admitted students and pre-engineering students interested in the program to ensure that communication is maintained and information is available to the students.

C. Transfer Students and Transfer Courses

Transfer students first apply to and are admitted to the University through the University admissions process, and then separately apply to the Department through the same admissions process as for the UW. Students may use up to 90 lower division quarter credits (100- and 200-level numbered courses) toward their degree. Any course that transfers to the UW as a 300-level or above can be used in combination with the lower division credits not to exceed 135 quarter credits. University policy states that a minimum of 45 credits must be taken at the UW, in order to obtain a degree.

Our program also permits the transfer of credit for any course that is part of our major requirements. If the course the student completed at another institution is on our list of pre-approved transfer courses (primarily, from the state's community colleges) then credit is granted immediately. If it is not, then the student is asked to go through the petition process described below. The outcomes can be that transfer credit is granted or denied (and the student must take the course in our department for credit), or granted under the condition that the student makes up for some gaps (this can take many forms, including but not limited to, an informal conversation with the faculty member evaluating the request, direct study to make up for slight differences to our courses, or the completion of previous course exams and/or assignments). This highly individualized approach is only practical because it is rare. The overwhelming majority of our transfer credits are from Washington State Community Colleges with which we have course articulation agreements. Most other transfer credits are from other four-year institutions – usually out of state.

The University of Washington has in place a process for the evaluation of transfer credits for Washington State community colleges, and a website with those course equivalencies is available to the general public:
http://admit.washington.edu/BeforeYouApply/Transfer/Plan/EquivalencyGuide.

Most students from community colleges are prepared to apply directly to the program. Therefore, prerequisites for program admissions are coordinated with the colleges. The only instances where potential problems can occur are in the smaller community colleges that do not offer a pre-engineering curriculum. Many of those students must take pre-engineering courses at the University of Washington.

The UW's Office of Undergraduate Admissions arranges the transfer of course credits from other four-year institutions. This process is somewhat less straightforward and often requires additional evaluation by our program's academic advisor or referral to a faculty member who is more familiar with a particular subject matter, as detailed below. The transfer policies of the University are posted on the website noted in the paragraph above; thus, students can determine if unusual types of credit might be accepted and where they might apply.

Often, transfer credits from other schools do not line up exactly with courses offered at the University of Washington. Transfer students may receive transfer credit, but the process frequently relies on the individual programs to decide if specific program requirements are met. This is normally done by petition and is handled as outlined below. A copy of the petition is kept in the students' files for those who have been admitted to the program. The petitions from students not yet in the program or applying to other programs are kept in a master file in the academic adviser's office, and the student is also given a copy.

1) The department's academic staff advisor assesses the course based on a detailed course description, supporting materials, and the petition submitted by the student. If the course meets our program's requirements, then the advisor sends the documentation to the Undergraduate Program Committee Chair, or to one of the faculty who teaches a similar departmental course, for approval. If the course is approved, the Office of Undergraduate Admissions is notified to adjust the original transfer information to reflect the new information on the student's academic record.

2) When the course is outside our department, the academic staff advisor requests that the student follow the same petition process with the responsible department and ask to have the course evaluated based on the supporting materials. After evaluation, the responsible department provides us with a completed form of approved transfer of credits to our program. They also advise the Office of Undergraduate Admission to update the student's record.

D. Advising and Career Guidance

Our program has a dedicated Undergraduate Advising Office that is staffed by one full-time professional advisor (Marlo Anderson, Manager Undergraduate Program and Academic Advisor). The program also has an Undergraduate Faculty Advisor (Prof. Adam Bruckner) who holds the position of Chair of the Undergraduate Program Committee.

The advising office provides advising to prospective students, pre-engineering students, and students who have been admitted to the department, with information about the department, curriculum planning, and the application process.

During the span of winter quarter each year, the Undergraduate Faculty Advisor meets with each member of the junior class individually, to discuss their progress, the curriculum, internships, graduate schools, job opportunities, etc., as well as to answer any questions or concerns that the students might have.

The undergraduate staff advisor holds an orientation session for admitted students each autumn before the academic year begins. During the orientation the staff advisor goes over the curriculum, outlines departmental requirements, and reviews University and College of Engineering requirements and policies. The academic orientation program is conducted in two parts. One session is for the newly admitted junior applicants, and one session is for the Direct Freshman Admission students, and the Early Admission students (sophomores). The two orientation sessions are held separately, because the academic portion of the orientation is different for each group. The Direct Freshmen Admits and the Early Admits are fulfilling pre-requisites that are provided in the AA Undergraduate Admissions Guide and the juniors are provided the AA Undergraduate Plan Book. The Plan Book differs from the Admissions Guide by the fact that the information about the curriculum is directed at the remaining two years' requirements, whereas the Admissions Guide outlines what a student needs to complete before the start of the junior year curriculum.

The students are advised via email about career opportunities and are encouraged at the new student orientation to keep their resumes constantly updated. The Undergraduate Faculty Advisor reviews the students' resumes and makes suggestions for their improvement, as needed. The students are also provided with information about resources that are available to help with resume writing as well as interviewing skills. The UW's Career Center has an on-line resume submission web site where students are able to submit resumes and are notified when companies are requesting applicants.

We have two undergraduate student organizations in the department: the student chapters of the American Institute of Aeronautics and Astronautics (AIAA), and Sigma Gamma Tau, the National Honor Society for Aerospace Engineering, work under the guidance of the Advising Office and faculty advisors. Both of these student-run organizations work to engage students in departmental activities. The AIAA student chapter yearly invites prospective students, as well as the freshmen and sophomores already admitted to the department, to a meeting where they are given the opportunity to select a student mentor. The objective is to help students assimilate to the culture of the department and learn about the resources available to them, as well as how to best approach faculty with their concerns.

The faculty maintain an open-door policy, and our students are strongly encouraged, from their first day in the program, to take part in undergraduate research opportunities. Students who do so work closely with faculty (and their graduate students) to learn more about other aspects of the department outside of their coursework. The advising staff also works closely with faculty so that they can recommend the right people to contact when students express interests in certain areas. For example, if a student has an interest in control systems, the undergraduate academic advisor will send an email introduction to the relevant faculty and the student to help bridge connections. Students often receive advice about graduate school, industry, and research directly from the faculty who teach their courses.

Each spring a meeting with the juniors is scheduled in a panel format. Faculty from each discipline group are invited to talk about their area of expertise, and to discuss the contents of the senior courses in more depth than is provided in the course descriptions. This opportunity opens up the students to feel more comfortable about approaching faculty that they might not have previously met.

E. Work in Lieu of Courses

The department generally does not offer any credit for work in lieu of courses, except for two cases:

1) The Co-Op Program administered by the College of Engineering: this program gives students the opportunity to work in their field while earning credit at the same time. Students are eligible for Co-op if they have completed at least one academic quarter at UW, are matriculated and are enrolled full-time (12 credits for undergraduates), have a GPA of 2.5 or above at UW, and are currently enrolled in or have completed Math 126 and Physics 121 **or** Math 126 and Chemistry 142. There are requirements on employers, too.

   Students in the Co-Op Program are registered by the course administrator in ENGR 321 while they are working. The quarter after the work period ends, students are registered in ENGR 322. Credit for both ENGR 321 & ENGR 322 is earned after requirements for both are completed. These requirements include a written Co-Op report and a post-work self-assessment report by the student, and a report from the employer. The grading scale is Credit/No Credit. Credits earned depend on hours worked. Full-time work earns two credits in ENGR 321; part-time work earns one credit per quarter.

   Historically, very few students have opted to enroll for Co-Op because our program does not permit Co-Op credits to count toward the 180 credits required for graduation. Because of this fact, there is no faculty involvement in the assignment of credit. Normally, a Co-Op requires six months to complete, which requires a participating student to extend his/her time to graduation by at least one academic quarter and possibly as long as one year, depending on when the student does the Co-Op. Instead of Co-Ops, our students have typically opted for internships during the summer.

2) The Summer Aerospace Program in France, administered by three Universities in the Ecole National Supérieure system: students admitted into this program earn 9 quarter credits for the intense 6-week program. These credits are in the form of UW 3XX credits. (There are no exact course equivalencies to our courses; thus, the Office of Undergraduate Admissions grants what is referred to as X credits. These credits are applied to the students' academic records, and our program's undergraduate academic advisor assigns them to the proper category. The total of 9 credits granted can be applied toward the general education requirements and/or the free elective category, which are part of the 180 credits required for graduation. The Summer Aerospace Program credits are not used in the assessment of the student outcomes.

F. Graduation Requirements

All students in the program must complete a minimum of 38 credits of college-level mathematics and natural sciences as designated by the College of Engineering. A minimum of 5 additional credits must be completed by students in the areas of natural science and 6 additional credits of mathematics, as designated by the department, for a total of 49 quarter credits for both areas, which represents, effectively, a little over a year of study. An additional 16 credits of engineering fundamentals are specified by the department. Most of these credits must be taken before admission to the Department. The Laboratory experience is guaranteed through physics laboratories that are required links to the physics series courses (Physics 121, 122, 123). The departmental required chemistry course (CHEM 142) also includes a laboratory. The specific breakdown can be seen in Table 1.3 below.

Table 1.3 Graduation requirements

AERONAUTICS AND ASTRONAUTICS GRADUATION REQUIREMENTS

MATHEMATICS			24 cr
MATH 124,125,126	(15 cr)	Calculus with Analytic Geometry	
MATH 307	(3 cr)	Introduction to Differential Equations	
MATH 308	(3 cr)	Matrix Algebra with Applications	
MATH324 *	(3 cr)	Advanced Multivariable Calculus I	
NATURAL WORLD			25 cr
CHEM 142	(5 cr)	General Chemistry with Lab	
CHEM 152*	(5 cr)	General Chemistry with Lab	
or Natural World Elect*	(5 cr)	Selection from approved list.	
PHYS 121, 122, 123	(15 cr)	Mechanics, Electromagnetism and Oscillatory Motion, & Waves with Labs	
*CHEM 152 Is not required but, a good choice if considering any other science or engineering majors.			
WRITTEN AND ORAL COMMUNICATIONS			5-cr
Required			
English Comp.	(5 cr)	Course from the Arts & Science Engl. Comp list	
The University's remaining 7 credits of writing requirements are included in the departmental courses.			
ENGINEERING FUNDAMENTALS			16 cr
AA 210	(4 cr)	Engineering Statics (Prereq: MATH 126, PHYS 121)	
AA 260	(4 cr)	Thermodynamics (Prereq: CHEM 142, PHYS 121,MATH 126)	
CEE 220	(4 cr)	Introduction to Mechanics of Materials (Prereq: AA 210)	
ME 230	(4 cr)	Kinematics and Dynamics (Prereq: ENGR 210)	
VISUAL LITERARY AND PERFORMING ARTS & INDIVIDUALS AND SOCIETIES			24 cr
Minimum 10 cr. Visual, Literary and Performing Arts and 10 cr. minimum Individuals & Societies and 4 additional credits from either area.			

Aeronautics & Astronautics 300 Level Required Courses					45 cr
AA 301 (4)	AA 302 (4)				
AA 310 (4)	AA 311 (4)	AA 312 (4)	AA 331 (4)	AA 332 (4)	
AA 320 (3)	AA 321 (3)	AA 322 (3)	AA 360 (4)	AMATH 301 (4)	

400 LEVEL CORE COURSES	
AA 410-411 or AA 420-421 Integrated Design Sequence	8 cr
AA 447 Controls in Aerospace Systems	4 cr
AA 496 Special Topics Seminar	1 cr
AA Senior Technical Electives	15 cr
Free Electives	13 cr
Total Credit Hours	180 cr

Two years of engineering topics are required. As shown on Table 1.3, this consists of 16-quarter credits of engineering fundamentals, 58 credits of departmental required courses, and 15 credits of department electives. The common junior-year department courses address the engineering sciences fundamental to aerospace engineering – some design content appears through lectures and assignments with open-ended content. An example is when an engineering objective is posed for which there may be a number of valid solutions, and the compromise involved in choosing one is discussed or worked on. This process culminates in the winter quarter of the senior year, when the students must begin either the aircraft or spacecraft and space systems design sequence (AA 410 and AA 411 or AA 420 and AA 421).

By then there has been sufficient preparation in engineering fundamentals to allow a meaningful integrated design experience on an overall aerospace system. The students are usually split into groups that pursue different aspects of the selected design project and report back to the class. Five formal contact hours per week assure sufficient time with the instructor to accomplish class objectives. Students are encouraged to think about the real world in which their design must function, and while the emphasis of necessity is on engineering, other issues, such as economic reality, environmental constraints, manufacturability, safety, social and political aspects, and ethics, are considered as well.

The general education component is met by a minimum of 10 credits from the University's Visual, Literary and Performing Arts (VLPA) category, and a minimum of 10 credits from the Individuals and Society (I&S) category. A total of 24 credits is required. The general education requirement meets the basic education breadth requirement of the University, and satisfies the College and Department requirement for well-rounded graduates.

Table 1.3 above contains more information about the courses required for the degree and shows how the courses fit into the categories just discussed. Each course description has detailed information on course content and also lists the specific student outcomes that the course meets (if any). These are provided in Appendix A.

Satisfactory progress in the Aeronautical and Astronautical Engineering program can be monitored online by viewing the UW DARs (Degree Audit Reporting System). Students are encouraged to periodically view their DARs report to keep track of their progress toward degree requirements. The undergraduate academic advisor reviews each student’s DARs degree audit in the autumn quarter of the senior year, and then sends an e-mail to each student to set up an appointment to review the graduation application and formally file for graduation. This allows two quarters for the students to make up any deficiencies in general education courses or identify any problems or missing requirements. The meeting includes reviewing the plan of courses in progress and also those scheduled for the remaining quarters leading up to graduation. The outcome is that each student is required to have an acceptable terminal course plan at least two quarters in advance of his/her actual graduation.

G. Transcripts of Recent Graduates

We will provide transcripts from recent graduates to our Program Evaluator or to the ABET review team whenever requested.

CRITERION 2. PROGRAM EDUCATIONAL OBJECTIVES

A. Mission Statement

<u>University of Washington Mission Statement</u>:

Founded 4 November 1861, the University of Washington is one of the oldest state-supported institutions of higher education on the Pacific coast. The University is comprised of three campuses: the Seattle campus is made up of seventeen schools and colleges whose faculty offer educational opportunities to students ranging from first-year undergraduates through doctoral-level candidates; the Bothell and Tacoma campuses, each developing a distinctive identity and undergoing rapid growth, offer diverse programs to upper-division undergraduates and to graduate students.

The primary mission of the University of Washington is the preservation, advancement, and dissemination of knowledge. The University preserves knowledge through its libraries and collections, its courses, and the scholarship of its faculty. It advances new knowledge through many forms of research, inquiry and discussion; and disseminates it through the classroom and the laboratory, scholarly exchanges, creative practice, international education, and public service. As one of the nation's outstanding teaching and research institutions, the University is committed to maintaining an environment for objectivity and imaginative inquiry and for the original scholarship and research that ensure the production of new knowledge in the free exchange of facts, theories, and ideas.

To promote their capacity to make humane and informed decisions, the University fosters an environment in which its students can develop mature and independent judgment and an appreciation of the range and diversity of human achievement. The University cultivates in its students both critical thinking and the effective articulation of that thinking.

As an integral part of a large and diverse community, the University seeks broad representation of and encourages sustained participation in that community by its students, its faculty, and its staff. It serves both non-traditional and traditional students. Through its three-campus system and through educational outreach, evening degree, and distance learning, it extends educational opportunities to many who would not otherwise have access to them.

The academic core of the University of Washington is its College of Arts and Sciences; the teaching and research of the University's many professional schools provide essential complements to these programs in the arts, humanities, social sciences, and natural and mathematical sciences. Programs in law, medicine, forest resources, oceanography and fisheries, library science, and aeronautics are offered exclusively (in accord with state law) by the University of Washington. In addition, the University of Washington has assumed primary responsibility for the health science fields of dentistry and public health, and offers education and training in medicine for a multi-state region of the Pacific Northwest and Alaska. The schools and colleges of architecture and urban planning, business administration, education, engineering, nursing, pharmacy, public affairs, and social work have a long tradition of educating students for service to the region and the nation. These schools and colleges make indispensable contributions to the state and, with the rest of the University, share a long tradition of educating undergraduate and graduate students toward achieving an excellence that well serves the state, the region, and the nation.

College of Engineering Mission Statement:

We are a diverse community of innovators working to dramatically improve the quality of life in our state, our nation, and the world. We do it by leading in engineering discovery, innovation, education, and engagement.

Department Mission Statement:

The mission of the Department of Aeronautics & Astronautics (A&A) at the University of Washington (UW) is to serve the region, the State of Washington, the nation, the profession, and society at large by attaining, and sustaining, the following goals:

1) To educate engineers for a lifetime of continuous learning and for contributions to all areas of aerospace engineering;
2) To provide a challenging and comprehensive education which develops necessary technical and professional skills, provides a solid foundation in the engineering sciences related to aerospace engineering, and develops engineering creativity through design experience and through research;
3) To expand knowledge by pursuing basic and applied research, by addressing critical technical problems related to aerospace engineering, and by devising innovative ways to develop and apply new technologies;
4) To contribute knowledge to, and participate in, the identification and solution of problems facing society; and
5) To work with local, national, and international aerospace and other industries to conduct joint research that advances the applications of new technologies and impacts engineering practice.

B. Program Educational Objectives

The education of engineers at the undergraduate level is one of the key missions of the William E. Boeing Department of Aeronautics and Astronautics. The undergraduate program prepares graduates to be successful and highly valued engineers in local, national, and international industry, as well as in government organizations and institutions of higher learning. The objectives of the undergraduate program are for our graduates to serve the region, the nation, the profession, and society at large, as follows:

1) Our graduates will be engineers who solve critical technical problems related to aerospace engineering, and who devise innovative ways to develop and apply new technologies.;
2) Our graduates will contribute knowledge to and participate in the identification and solution of problems facing society;

3) Our graduates will engage in a lifetime of continuous learning and contribution to all areas of aerospace engineering.

To achieve these objectives, faculty, staff, and teaching assistants pursue excellence in the department's educational programs, supported by state-of-the-art computing, laboratory, and instructional facilities, and utilize the fruits of developments in educational technology and engineering education research.

C. Consistency of the Program Educational Objectives with the Mission of the Institution

Our program educational objectives are consistent with the mission statements of the University and of the College of Engineering with respect to the preservation, advancement, and dissemination of knowledge. Our program objectives enable our graduates to serve the state, the region, and the nation as first-rate engineers and leaders who are ready to make immediate positive contributions to society.

D. Program Constituents

Industry and government agencies (NASA, JPL) are constituents of our program because these entities are the destination of many of our students after they graduate. Interactions with the these constituents include the external Visiting Committee[*] (which has members from both industry and government agencies), guest lecturers for our undergraduate seminar series, internships for our students in their organizations, and faculty interactions with industry colleagues. It is the nature of the program that we want our graduates to be highly desired by future employers; thus, interaction with industry and government is key to achieving this objective.

University graduate programs are also program constituents because some of our graduates continue their education at other graduate schools. Interactions with other academic institutions are established with strong representation of faculty from other universities in the department's Visiting Committee, through research collaborations between our faculty and faculty at other institutions, and through technical meetings at national and international conferences.

Finally, our students themselves are constituents because they comprise the *raison d'être* for our program and represent the output of our program. The students come from many geographical regions and backgrounds. The majority of our students are from the University of Washington or are transfers from Community Colleges in our state. Some students typically come from the Running Start program.

Our Program Educational Objectives meet the needs of the constituents because what the PEOs state is what our constituents look for in our graduates. The industry, government, and university graduate program constituents look at the PEOs as what the program should enable our graduates to do, while our students look at the PEOs as what they hope the program will help them achieve.

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[*] See Appendix E for the list of current Visiting Committee members.

E. Process for Revision of the Program Educational Objectives

Assessment of our PEOs occurs approximately every three years, on the average, and involves the department's constituents. The aerospace industry and government agencies provide input on the PEOs directly or through the Visiting Committee, which is comprised of leaders in the aerospace industry and government agencies, and faculty from other universities. Alumni also provide feedback regarding the PEOs, through the 5-years-post-graduation surveys we administer. The Undergraduate Committee is responsible for determining the appropriateness of our PEOs based on the feedback from our constituents, to ensure that they remain consistent with the University's mission, our program constituents' needs, and the engineering accreditation criteria. The faculty at large review the Committee's recommendations regarding the PEOs and either accept them or suggest revisions.

Our PEOs were significantly revised during our last ABET review in 2007, at the suggestion of the Program Evaluator (PEV), who pointed out the PEOs at the time resembled student outcomes. The revised PEOs, which were approved by the PEV during the review, were used until about 6 months ago, when they underwent a slight revision to make them more clear. These are the PEOs that are listed in Section 2.B above.

CRITERION 3. STUDENT OUTCOMES

A Student Outcomes

The Student Outcomes describe the attributes, skills, and abilities that students should have upon graduating from the Program. We have used the ABET student outcomes (Table 3.1) since our last review in 2007. Every program course syllabus (see Appendix A) includes the outcomes relevant to that course, and faculty are expected to evaluate those outcomes for the courses they have taught, at the end of the relevant academic. In addition, every year the department conducts a general survey of juniors and seniors, in which they are asked to rate each outcome, both as to its importance and as to the students' prepared ness in each. The surveys also address other criteria about their experience in the department (sample surveys are shown in Appendix F). The results of these surveys are collected and tabulated and the weighted averages plotted on bar graphs. The surveys and their results for the past two years are documented in Criterion 4.

Table 3.1 ABET Student Outcomes

a) An 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
c) An ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability
d) An ability to function on multi-disciplinary teams
e) An ability to identify, formulate and solve engineering problems
f) An understanding of professional and ethical responsibilities
g) An ability to communicate effectively
h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context
i) A recognition of the need for, and an ability to engage in life-long learning
j) Knowledge of contemporary issues
k) An ability to use the techniques, skills and modern engineering tools necessary for engineering practice

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

The key elements of the Program Educational Objectives are as follows:

Our program educational objectives (described in the section on Criterion 2) are for our graduates to serve the region, the nation, the profession, and society at large, as follows:

1) Our graduates will be engineers who solve critical technical problems related to aerospace engineering, and who devise innovative ways to develop and apply new technologies.;
2) Our graduates will contribute knowledge to and participate in the identification and solution of problems facing society;
3) Our graduates will engage in a lifetime of continuous learning and contribution to all areas of aerospace engineering.

The correlation between our PEOs and student outcomes is shown in Table 3.2

Table 3.2 Correlation between PEOs and Student Outcomes

	(a)	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
PEO 1	●	●	●	●	●	●	●	●		●	●
PEO 2				●	●	●	●	●		●	●
PEO 3			●		●	●	●	●	●	●	●

The connection between the Student outcomes and the Program Educational Objectives are straightforward: Outcomes (a)-(h), (j), and (k) are key to successfully meeting PEO 1. These outcomes stress the fundamental aerospace disciplines as well as the tools required to apply them. Outcomes (d)-(h), (j), and (k) are important ingredients to reaching PEO 2. Continued success in each of these outcomes will keep our students employable after graduation. Finally, outcomes (c) and (e)-(k) are explicit criteria for attaining PEO 3.

CRITERION 4. CONTINUOUS IMPROVEMENT

A. Student Outcomes

4.A.1. Assessment Processes and Frequency

Our program has been undergoing continuous development and improvement since its inception in 1929, through a variety of mechanisms, both formal and informal. Improvements are based on assessments, which are performed in a variety of ways, both formal and informal. The various methods of assessment are listed in Table 4.1 and further details are provided below.

Table 4.1 Assessment methodologies.

Type	Assessment	Frequency
Formal	Entry and exit surveys of students*	Annual
	Survey of Visiting Committee*	Annual
	Survey of industry and government employers*	Annual
	Reviews by UW Office of Educational Assessment	Biennial
	Course evaluations	Quarterly
Informal	Interviews of juniors by faculty advisor in winter quarter	Annual
	Faculty/student discussions	Ongoing
	Feedback from academic advisor	Ongoing
	Feedback from Student Advisory Committees	Quarterly
	Discipline-specific curriculum reviews by faculty	Yearly

* Appendix F provides a sampling of the different types of surveys that we use.

<u>Role of the Undergraduate Program Committee (UPC)</u>

On regular basis (usually annual or biennial) the Undergraduate Program Committee (UPC) reviews the student outcomes, as well as the PEOs. The UPC is responsible for determining how well the student outcomes have been met and to recommend to the faculty any necessary adjustments to the curriculum based on the information gathered. Similarly, this committee makes recommendations regarding the appropriateness of the PEOs.

<u>Role of the Faculty</u>

Groups of discipline-specific faculty (fluids, structures, controls, energetics) meet yearly during winter quarter to update their course contents, learning goals, and objectives, as needed, and develop strategies and actions. In addition the faculty groups make recommendations to the department chair regarding the following year's teaching assignments in their discipline. Furthermore, on a quarterly basis, the grades of each student are assessed and compared with course averages, while noting trends, variances, and consistencies from year to year and in comparison with other courses in the department. In the undergraduate classes, faculty use a variety of methods to assess learning and student outcomes on an ongoing basis, such as weekly pop quizzes, midterm and final exams, individual student-instructor and student-TA conferences, etc. Some courses have projects instead of final exams, and also require students to make oral presentations, on which they are evaluated as well. In addition to the above, the overall student learning and integration of skills at the end of the students' undergraduate program are assessed by faculty and industry representatives as part of their participation in either of the two required capstone senior design projects, Aircraft Design or Space Systems Design.

Role of the Visiting Committee

The department's Visiting Committee (VC), in existence since 1998, consists of a mix of industry and academic representatives. The nominal meeting frequency is every two years. During the years that the VC meets, assessment data are collected at the meeting. For the alternate years, the assessment data from the VC are obtained via a web-based survey. At the meetings, the assessment of outcomes is handled in verbal discussion format, and feedback is obtained verbally and through the report the VC submits after the meeting. After the conclusion of the VC meetings the faculty study the data provided, as described below, and take appropriate actions, as needed.

Role of Industry and Government Agencies

Feedback from industry and government agencies has been solicited through online surveys, using the same type of survey as used with the Visiting Committee. We have observed that industry and government representatives at times exhibit significant subjective bias, i.e., they have tended to emphasize the need for particular skills that can immediately benefit their specific organizations at the time the survey is conducted. If we were to implement all such suggestions, our program would eventually look more like that of a vocational school than a university.

4.A.2 Assuring Achievement of Student Outcomes

To assure that graduates have achieved the student outcomes, the strategies and actions listed in Tables 4.2 through 4.12 are employed for each outcome. The processes and procedures listed therein assure that students achieve the outcomes by the time they graduate. The student outcomes are fully addressed by the required and elective courses of the Aeronautical and Astronautical Engineering Program, as shown in Table 4.13.

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Table 4.2 Student Outcome (a)

An ability to apply knowledge of mathematics, science, and engineering

Strategies and Actions	Results	Relevance to other ABET Outcomes (a-k)	Assessment Methods/Metrics
1) Ensure prerequisite courses have been met and are appropriate for students so that students are adequately prepared.	Students entering the A&A department will have the basic science, math and technology skills to succeed.		• Grades on prerequisite courses for admission to the A&A department • Feedback in Junior interviews on preparedness • Interviews with instructors teaching core A&A courses
2) Core A&A courses emphasize fundamental principles. These courses include AA 301, AA 302, AA 310, AA 311, AA 312, AA 331, AA 332, AA 360 and AA 447.	Students will be able to show knowledge of the basic fundamentals in aerospace engineering. They will be able to apply these fundamental concepts to a wide variety of problems.	e,k	• Performance on exam questions, homework and projects that emphasize the application of fundamentals in aerospace related problems
3) The Aerospace Lab sequence (AA 320, AA 321, AA 322) and design courses (AA 410, AA 411, AA 420, AA 421) integrate fundamentals learned in core courses.	Students will be able to tie together knowledge of fundamental concepts into hands-on experiments and design experiences.	b,c,e,f,k	• Successful completion of lab experiments • Design projects that use technical analysis
4) Make use of fundamental concepts in technical electives.	Students will have an ability to apply fundamental concepts to a variety of problems.	b,c,e,k	• Exit interviews • Assess technical knowledge through: Homework assignments, Exams, Projects, Labs

Table 4.3 Student Outcome (b)

An ability to design and conduct experiments, as well as to analyze and interpret data

Strategies and Actions	Results	Relevance to other ABET Outcomes (a-k)	Assessment Methods/Metrics
1) Aerospace Lab sequence (AA 320-322) consists of a major hands-on learning component that emphasizes the connection between the theory and the application.	Students will be able to design and perform experiments, and will be able to apply analytical techniques to interpret the results.	a,c,e,g,k	• Lab reports • Oral presentations • Exams • On-site evaluation by teaching assistants
2) Incorporate experimental demonstrations into class lectures.	Students will be able to relate analytical methods to computational and experimental applications.	a,e,k	• Homework assignments related to demonstrations • Exit interviews
3) Design Aerospace Lab experiments to confirm selected analytical materials presented in core classes.	Students will be able to show their comprehension of theoretical concepts by applying them to hands-on experiments.	a,c,e,k	• Lab write-ups • Homework assignments • Exams
4) AA 322 independent projects will encompass a variety of experimental techniques.	Students will be able to propose, conduct , and report independent experimental projects.	a,c,d,e,g,k	• Result of project or design • Weekly, interim, and final report • Oral report • Group self-assessment • Exit interview

Table 4.4 Student Outcome (c)

An ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability

Strategies and Actions	Results	Relevance to other ABET Outcomes (a-k)	Assessment Methods/Metrics
(1) Students will attend seminars given by industry and government personnel.	Students will understand issues relating to economic, environmental, social, political, ethical, health, and safety, constraints, as well as issues of manufacturability and sustainability.	f,h	• Seminar attendance • Exam • Exit interviews
(2) In the third course in the Aerospace Laboratory series (AA 322) students will propose, design, conduct, and report on an independent experimental project of their choice.	Students will be able to design all aspects of their chosen experiment.	b,d,e,g,j,k	• Oral presentations • Written reports • Peer evaluation
(3) Students will participate as teams in a capstone design course emphasizing either airplane or space systems.	Students will be able to identify the components and the requirements of a complex system, and to recognize and identify the various tradeoffs.	c,d,e,g,k	• Instructor assessment • Peer review
(4) Participation in AIAA student conferences will be encouraged.	Students will have experiences giving presentations about independent or group projects to professional audiences.	a,b,c,d,e,f, h,i,j,k	• Technical evaluations from audience and judges. • Prize awards

Table 4.5 Student Outcome (d)

An ability to function on multi-disciplinary teams

Strategies and Actions	Results	Relevance to other ABET Outcomes (a-k)	Assessment Methods/Metrics
(1) Students will participate as teams in a capstone design course emphasizing either airplane or space systems.	Students will be able to apply basic concepts to design.	a,c,e,k	• Instructor assessment of design project • Peer review of individual contributions to group design
(2) Required capstone design courses will include multi-disciplinary and systems analysis concepts.	Students will be able to identify the components and the requirements of a complex system, and to recognize and identify the various tradeoffs.	c,e,g,k	• Instructor assessment • Peer review
(3) Contemporary design problems will be selected for capstone designs.	Students will be familiar with the use of current technology in design.	a,c,h,i,j,k	• Instructor assessment • Peer review • Exit interviews
(4) Design courses will include aspects of ethical, social and environmental issues.	Students will have the awareness of the social and environmental issues.	f,g,h	• Exit interviews
(5) A panel of outside experts will conduct a final design review.	Students will be able to defend their work to peers and/or outside experts.	g,k	• Outside expert review
(6) Issues of design will be introduced in various fundamentals courses.	Students will be able to recognize when and where design choices are influenced by individual disciplines.	a,c,e,k	• Homework involving design issues • Projects
(7) Capstone design courses will require oral and written presentations.	Students will have the ability to communicate technical ideas.	g	• Written reports • Oral presentations

Table 4.6 Student Outcome (e)

An ability to identify, formulate and solve engineering problems

Strategies and Actions	Results	Relevance to other ABET Outcomes (a-k)	Assessment Methods/Metrics
1) Ensure prerequisite courses have been met and are appropriate for students so that students are adequately prepared.	Students entering the A&A department will have the basic science, math and technology skills to succeed.	a	• Grades on prerequisite courses for admission to the A&A department • Feedback in Junior interviews on preparedness • Interviews with instructors teaching core A&A courses
2) Core A&A courses emphasize fundamental principles. These courses include AA 301, AA 302, AA 310, AA 311, AA 312, AA 331, AA 332, AA 360 and AA 447.	Students will be able to show knowledge of the basic fundamentals in aerospace engineering. They will be able to apply these fundamental concepts to a wide variety of problems.	a,k	• Performance on exam questions, homework and projects that emphasize the application of fundamentals in aerospace related problems
3) The Aerospace Lab sequence (AA 320-322) and design courses (AA 410/411, AA 420/421) integrate fundamentals learned in core courses.	Students will be able to tie together knowledge of fundamental concepts into hands-on experiments and design experiences.	a,b,c,f,k	• Successful completion of lab experiments • Design projects that use technical analysis
4) Make use of fundamental concepts in technical electives.	Students will have an ability to apply fundamental concepts to a variety of problems.	a,b,c,k	• Exit interviews • Assess technical knowledge through: • Homework assignments, Exams, Projects, Labs

Table 4.7 Student Outcome (f)

An understanding of professional and ethical responsibilities

Strategies and Actions	Results	Relevance to other ABET Outcomes (a-k)	Assessment Methods/Metrics
(1) Students will attend seminars given by industry and government personnel.	Students will understand contemporary issues and the connection between their work and the needs of society.	h	• Seminar attendance • Exam • Exit interviews
(2) Students will be introduced to ethical conduct.	Students will be able to make decisions involving ethical dilemmas.	e,g,k	• Ability to solve ethical problems • Exit interviews
(3) Students will be given a statement on plagiarism.	Students will not plagiarize.	e,g,k	• Students sign statement

Table 4.8 Student Outcome (g)

An ability to communicate effectively

Strategies and Actions	Results	Relevance to other ABET Outcomes (a-k)	Assessment Methods/Metrics
(1) Students will give presentations in AA 322, Aerospace Laboratory II, and in their design courses.	Students will be able to present designs for review to their peers.	J,k	• Oral presentations • Written reports • Peer evaluation
(2) Student reports will be given in some core courses and electives.	Students will be able to gather information and report to a group.	f,g,h,i,j,k	• Oral presentations
(3) Students will work on group assignments in some core courses, such as Aerospace Lab, and electives.	Students will have interpersonal skills to produce a given result.	d,e	• Reports • Peer reviews • Exit interviews
(4) Participation in AIAA student conferences will be encouraged.	Students will have experiences giving presentations about independent or group projects to professional audiences.	a,b,c,d,e,f, h,i,k	• Technical evaluations from audience and judges. • Prize awards
(5) Presentation software will be introduced to students and used in class.	Students will have the skills necessary to prepare technical presentations.	k	• Review by instructors • Peer reviews
(6) Students will have many writing assignments through the program, particularly in the Aerospace Laboratory sequence (AA 320-322) and in their capstone design courses.	Students will be able to write clear, concise technical documents.	k	• Evaluation of reports.
(7) Social interactions shall be fostered by the department through special social events, use of student study areas, and the student chapter of AIAA.	Students will be comfortable in a social environment.	h,k	• Exit interviews.

Table 4.9 Student Outcome (h)

The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context

Strategies and Actions	Results	Relevance to other ABET Outcomes (a-k)	Assessment Methods/Metrics
1) Students will attend a weekly seminar series.	Students will learn a broad spectrum of topics.	f,h,k	• Seminar attendance
2) Students will be given outside, independent research problems in some classes.	Students will be exposed to global, economic, environmental, and societal issues.	j,k	• Exit interview
3) Students will participate as teams in a capstone design course emphasizing either airplane or space systems.	Students will be able to develop a design in the proper global and societal context.	a,c,e,k	• Instructor assessment of design project • Peer review of individual contributions to design

Table 4.10 Student Outcome (i)

A recognition of the need for, and an ability to engage in life-long learning

Strategies and Actions	Results	Relevance to other ABET Outcomes (a-k)	Assessment Methods/Metrics
1) Students will attend a weekly seminar series.	Students will learn a broad spectrum of topics.	f,h	• Seminar attendance
2) Students will take a project laboratory course (AA 322), and a capstone design course sequence (AA 410/411 or AA 420/421) that will involve research.	Students will be able to perform literature research and Web-based research.	k	• Written and oral reports • Exit interviews
3) Students will be given outside, independent research problems in some classes.	Students will be able to learn outside the classroom.	i,j,k	• Exit interview

Table 4.11 Student Outcome (j)

Knowledge of contemporary issues

Strategies and Actions	Results	Relevance to other ABET Outcomes (a-k)	Assessment Methods/Metrics
(1) Students will attend seminars given by industry and government personnel.	Students will understand contemporary issues and the connection between their work and the needs of society.	f,h	• Seminar attendance • Exam • Exit interviews
(2) Airplane and space history will be included where appropriate into the curriculum.	Students will understand the historical context of aerospace designs.	h,i,j	• Design projects • Exit interviews

Table 4.12 Student Outcome (k)

An ability to use the techniques, skills and modern engineering tools necessary for engineering practice

Strategies and Actions	Results	Relevance to other ABET Outcomes (a-k)	Assessment Methods/Metrics
1) Ensure prerequisite courses have been met and are appropriate for students so that students are adequately prepared.	Students entering the A&A department will have the basic science, math and technology skills to succeed.	a,e	• Grades on prerequisite courses for admission to the A&A department • Feedback in Junior interviews on preparedness • Interviews with instructors teaching core A&A courses
2) Core A&A courses emphasize fundamental principles. These courses include AA 301, AA 302, AA 310, AA 311, AA 312, AA 331, AA 332, AA 360 and AA 447.	Students will be able to show knowledge of the basic fundamentals in aerospace engineering. They will be able to apply these fundamental concepts to a wide variety of problems.	a,e	• Performance on exam questions, homework and projects that emphasize the application of fundamentals in aerospace related problems
3) The Aerospace Lab sequence (AA 320-322) and design courses (AA 410/411, AA 420/421) integrate fundamentals learned in core courses.	Students will be able to tie together knowledge of fundamental concepts into hands-on experiments and design experiences	a,b,c,e,f	• Successful completion of lab experiments • Design projects that use technical analysis
4) Make use of fundamental concepts in technical electives.	Students will have an ability to apply fundamental concepts to a variety of problems.	a,b,c,e	• Exit interviews • Assess technical knowledge through: • Homework assignments, Exams, Projects, Labs

Table 4.13 Mapping of program courses to student outcomes

Course	a	b	c	d	e	f	g	h	i	j	k	Required
AA 198	●							●	●	●		N
AA 210	●				●						●	Y
AA 260	●				●						●	Y
AA 299	●	●	●	●	●	●	●	●	●	●	●	N
AA 301	●				●						●	Y
AA 302	●		●		●						●	Y
AA 310	●				●						●	Y
AA 311	●				●						●	Y
AA 312	●				●						●	Y
AA 320	●	●			●		●				●	Y
AA 321	●	●			●		●				●	Y
AA 322	●	●	●	●	●		●		●	●	●	Y
AA 331	●				●						●	Y
AA 332	●				●						●	Y
AA 360	●				●						●	Y
AA 400	●				●				●		●	N
AA 402	●				●				●		●	N
AA 405	●	●			●				●		●	N
AA 410	●	●	●	●	●	●	●	●	●	●	●	Y*
AA 411	●	●	●	●	●	●	●	●	●	●	●	Y*
AA 419	●				●		●				●	N
AA 420	●	●	●	●	●	●	●	●	●	●	●	Y*
AA 421	●	●	●	●	●	●	●	●	●	●	●	Y*
AA 430	●		●		●				●		●	N
AA 432	●				●				●		●	N
AA 440	●				●		●		●		●	N
AA 441	●	●			●		●		●		●	N
AA 447	●		●		●				●		●	Y
AA 448	●	●	●	●	●				●		●	N
AA 449								●	●	●		N
AA 461	●		●		●				●		●	N
AA 462	●		●		●				●	●	●	N
AA 470	●		●		●		●	●	●	●	●	N
AA 480	●				●				●		●	N
AA 496						●			●	●		N
AA 498												N†
AA 499	●	●	●	●	●	●	●	●	●	●	●	N

* Students are required to take either AA 410 & 411 or AA 420 & 421.
† Outcomes vary, depending on topic.

4.A.3. Expected Level of Attainment for Outcomes

All the Catalyst WebQ surveys sent to the various stakeholders identified earlier use a 5-point scale to evaluate both the importance of the student outcomes and their own level of preparation in them:

5 – Excellent	or	(Strongly Agree)
4 – Above average		(Moderately Agree)
3 – Average		(Slightly agree)
2 – Below average		(Slightly Disagree)
1 – Poor		(Strongly Disagree)

An additional category, labeled "No Opinion" is also provided, and assigned a value of 0, but is not used in computing the averages of the responses. We expect the level of attainment for each of the student outcomes to be 3.0 or higher by the time of the exit survey in the senior year.

4.A.4. Summary of the Results

Surveys of Juniors

As noted earlier, the students are surveyed at the beginning and end of their junior year, using the online survey provided by the UW's Catalyst WebQ. The collected information (for which student identities are kept confidential) provides valuable feedback, and has resulted in program improvements over the years (see Section 4.B). As part of these surveys the students are asked to rate the level of importance of, and also their level of preparation in the (a)-(k) student outcomes. Results for the 2011-2012 academic year are shown in Figs. 4.1 – 4.2 (results for prior years are similar). The juniors rated almost all student outcomes to be of great importance, with ratings averaging at or above ~3.5 at the beginning of their junior year, and 4.0 or above at the end of the junior year. It is clear that there is an increase in the students' perception of the importance of the outcomes after they have spent a year in our program. Comparison of the "entering" and "exiting" ratings of their preparation in the (a)-(k) outcomes, indicate that their perceived levels of preparation consistently increase from the beginning to the end of the junior year. In both the importance and preparation categories the students show that our program is addressing the outcomes well.

In response to other parts of the survey, almost all the juniors have stated that they are very pleased with their choice to enter the aeronautical and astronautical engineering program. Even after completing only one quarter with three courses in the major (in addition to the two prerequisites managed and taught by our faculty, AA 210 (Statics) and AA 260 (Thermodynamics), the students begin to feel a sense of camaraderie and family. Almost all commented on the benefits of a smaller department, were happy about the openness of the faculty, and were especially pleased with the quality of advising. Students feel that the department has invested in giving them materials and resources to help facilitate their learning (e.g., 24-hr computing lab access, computer programs, wind tunnel facilities, opportunities for undergraduate participation in research labs, and opportunities for extracurricular independent projects, such as Design, Build, Fly and Design, Build, Launch). The students have also expressed satisfaction in a well-rounded curriculum. They have found the curriculum to be very challenging as well as informative but have asked for more sample problems to be discussed in some of their classes. All commented on the “cultural shock” of entering a program that is much more challenging than the first two years at the University (or community college for transfer students).

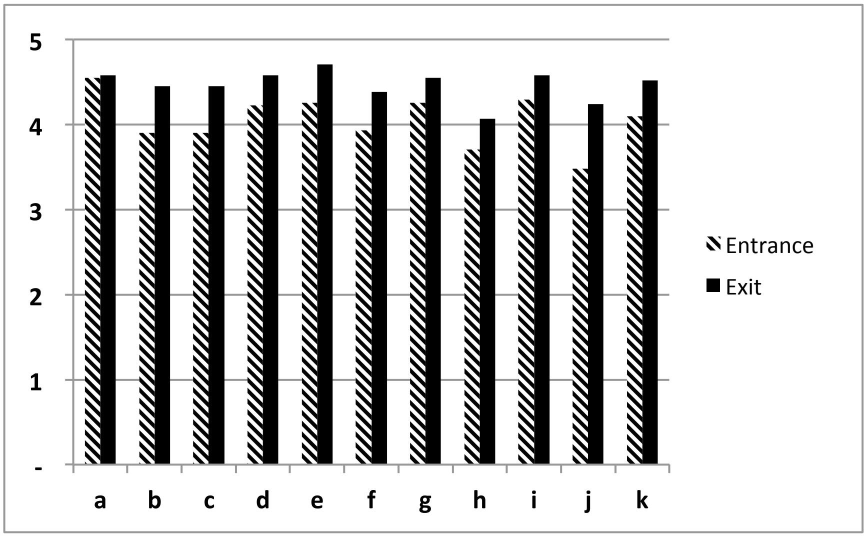

Fig. 4.1 Students’ perceived level of importance of the student outcomes, at the beginning and end of the junior year (2011-2012).

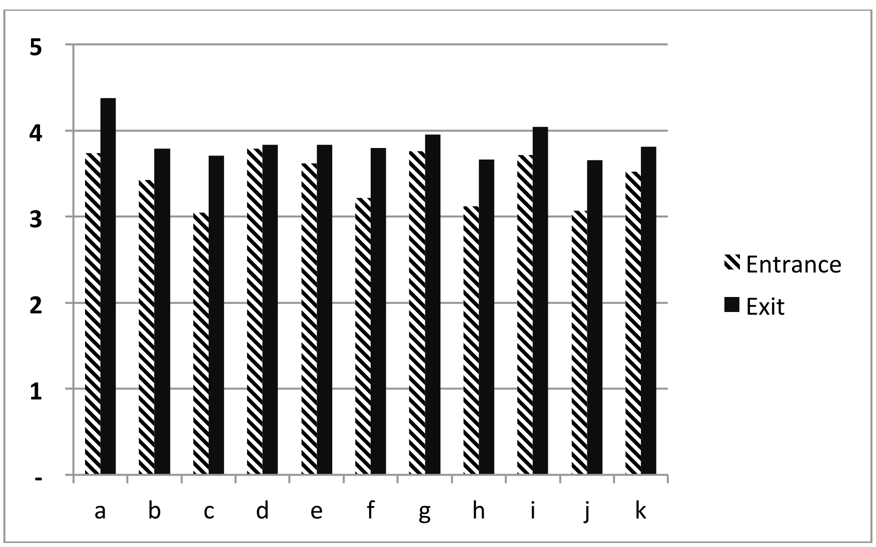

Fig. 4.2 Students’ perceived level of preparation of the student outcomes, at the beginning and end of the junior year (2011-2012).

Exit Surveys of Seniors

Seniors are surveyed near the end of their final spring quarter using the same online survey methodology as used for the juniors and other program constituents, but with different questions other than the ones about the student. The collected information (for which student identities are kept confidential, as for the juniors) also provides important feedback, and has also resulted in some program improvments over the years. As with the survey of juniors, the seniors are asked to rate the level of importance of, and also their level of preparation in the (a)-(k) student outcomes. Results for the 2012-2013 academic year are shown in Figs. 4.3 and 4.4. This is the same cohort whose survey results as juniors in 2011-2012 are shown in Figs. 4.1 and 4.2 above. The evolution of their preceived level of preparation in the outcomes is evident.

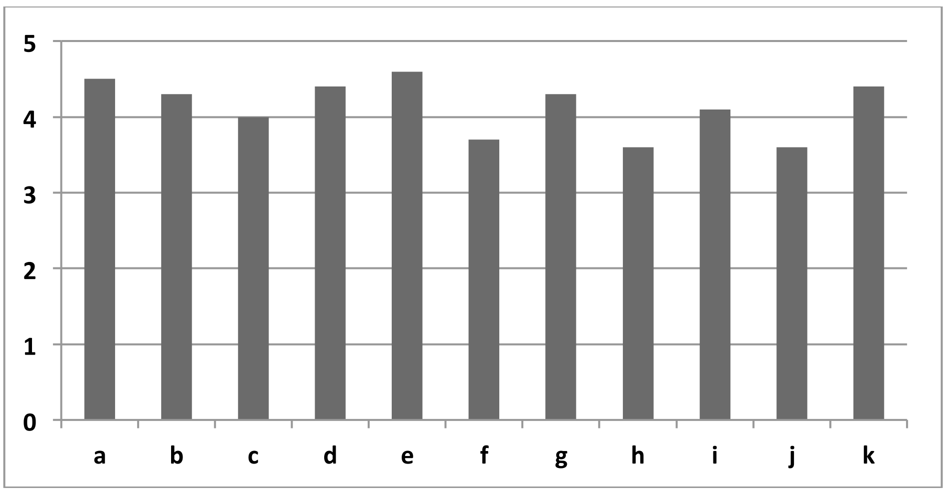

Fig. 4.3 Students' perceived level of importance of the student outcomes, at the end of the senior year (2012-2013).

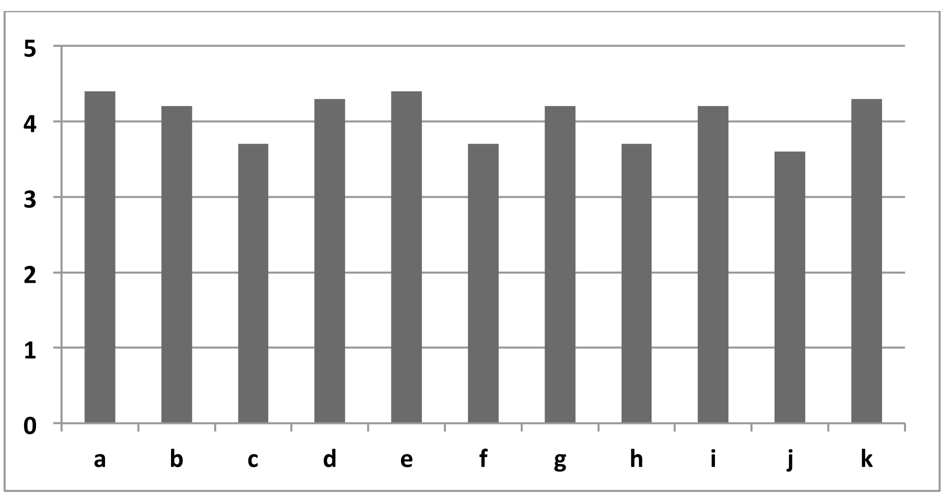

Fig. 4.4 Students' perceived level of preparation of the student outcomes, at the end of the senior year (2012-2013).

It can be seen that on the verge of graduation students are rating the ABET outcomes highly, both for their perceived importance and the student's perceived preparation in them. All ratings are above 3.5, showing that the graduating students feel our program is attaining the outcomes well.

General Student Impressions from Recent Exit Surveys

Overall, the seniors have felt that their experience in the program is very good. Many believe that our program is the best in the College of Engineering. They point to the moderate size of the student body and the approachability of faculty as primary strengths. All have felt that they learned a great deal and that they were well prepared for what lies ahead.

When asked about their future plans; about half the seniors this year stated that they were still uncommitted near the end of spring quarter. The many seniors who planned to work in industry or government had some difficulty finding job opportunities, a situation that has been prevalent since the start of the Great Recession in 2008, and especially since this past March, when the Federal Government's budget sequestration went into effect. As a result of the sequestration, companies are holding back on their hiring due to cuts in their government contracts, or their outright cancellation. Of those who have succeeded in finding jobs in the industry, several have commented that during their job interviews they were told that they were recruited as a result of the particular company's experience with past graduates of our program. Apparently, our graduates are highly regarded at Boeing, Lockheed-Martin, Raytheon, JPL, and NASA, among others, and also at smaller companies throughout the country.

The students feel that the our faculty are overall good teachers and care about educating the students. In comparing them with peers in other departments, there is a feeling that our faculty are outstanding. The seniors generally feel that the department has prepared them very well for their careers. The program is considered to be very challenging, with a wide curriculum base in both requirements and electives.

In the surveys students have been open in providing their feedback concerning the program. Some of their concerns have been as follows: During the junior year the class workload is considered especially challenging, compared to what students had experienced as freshmen and sophomores. Another general comment in the past has been that the program is too focused on theory. However, this concern is typically lower in the senior year, during which the students are involved in more applied problems and capstone designs. The majority of students agreed that the design experiences during the Senior year are the highlight of their time in the program. The enthusiasm for the airplane design course has been somewhat stronger than for the space systems design course, because the airplane project project is much more hands-on oriented, i.e., the students not only design an aircraft but also build a scale model the flight vehicle, test it in the wind tunnel, and eventually test fly the final configuration. As a result of the expressed desire for more hands-on experiential learning, the junior-level laboratory course sequence was reconfigured this year, such that the spring quarter offering now involves independent group projects rather than set-piece experiments. The impact of this improvement should be discernible in next year's exit interviews, but the feedback so far has been very positive.

Surveys of Industry and Government Constituents, and Visiting Committee

The responses of the industry and government constituents and the Visiting Committee to our graduates' preparedness in the (a)-(k) outcomes are plotted in Figs. 4.5 and 4.6 for the current year. Not surprisingly, the average ratings in each category are somewhat lower than the students' perceptions but in each outcome the rating is above 3.0, thus meeting the expected level of attainment defined above. Note that the Visiting Committee's ratings are higher than those of industry and government.

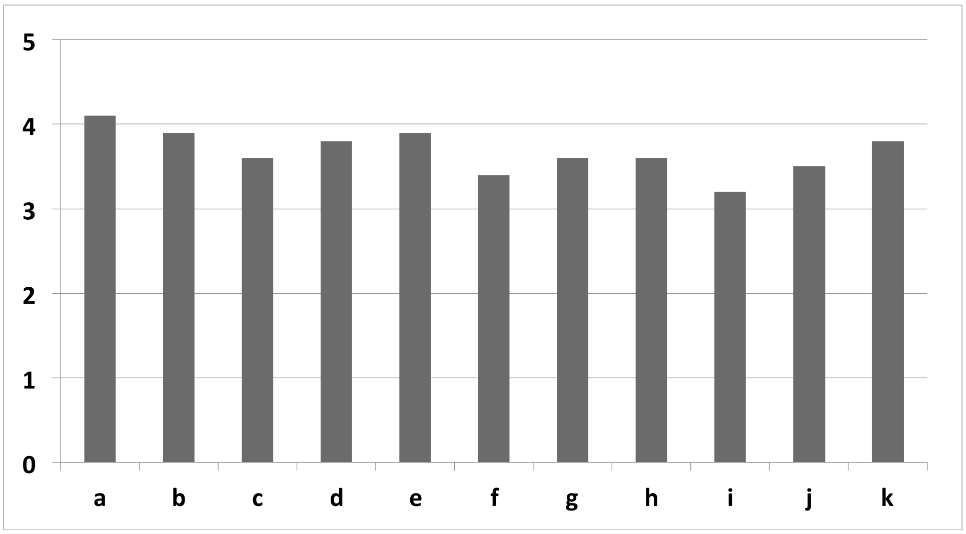

Fig. 4.5 Industry and Government constituents' assessment of the preparation of program graduates in the (a)-(k) student outcomes (2013).

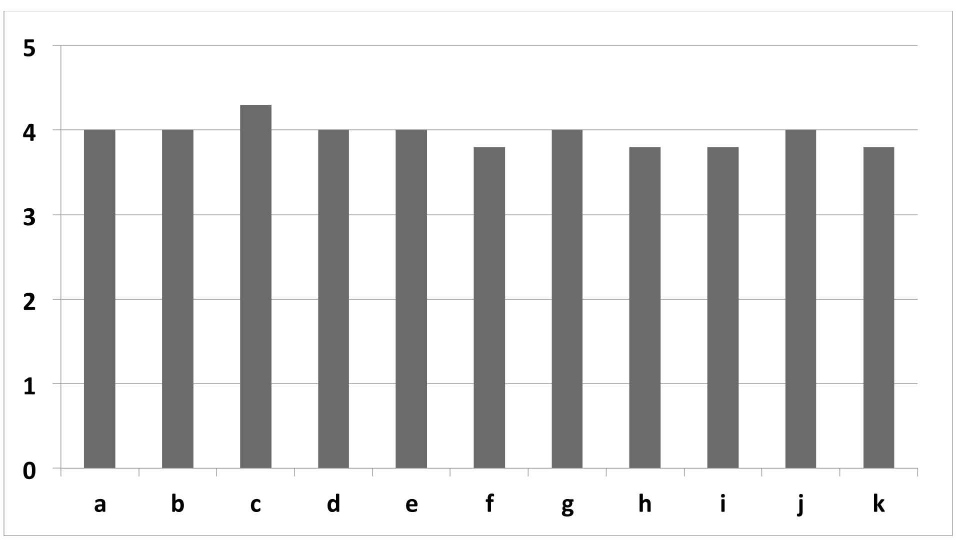

Fig. 4.6 Visiting Committee assessment of the preparation of program graduates in the (a)-(k) student outcomes (2013).

Some of the individuals in both groups surveyed commented on general issues important to them:

> *I think it should be a requiremetn that every student intern at at least one aerospace company in order to receive a degree. All other aspects being equal, our company will hire the new graduate with aero interning experience every time*
>
> *One of the areas of education and professional development of engineers (and college students in general) that we often observe is a limited ability to explain issues, factions, design, and principles how/why in multiple ways. This is something that is extremely valuable as a professional engineer...and as a member of society. While group projects are good, teaching to underclassmen or K-12 students would help foster such skills.*
>
> *Some fundamentals of business should be included as mandatory in the curriculum.*
>
> *All college students -- even engineering students -- should be expected to provide Service Learning opportunities with local K-12 students. That will help start and promote life-long learning and incentives.*

<u>Assessment of Individual Courses</u>

Faculty assessed the outcomes of the junior and senior courses they taught in spring quarter 2013, based on student performance in the final exams. The specific outcomes addressed are the ones listed for each course in the syllabi in Appendix B, specifically the categories labeled "Relationship to ABET Outcomes." The results are presented in the charts below. All these courses show a satisfactory attainment in each of the relevant outcomes.

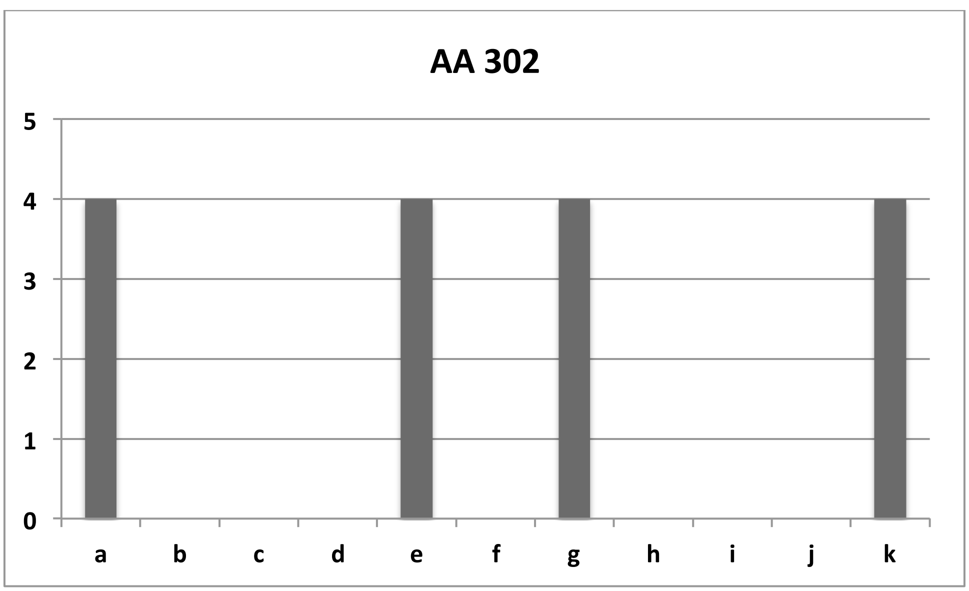

Fig. 4.7 Outcomes for AA 302, Incompressible Aerodynamics.

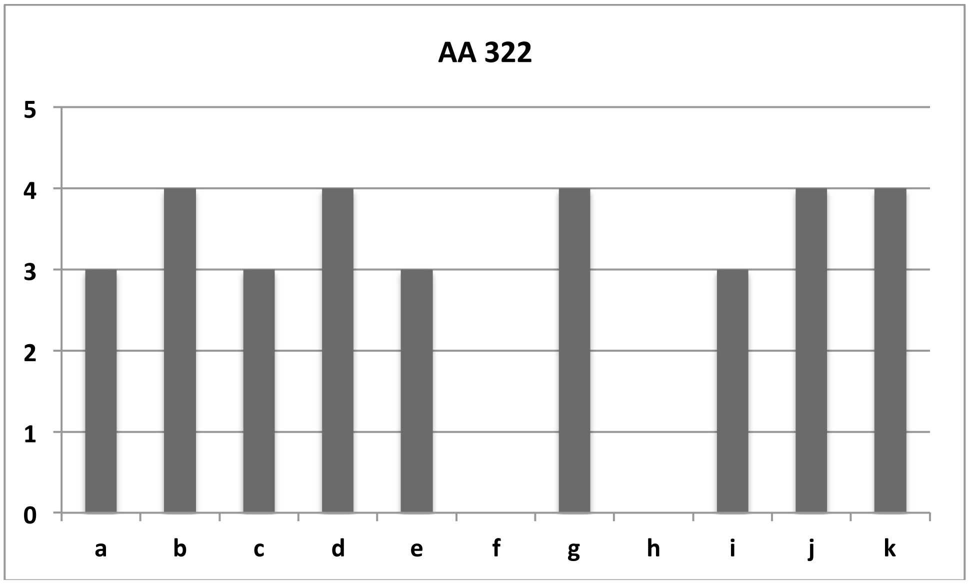

Fig. 4.8 Outcomes for AA 322, Aerospace Laboratory II.

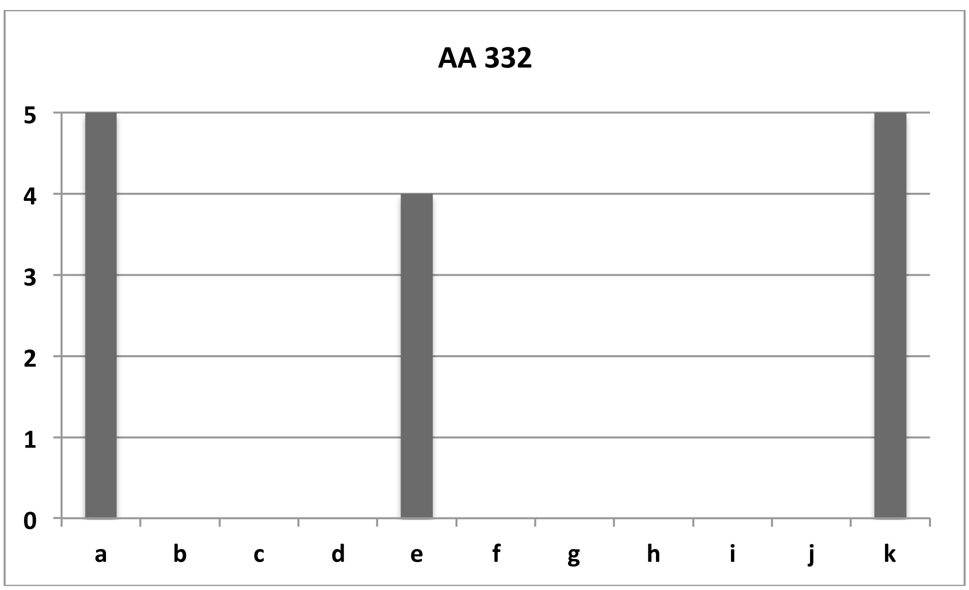

Fig. 4.9 Outcomes for AA 332, Aerospace Structures II

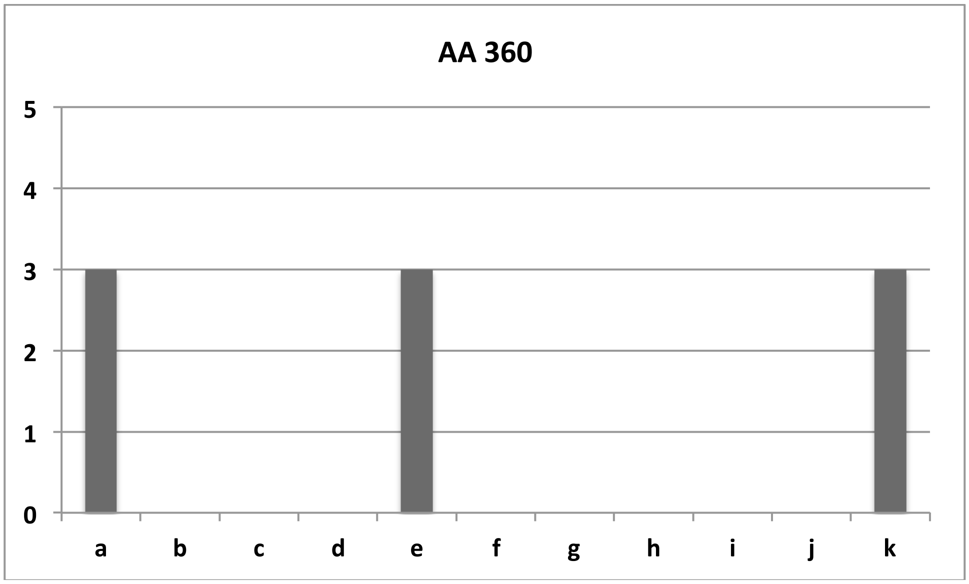

Fig. 4.10 Outcomes for AA 360, Propulsion

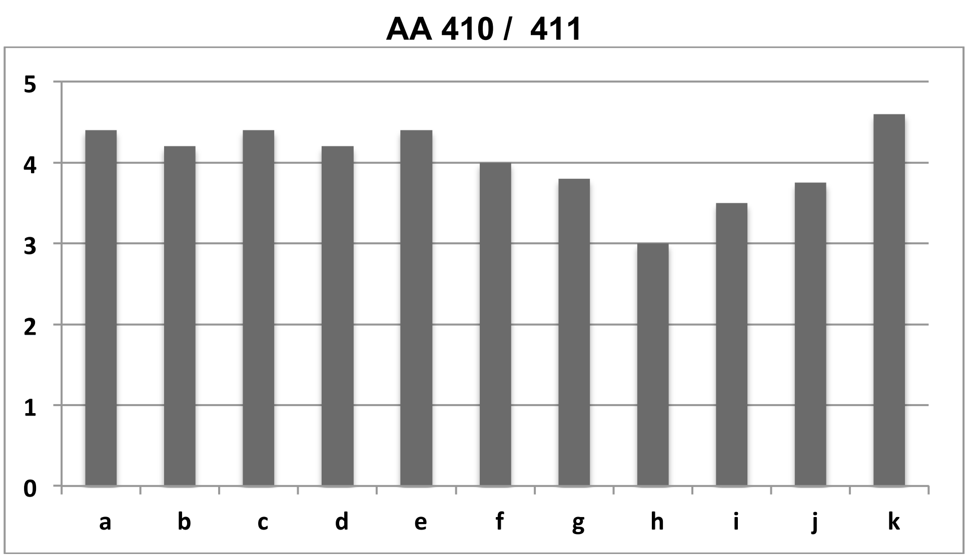

Fig. 4.11 Outcomes for AA 410 / 411, Aircraft Design I / II
(Note: These outcomes evaluated by guest industry representatives, based on final class presentation.)

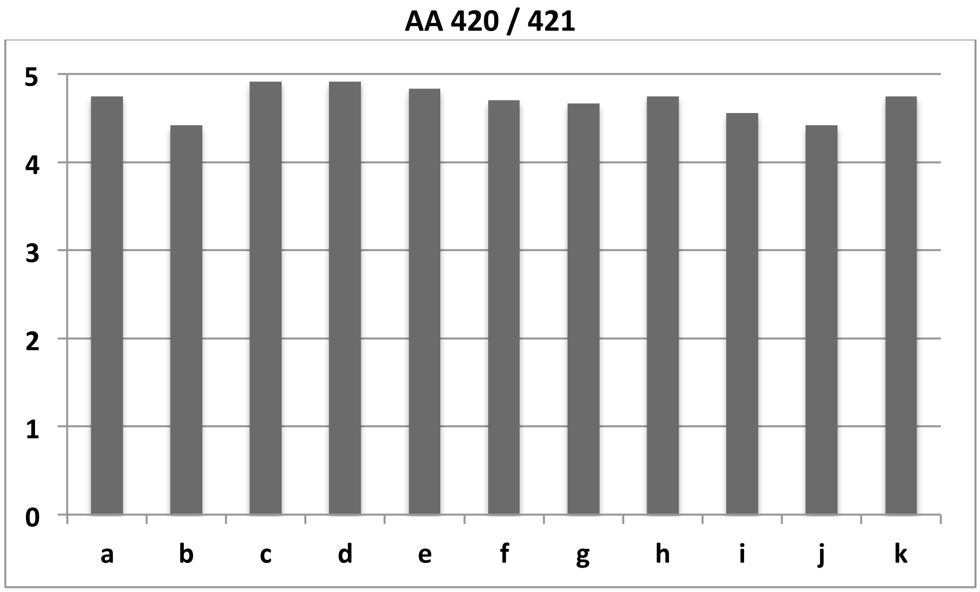

Fig. 4.12 Outcomes for AA 420 / 421, Spacecraft and Space Systems Design I / II (Note: Outcomes evaluated by guest faculty and students, based on final class presentation.)

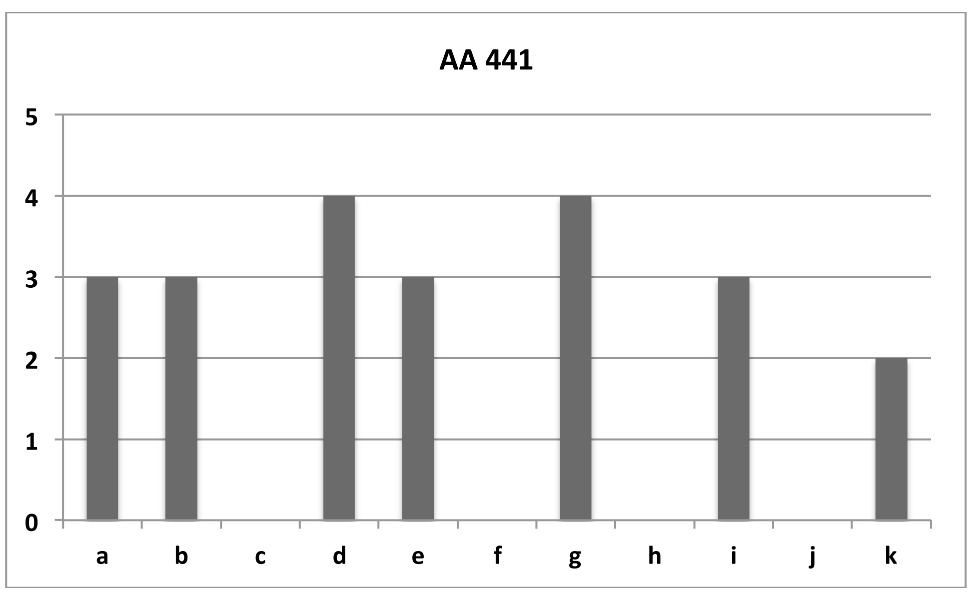

Fig. 4.13 Outcomes for AA 441, Flight Test Engineering.

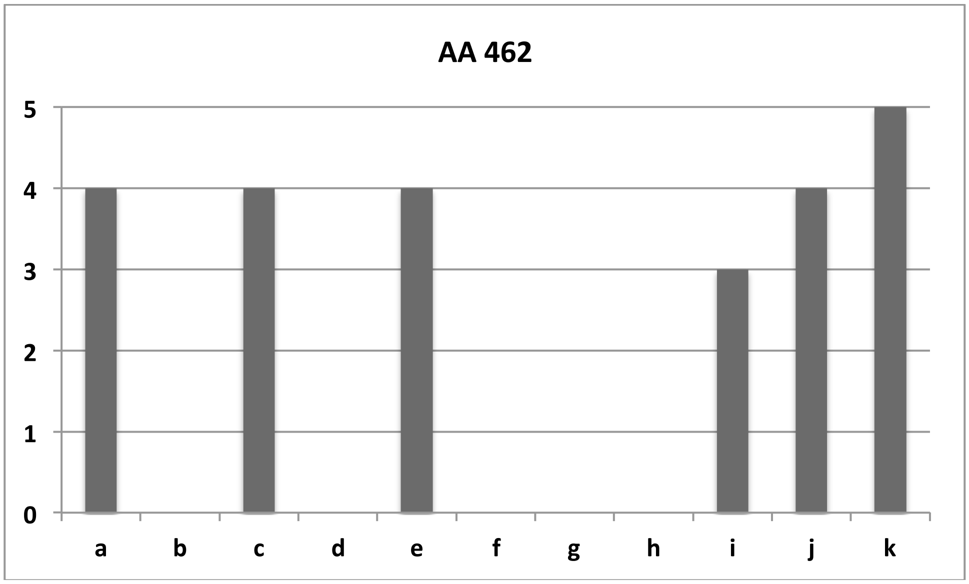

Fig. 4.14 Outcomes for AA 462, Rocket Propulsion

It must be kept in mind that the assessments of the (a)-(k) outcomes in all cases are subjective, as they reflect the opinions of the individuals who are doing the assessment. This is evident in the assessments of the outcomes related to the courses presented above, in particular in the junior 300-level courses. The student cohort whose (a)-(k) performance was evaluated is the same in each of the 300-level classes. What is different is the individual instructors, and their judgement of the outcomes.

Surveys by Office of Educational Assessment

The Office of Educational Assessment (OEA) at the University of Washington biennially surveys alumni one year after graduation. The survey instruments have been used since 1978 and have evolved to address educational outcomes and employment information. Because the questions asked by OEA were developed independently and prior to ABET EC2000 outcomes, the questions do not map identically to ABET-suggested student outcomes. The OEA questions are designed for all University alumni; hence, the questions tend to be more general than desired for an engineering program. However, the mapping of the OEA questions to the student outcomes is quite completeas can be seen in Table 4.1.

The results of the Office of Educational Assessment surveys for 2009 and 2011 are presented in Table 4.2. The data are the average values given by the graduates one year after graduating from the Program. The values represent the answer to “How satisfied are you with the University of Washington’s contribution to your academic and/or personal growth in the each of the following areas?” The possible responses are: 1 (Not at all), 2 (Little), 3 (Somewhat), 4 (Mostly), 5 (Very).

Statistically, the number of returns from the alumni survey is usually low, around 20%-30%. In 2009 it was 29% and in 2011 it was 18%, but these figures are higher than for the College of Engineering as a whole. However, a general trend can be seen in the consistently high scores in the technical, scientific, and engineering categories. Consistently low scores in the categories of liberal arts are noted in general for engineering students as a whole, which is not surprising.

Table 4.1 Mapping of Office of Educational Assessment outcomes to Student Outcomes.

OEA Outcomes	**ABET Suggested Outcomes**										
	(a)	**(b)**	**(c)**	**(d)**	**(e)**	**(f)**	**(g)**	**(h)**	**(i)**	**(j)**	**(k)**
Writing effectively							●				
Speaking effectively					●		●				
Critically analyzing written information					●				●		
Defining and solving problems					●						
Working and/or learning independently									●		
Working cooperatively in a group				●							
Using a foreign language							●		●		
Understanding and appreciating the arts								●			
Understanding and applying scientific principles and methods	●	●	●								
Understanding and applying quantitative principles and methods	●	●	●								
Understanding and appreciating diverse philosophies and cultures								●		●	
Understanding the interaction of society and the environment								●			
Working effectively with modern tech especially computers											●
Locating information needed to make decision or solve problem										●	●
Using the knowledge, ideas or perspectives gained from major field	●	●	●						●		
Using knowledge gained from outside of your major field								●			
Using management or leadership capabilities						●		●			
Recognizing your rights, responsibilities, and privileges as citizen						●		●			

Table 4.2 Results from the Office of Educational Assessment surveys.

OEA Outcomes	Graduation Year	
	2009*	2011†
Writing effectively	3.91	4.00
Speaking effectively	3.45	3.13
Critically analyzing written information	3.91	3.88
Defining and solving problems	4.11	4.38
Working and/or learning independently	3.80	4.25
Working cooperatively in a group	3.78	3.88
Using a foreign language	1.56	1.5
Understanding and appreciating the arts	2.67	2.13
Understanding and applying scientific principles and methods	4.1	4.71
Understanding and applying quantitative principles and	4.0	4.50
Understanding and appreciating diverse philosophies and	3.33	2.63
Understanding the interaction of society and the environment	3.00	3.00
Working effectively with modern tech., especially computers	4.20	4.75
Locating information needed to make decision or solve	3.70	4.50
Using knowledge, ideas or perspectives gained from major	3.90	4.50
Using knowledge, ideas or perspectives gained from outside	3.22	3.63
Using management or leadership capabilities	3.44	3.50
Recognizing your rights, responsibilities, and privileges as	3.33	3.75

* Response rate: 29%
† Response rate: 18%

4.A.5. Documentation and Maintenance of Results

The results of our assessments are documented, archived, and maintained by the Undergraduate Program Manager, and shared with the chair of the Undergraduate Program Committee, the Committee members, and the department chair. All faculty also have access to the data.

B. Continuous Improvement

The various evaluation processes have shown that the program does a good job in meeting the ABET-suggested student outcomes (see previous section). The results of our surveys are systematically considered in the yearly discipline-specific faculty discussions mentioned in Section 4.A, by the Undergraduate Program Committee, and the faculty as a whole. From time-to-time, the formal, ABET-related evaluation processes lead to changes in the curriculum. Information gleaned from the informal assessment processes outlined in Section 4.A allow us to drill down to individual issues raised by students and faculty, and also from time to time lead to improvements to existing courses, changes in their scheduling, changes in instructor assignments, the elimination of some courses, and the development of new ones.

1) Specific Improvements

Prior to our previous ABET review in 2007, data from the surveys indicated that the students were not receiving adequate preparation in the use of engineering computer analysis software. As a direct result, the curriculum was changed to include AMATH 301, "Beginning Scientific Computing" as a required course, which replaced the formerly required CSE 142, Computer Programming I (a Java-oriented programming course that many students did not find useful). AMATH 301, which is MATLAB-based was expected to be helpful in providing students the ability to use MATLAB in solving engineering problems in their coursework. This course achieved some of its expected outcomes but increasing complaints from our students in recent years that the course was too theoretical and did not provide sufficient or useful instruction in MATLAB programming led us to meet with representatives from the Applied Mathematics department to convey the students' frustrations. It turned out that other programs from within the College of Engineering had raised similar issues. The overall result has been a complete overhaul of how AMATH 301 will be taught, beginning in the 2013-2014 academic year. A series of master lectures by the best instructors in the AMATH department will be recorded and made available to students for asynchronous viewing prior to each week's classes. In the classroom, instructors will work with students in workshop style, reviewing and emphasizing the material in the master lecture and guiding the students through in-class exercises.

Students and alumni have also expressed interest in instruction in computational fluid dynamics (CFD) software, such as STAR-CCM+ and other software, such as vortex lattice codes, and orbital mechanics software such as STK. (Instruction in the use of finite element codes, such as ANSYS, is already available through one of our senior courses, AA 430, Finite Element Analysis in Aerospace.) The desirability of giving our students instruction in the desired software is self-evident, but its implementation has been thwarted by the severe budget cuts that have dogged the program and the University since 2008.

Another improvement that is being considered in response to student feedback is to introduce instruction in the programming and use of LabVIEW, a very useful software package that is being used in an increasing number of the experiments featured in the junior-level Aerospace Laboratory course sequence and in independent projects.

Although our program had been offering AA 409, Computer Tools II, a course devoted to computer-aided design (CAD) using SolidEdge software, the severe budget cuts which began taking effect beginning in the 2008-2009 academic year, forced the department to stop offering this course (it had been taught by teaching assistants). In its stead, we began to strongly encourage students in the freshman and sophomore years to take ME 123, Introduction to Visualization and Computer-Aided Design, in the Mechanical Engineering department during their first two years in the College of Engineering. Many students have elected to do so prior to entering our department.

A new program course, AA 470, Systems Engineering was formally introduced in Autumn 2007, just prior to the last ABET site visit. The course was first taught in Winter 2007 on a trial basis, under the Special Topics course designation, AA 498A. It was so well received that the decision was made to permanently offer it. The course, which is joint-listed with Industrial Engineering, provides students an excellent primer on Systems Engineering, a very useful preparation for the ensuing capstone design courses and for those students who go on to careers in industry. Since its inception, the course has been taught by affiliate faculty from industry, in particular Boeing. The current instructor, who is herself systems engineer and program manager at the company, brings direct industry perspectives to the classroom, which is much appreciated by the students.

Some faculty have introduced group projects into their undergraduate classes to encourage more interactive learning. From time to time two or more faculty teaching different core courses have collaborated to develop projects that are common to their corresponding courses. New instructors, including postdocs and graduate students who teach, are encouraged to create non-graded pop quizzes to understand if the students are learning what they are expected to. This method benefits the new instructors and the students by bringing each party to the same level of expectations. There is much greater use of online tools now than ever before. In particular, lecture materials (lecture notes, homework, examples of worked problems, lab instruction sheets, etc.) are now routinely provided online and the use of online chat areas is encouraged for student problem-solving sessions.

Program Integration:

Several years ago the department sought the help of Center of Teaching and Learning's predecessor, CIDR, in obtaining feedback from Juniors and Seniors as to their experiences with the prerequisite mathematics courses Math 307 (Introduction to Differential Equations) and Math 308 (Matrix Algebra with Applications). The overall consensus was that these courses are helpful. However, a common complaint was that these courses tended to be too theoretical, with few practical applications; hence, making retention of the materials difficult. The Undergraduate Committee subsequently met with representatives of the Math department to discuss ways to improve problem-solving skills for engineering students taking these courses. This meeting led to improvements in how the relevant courses were taught, which led to increased student satisfaction. The Math department contacts our department from time to time to inquire about our satisfaction with their courses. In recent years we have had no specific complaints to report, other than the usual one of occasional dissatisfaction with a particular instructor's teaching style. For those students who wish to have even greater emphasis on engineering applications we have suggested they take AMATH 351 and AMATH 352, from the Applied Math department, in place of Math 307 and Math 308. In AMATH 351 and 352 numerical methods receive significant coverage, whereas in Math 307 and 308 they do not. However, few students have selected the AMATH option in recent years, largely because Math 307 and 308 have increased the emphasis on practical applications of the material presented to a satisfactory level.

Writing Credits:

One change (and improvement) to the program's curriculum was precipitated partly by events outside the control of this program, as well as by student feedback. Because of the severe budget cuts of the past five years, the technical writing service courses originally offered by the department of Human-Centered Design and Engineering (HCDE) were cancelled.[*] Accordingly, we compensated for this development by officially designating our junior-level Aerospace Laboratory courses (AA 320, 321, 322) as "W" or "writing" courses. (This means that in addition to technical credits, students also receive writing credits (a total of 9 credits in this case.) In order to make the course sequence worthy of the "W" designation, its report writing requirements were made significantly more stringent. Specifics are as follows:

AA 320 (Autumn): This is the first course in which students have to prepare formal lab reports. Although students typically do the experiments in groups of two or three, each one must submit his/her own report (of about 10 pages in length). At the beginning of the course the instructor posts a document called *Course Guidelines and Policies*, in which the required report structure and format are described in detail (these hew quite closely to AIAA manuscript requirements). The instructor also posts a scoring rubric for the labs for the TAs to follow. In class the better part of the first lecture is spent going over what is expected in the reports, and later in the quarter specific issues that come up are addressed as needed. The main emphasis in this quarter is on proper structure and format, figures, tables, appendices, etc., as well as the content. The students write a total of 9 reports.

Prior to the start of the quarter the instructor meets with the TAs to go over the report writing requirements and the scoring rubric. It is the TAs who read and grade the reports. The instructor samples a few at random throughout the quarter to see how the students are progressing, and takes corrective action as needed. The students do not submit draft reports, just final versions. In their grading, the TAs comment on format, content, and writing issues. Students who have questions about these issues consult the TAs, and occasionally the instructor. Over the duration of the quarter there is a marked improvement in the quality of the reports.

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[*] Recently, the College of Engineering reinstated one course in technical writing, HCDE 231, under its own new writing program, for which professional instructors will be hired, who will work under the supervision of the HCDE department. The Aeronautical and Astronautical Engineering program will not require this course but will recommend it. For details about the course and the COE writing program, please consult the COE.

AA 321 (Winter): At the beginning of the quarter the instructor reviews the report writing requirements with the class, and discusses any common issues that arose during Autumn quarter. The requirements are now even more stringent, and increased emphasis is placed on style, grammar, and conciseness, and the scoring rubric is expanded. In addition, students are required to now write an abstract for each report. However, the reports are now group efforts (typically each lab group consists of three to four students). The purpose of the group reports is to expose the students to a collaborative environment in which each one has to do an equal amount of work. The students in the group police themselves in this regard and review and edit each other's contributions before submitting the report for grading. Each week a different member of the group acts as the leader and editor-in-chief. Thus, throughout the quarter, each student gets at least two, sometimes three, stints at leading the group. The reports are typically 15-20 pages long, and the groups write 10 of them during the quarter.

AA 322 (Spring): Until this year (2013), Spring quarter was handled like Winter quarter but with the bar raised even higher. However, this year a major change was implemented, in this case driven directly by the students' desire for more hands-on experiences, namely independent projects by groups of 3-4 students.

At about the 5th week of Winter quarter, in the AA 321 class, 2-3-page proposals from the students were solicited for independent projects to carry out in AA 322 in Spring quarter. The students first had to form project groups (typically 3-4 students per group and had to seek faculty advisors for their specific proposed projects (the course instructor's role was as overall advisor). The instructor and TAs reviewed the proposals and then shared them with the appropriate advising faculty. Once the projects were approved, the student groups were required to submit a proposed budget, and the department's research engineer and instrument maker were consulted to line them up to help as necessary during spring quarter. During the spring, the groups were required submit weekly, one-page progress reports, a midterm interim report of about 15-20 pages, and a final report in AIAA manuscript format, about 20-30 pages long, at the end of the quarter. During the second half of the quarter each group made a formal 10-minute presentation in a conference-like environment attended by the faculty advisors and TAs. Throughout the quarter, report writing issues were addressed, and the instructor and the TAs met separately with each project group on a regular basis, to discuss project issues and progress, and various writing and presentation issues

By the time the students complete this "W" course sequence, they are capable of writing good-quality reports or papers for submission to conferences, such as the AIAA Region VI Student Conference, or to a professional conference with their advisor (if they are conducting independent research under faculty supervision). The report-writing skills they acquire in the course of the AA 320-322 sequence are of great help for the reports the students will write for their capstone design courses as seniors, and for reports, papers, and proposals they will have to write once they are employed. This experience significantly strengthens student outcome (g).

The only caveat to the above approach to satisfying the UW requirement for writing credits is the quality of the TAs, namely their own writing and critical reading skills. It is well-known that international graduate students are generally weak in their verbal and writing skills; thus, a recommendation has been made to the department's chair and the Graduate Committee that prospective TAs for the junior-level laboratory course sequence undergo specific training in writing and critical reading skills. (See below for other TA training requirements.)

Teaching Assistants:

A frequent issue raised by our undergraduates over the years has been the occasionally spotty quality of the teaching assistants (TAs) assigned to the program's core courses. The UW has long offered a TA workshop prior to the beginning of the academic year but the department ultimately deemed this training to be insufficient to ensure the quality of our TAs. Accordingly, since our last ABET review we have initiated our own TA training program, which is also held prior to the start of the school year. In addition, faculty teaching core undergraduate courses have been given a greater say in the selection of TAs for these courses. The TAs are also trained for the individual classes by the course instructor, are given job descriptions, and are evaluated at the end of each academic quarter, as well as four weeks into each quarter.

Postdocs and senior graduate students in the department have, from time-to-time, taught some service courses (e.g., AA 210, Statics and AA 260, Thermodynamics) and occasionally junior-level core courses (e.g., AA 311, Introduction to Flight Mechanics) or even the senior-level controls course, with good success. Peer mentors, as well as senior faculty members, are made available for guidance to those postdocs and graduate students who have not previously taught. All instructors (faculty, postdocs, and graduate students) are given the opportunity to participate in teaching symposia, to receive CELT consultations, and younger faculty are mentored by senior faculty.

Future Program Improvement Plans:

Based on the evaluations of the past several years, improvements that are planned include the offering of an undergraduate course in Computational Fluid Dynamics, beginning in winter quarter 2015; the inclusion of instruction in the use of LabVIEW in the junior-level laboratory course sequence, beginning in the 2013-2014 academic year; the inclusion of more project-based activities in the core courses and project collaborations across courses at the junior level (e.g., aerodynamics and aerospace structures); and general, minor improvements to other courses. The rationale for these improvements is the consistent demand for them not only from the students themselves but also from our external constituents, particularly industry and government.

C. Additional Information

Additional information will be available at the time of the visit.

CRITERION 5. CURRICULUM

A. Program Curriculum

The program curriculum is presented in Table 5.1.1–5.1.4 on the following pages. For the convenience of the reader, each year of the curriculum is shown in a separate table.

5.A.2 Alignment of Curriculum with Program Educational Objectives

The curriculum aligns with the program education objectives through the structure of the prerequisites and the core curriculum of the major, culminating in the capstone design sequences in the senior year. The sequences of courses required for the aeronautics and astronautics major build upon each other from the beginning of the freshman year, the students are introduced to problem-solving issues throughout the curriculum, and are encouraged to think creatively. Some courses, particularly the capstone design courses, involve team projects that focus on solving specific and more general design problems. This structure prepares the students to solve critical technical problems related to aerospace engineering, to devise innovative ways to develop and apply new technologies, and to participate in the identification and solution of problems facing society.

The curriculum is broad-based and covers many areas. The undergraduate degree encourages students to reach beyond what they have learned in the classroom. The capstone design courses frequently feature guest lecturers who present real-world problems that industry is facing, and discuss how these issues can be considered. The program also encourages students to be involved in undergraduate research activities that they can then apply toward their AA technical electives. This allows students to discover more about particular discipline areas and their relationship to the world at large. It also and influences their choices for continuous learning. In other words, the curriculum and research experience opens the eyes of students to see what lies beyond the classroom and to independently seek out more information, thus laying the foundation for lifelong learning.

(This space left intentionally blank.)

Table 5.1.1 Year 1

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 and SE	Subject Area (Credit Hours) Math & Basic Sciences	Engineering Topics Check if contains Significant Design	General education	Other	Last Two Terms the Course was Offered: Year and Semester or Quarter	Maximum Section Enrollment for the last two terms the course was offered.
MATH 124 Calculus I	R	5				W, Sp 2013	Various
CHEM 142 Gen. Chemistry & Lab	R	5				W, Sp 2013	Various
General Elective - VLPA or I & S	SE			5		W, Sp 2013	Various
MATH 125 Calculus II	R	5				W, Sp 2013	Various
ENGL 131 English Comp or Equivalent	R			5		W, Sp 2013	Various
General Elective – Natural World	SE	5				W, Sp 2013	Various
Free Elective (AA 496)	E			1		W, Sp 2013	Various
MATH 126 Calculus III	R	5				W, Sp 2013	Various
PHYS 121 Mechanics & Lab	R	5				W, Sp 2013	Various
Free Elective (ESS 495 recommended)	E			1		W, Sp 2013	Various
General Elective - VLPA or I & S	SE			4		W, Sp 2013	Various

Table 5.1.2 Year 2

		Subject Area (Credit Hours)					
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 and SE	Math & Basic Sciences	Engineering Topics Check if contains Significant Design	General education	Other	Last Two Terms the Course was Offered: Year and Semester or Quarter	Maximum Section Enrollment for the last two terms the course was offered.
MATH 307 Differential Equations	R	3				W, Sp 2013	Various
AA 210 Statics	R		4			Au-12, W-13	195
PHYS 122 Electromagnetic & Lab	R	5				W, Sp 2013	Various
Free Elective	E			1		W, Sp 2013	Various
General Elective - VLPA or I & S	SE			3		W, Sp 2013	Various
MATH 308 Matric Algebra	R	3				W, Sp 2013	Various
M E 230 Dynamics	R		4			W, Sp 2013	Various
PHYS 123 Waves & Lab	R	5				W, Sp 2013	Various
AMATH 301 Beg. Sci. Computing	R		4			W, Sp 2013	Various
CEE 220 Mech. Of Materials	R		4			W, Sp 2013	Various
AA 260 Thermodynamics	R		4			Su-12, Sp13	140
Free Elective	E			3		W, Sp 2013	Various
General Elective - VLPA or I & S	SE			2		W, Sp 2013	Various

Table 5.1.3 Year 3

		Subject Area (Credit Hours)					
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 and SE	Math & Basic Sciences	Engineering Topics Check if contains Significant Design	General education	Other	Last Two Terms the Course was Offered: Year and Semester or Quarter	Maximum Section Enrollment for the last two terms the course was offered.
AA 310 Space Flight Mechanics	R		4			Au-12, Au-11	64
AA 311 Atmos. Flight Mechanics	R		4			Au-12, Au-11	64
AA 320 Aerospace Instruments	R		3			Au-12, Au-11	64
MATH 324 Adv. Multivariable Calculus	R	3				W, Sp 2013	Various
AA 301 Comp. Aerodynamics	R		4			W-13, W-12	62
AA 312 Structural Vibrations	R		4			W-13, W-12	62
AA 321 Aerospace Lab I	R		3			W-13, W-12	61
AA 331 Aerospace Structures I	R		4			W-13, W-12	61
AA 496 Undergraduate Seminar	R		1			W-13, W-12	136
AA 302 Incompressible Aerodynamics	R		4✓			Sp-13, Sp-12	61
AA 322 Aerospace Lab II	R		3✓			Sp-13, Sp-12	61
AA 332 Aerospace Structures II	R		4			Sp-13, Sp-12	61
AA 360 Propulsion	R		4			Sp-13, Sp-12	61

Table 5.1.4 Year 4

		Subject Area (Credit Hours)					
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 and SE	Math & Basic Sciences	Engineering Topics Check if contains Significant Design	General education	Other	Last Two Terms the Course was Offered: Year and Semester, or Quarter	Maximum Section Enrollment for the last two terms the course was offered.
AA 447, Control Aerospace System	R		4			Au-12, Au-11	65
AA 402, Fluid Mechanics	SE		3			Au-12, Au-11	31
AA 405, Introduction to Aerospace Plasmas	SE		3			Au-12, Au-11	24
AA 430, Finite Element Analysis in Aerospace	SE		3			Au-12, Au-11	34
AA 461, Advanced Air Breathing Propulsion	SE		3			Au-12, Au-11	52
AA 470, System Engineering	SE		3			Au-12, Au-11	17
Free Elective	E			5		W, Sp 2013	Various
AA 410, Aircraft Design I (or AA 420)	R		4✓			W-13, W-12	34
AA 420, Spacecraft and Space Systems Design I (or AA 410)	R		4✓			W-13, W-12	23
AA 400, Gas Dynamics	SE		3			W-13, W-12	14
AA 419, Aerospace Heat Transfer	SE		3			W-13, W-12	21
AA 432, Composite Materials for Aerospace Structures	SE		3			W-13, W-12	22
AA 440, Flight Mechanics I	SE		3			W-13, W-12	29
AA 448, Control Systems Sensors and Actuators	SE		3✓			W-13, W-12	28
General Elective - VLPA or I & S	SE			5		W, Sp 2013	Various

AA 411, Aircraft Design II (or AA421)	R		4✓			Sp-13, Sp-12	34
AA 421, Spacecraft and Space System Design II (or AA 411)	R		4✓			Sp-13, Sp-12	23
AA 441, Flight Test Engineering	SE		3			Sp-13, Sp-12	28
AA 462, Rocket Propulsion	SE		3			Sp-13, Sp-12	33
AA 449, Special Topics in Controls	SE		3			Sp-13, Sp-12	3
Free Elective	E			2		W, Sp 2013	Various
General Elective - VLPA or I & S	SE			5		W, Sp 2013	Various

TOTALS-ABET BASIC-LEVEL REQUIREMENTS		49	89	42			
OVERALL TOTAL CREDIT HOURS FOR COMPLETION OF THE PROGRAM	180						
PERCENT OF TOTAL		27%	49%	23%			
Total must satisfy either credit hours or percentage	Minimum Semester Credit Hours	32 Hours	48 Hours				
	Minimum Percentage	25%	37.5 %				

5.A.3 How the Curriculum Supports Student Outcomes

The program's curriculum is summarized in Table 5.2. The prerequisites build upon each other from the very beginning. The first year consists of mathematics and basic sciences, balanced by general education requirements. The second year the upper division mathematical courses are introduced, along with the specified engineering fundamental courses, and remaining natural sciences courses, and are balanced again with free electives. All these prerequisites make up the foundation upon which the aeronautical and astronautical engineering major is built, and constitute the requirements for application to the department. These courses provide the solid foundations necessary for the students to be able to be successful in the junior year program courses.

This structure provides the students skills in mathematics, science, and engineering fundamentals during the first two years, which prepare them to work in teams and apply the fundamentals of engineering to solve problems in their discipline. Those who have already been involved in undergraduate research have the ability to conduct experiments, analyze and interpret data, work as part of a team and would have learned about the professional and ethical responsibilities necessary to be part of a research team. Those not involved in research during the first two years have the opportunity to join a research program in their junior and senior years. All students must take the three-course laboratory sequence during their junior year.

Table 5.3 on the page following Table 5.2, shows how the program courses map to the student outcomes. (Table 5.3 is the same as Table 4.13 shown in Criterion 4.)

(This space left intentionally blank; Table 5.2 follows.)

Table 5.2

DEPARTMENT OF AERONAUTICS AND ASTRONAUTICS

4 Year Sample Schedule 11-12

Autumn Quarter		Winter Quarter		Spring Quarter	
MATH 124 Calculus I	**$5^{1\&2}$**	**MATH 125 Calculus II**	**$5^{1\&2}$**	**MATH 126 Calculus III**	**$5^{1\&2}$**
CHEM 142 Gen. Chem & Lab	**$5^{1\&2}$**	CHEM 152^ Gen. Chem & Lab	5^{2}	**PHYS 121 Mechanics & Lab**	**$5^{1\&2}$**
ENGL 131 English Comp. or Equiv+	**5^{2}**	**or NW Alternative**	5^{1}	VLPA or I & S	4^{1}-3^{2}
Or VLPA or I & S	5^{1}	**ENGL 131 English Comp or Equiv**	**5^{1}**	Free Elective (ESS 495)	$1^{1\&2}$
		Or VLPA or I & S	5^{2}		
		Free Elective (AA 496)	$1^{1\&2}$		
QUARTER TOTAL	**$15^{1\&2}$**	**QUARTER TOTAL**	**$16^{1\&2}$**	**QUARTER TOTAL**	**15^{1}-14^{2}**

Autumn Quarter		Winter Quarter		Spring Quarter	
MATH 307 Differential Equations	**$3^{1\&2}$**	**MATH 308 Matrix Algebra w/Apl.**	**$3^{1\&2}$**	**CEE 220 Mech. of Materials**	**$4^{1\&2}$**
AA 210 Statics	**$4^{1\&2}$**	**ME 230 Dynamics**	**$4^{1\&2}$**	**AA 260 Thermodynamics**	**$4^{1\&2}$**
PHYS 122 Electromag. & Lab	**$5^{1\&2}$**	**PHYS 123 Waves & Lab**	**$5^{1\&2}$**	VLPA or I&S	2^{1}-3^{2}
VLPA or I & S	$3^{1\&2}$	*AMATH 301 Beg. Sci. Computing*	4^{1}	Free Elective.	3^{1}-1^{2}
Free Elective	$1^{1\&2}$	Or Free Elective	3^{2}	or MATH 324	3^{2}
QUARTER TOTAL	**16^{1}-16^{2}**	**QUARTER TOTAL**	**16^{1}-15^{2}**	**QUARTER TOTAL**	**13^{1}-15^{2}**

Autumn Quarter		Winter Quarter		Spring Quarter	
AA 310 Space Flight Mechanics	4#	AA 301 Comp. Aerodynamics	4	AA 302 Incompr. Aerodynamics	4
AA 311 Atmos. Flight Mechanics	4#	AA 312 Structural Vibrations	4	AA 322 Aerospace Lab II	3
AA 320 Aerospace Instruments	3#	AA 321 Aerospace Lab I	3	AA 332 Aerospace Structures II	4
MATH 324 Adv. Multiv. Calc. I <	3^{1}	AA 331 Aerospace Structures I	4	AA 360 Propulsion	4
and/or		AA 496 Undergraduate Seminar	1		
AMATH 301 Beg. Sci. Computing<	4^{2}-$0^{1\&2}$				
QUARTER TOTAL	**14^{1}-15^{2}-11#**	**QUARTER TOTAL**	**$16^{1\&2}$**	**QUARTER TOTAL**	**$15^{1\&2}$**

Autumn Quarter		Winter Quarter		Spring Quarter	
AA 447 Control Aerospace Systems	4	*AA 410 or 420-Integrated Design I*	4	*AA 411or 421-Integrated Design II*	4
Technical Elective	3	Technical Elective	3	Technical Elective	3
(AA 402,405,430,461, 470*)		(AA 400,419,432,440,448)		(AA 441*,462,449 *)	
Technical Elective	3	Technical Elective	3	VLPA or I & S	$5^{1\&2}$
VLPA or I & S or	5^{2}	VLPA or I & S	5^{1}	or Free Elective	2^{1}-3^{2}
or Free Elective	5^{1}	or Free Electives	3^{2}		
QUARTER TOTAL	**15^{1}-15^{2}**	**QUARTER TOTAL**	**15^{1}-13^{2}**	**QUARTER TOTAL**	**14^{1}-15^{2}**

Courses shown in **BOLD during the first two years** are required in order to be considered for admission and the grades will be used in the calculation of the technical grade point average. It is recommended that either Math 324 or AMATH 301 be completed before the autumn quarter to decrease the number of credits required for the first quarter in the department. Courses shown in *italics* are required during the senior year. Please check with the department advisor if problems arise in which you find you are unable to fulfill these requirements. Exceptions are granted to the admissions requirement on a case per case basis.

It is expected that you complete a minimum of 14 credits of Visual, Literary and Performing Arts and Individuals and Societies courses during the first two years. The number of credits in each quarter will vary depending on which path to complete them. The free electives needed to graduate depend upon whether nor not your take courses that may be recommended but, not required.

^ If you are considering other engineering programs CHEM 152 is probably a good choice although it's not required for AA.

\+ English Composition is not available during autumn quarter unless you are enrolled in a FIG. (Freshman Interest Group)

< Math 324 and AMATH 301 may be taken as late as the autumn quarter of admission but, taking both will create an extremely heavy course load on top of the departments 11 credits. It is recommended that one or both be completed before starting the departmental program.

\# If both MATH 324 and AMATH 301 have been completed prior to Autumn quarter plan on taking an additional course to maintain your full time student status which requires 12 credits.

* AA technical electives that may not be offered every year.

Table 5.3 Mapping of program courses to student outcomes

Course	a	b	c	d	e	f	g	h	i	j	k	Required
AA 198	●							●	●	●		N
AA 210	●				●						●	Y
AA 260	●				●						●	Y
AA 299	●	●	●	●	●	●	●	●	●	●	●	N
AA 301	●				●						●	Y
AA 302	●		●		●						●	Y
AA 310	●				●						●	Y
AA 311	●				●						●	Y
AA 312	●				●						●	Y
AA 320	●	●			●		●				●	Y
AA 321	●	●			●		●				●	Y
AA 322	●	●	●	●	●		●		●	●	●	Y
AA 331	●				●						●	Y
AA 332	●				●						●	Y
AA 360	●				●						●	Y
AA 400	●				●				●		●	N
AA 402	●				●				●		●	N
AA 405	●	●			●				●		●	N
AA 410	●	●	●	●	●	●	●	●	●	●	●	Y*
AA 411	●	●	●	●	●	●	●	●	●	●	●	Y*
AA 419	●				●		●				●	N
AA 420	●	●	●	●	●	●	●	●	●	●	●	Y*
AA 421	●	●	●	●	●	●	●	●	●	●	●	Y*
AA 430	●		●		●				●		●	N
AA 432	●				●				●		●	N
AA 440	●				●		●		●		●	N
AA 441	●	●			●		●		●		●	N
AA 447	●		●		●				●		●	Y
AA 448	●	●	●	●	●				●		●	N
AA 449								●	●	●		N
AA 461	●		●		●				●		●	N
AA 462	●		●		●				●	●	●	N
AA 470	●		●		●		●	●	●	●	●	N
AA 480	●				●				●		●	N
AA 496						●			●	●		N
AA 498												N†
AA 499	●	●	●	●	●	●	●	●	●	●	●	N

* Students are required to take either AA 410 & 411 or AA 420 & 421.
† Outcomes vary, depending on topic.

5.A.4 Prerequisite Structure of Program's Required Courses

The structure of the program's prerequisite courses is shown in Table 5.4 below. The courses in italic font are the ones on which Early Admission students are evaluated (see Criterion 1 Table 1.1, *et seq.*).

Table 5.4 Prerequisites for the program's required courses

MATH 124, Calculus I	*CHEM 142, Chemistry I*	AMATH 301, Scientific Computing*
MATH 125, Calculus II	*PHYS 121, Mechanics & Lab*	AA 210, Statics
MATH 126, Calculus III	PHYS 122, Electricity & Magnetism & Lab	CEE 220, Mechanics of Materials
MATH 307, Differential Equations	PHYS 123, Waves & Lab	ME 230, Dynamics
MATH 308, Linear Analysis	*ENGL, Composition*	AA 260, Thermodynamics
MATH 324, Advanced Multivariable Calculus*		

*Must be taken prior to or not later than Autumn quarter of admission

5.A.5 How Program Meets Requirements for Each Subject Area

All students in the program must complete a minimum of 38 quarter credits of college level mathematics and natural sciences, as designated by the College of Engineering. An additional 11 credits must be completed by the students in the area of natural science and mathematics as designated by the department, for a total of 49 quarter credits total for both areas, which represents, effectively, a little over a year of study. Most of these courses must be taken before upper-division admission to the Department. Laboratory experience is guaranteed through three required Physics courses, that have accompanying labs (Physics 121, 122 and 123, and the required Chemistry course (Chem 142), which also has a laboratory. The breakdown can be seen in Table 5.1.

All department students meet the program criteria for aeronautical engineering. This is demonstrated by completion of the following required courses (or their equivalents) with a grade of 2.0 or better: aerodynamics (AA 301, AA 302), structures (AA 331, AA 332), propulsion (AA 360), flight mechanics (AA 311), and stability and control (AA 447). Aerospace materials is covered in the strength-of-materials course (CE 220), the structures sequence just mentioned, by at least one lecture and laboratory in first aerospace laboratory course (AA 321), and usually in topics brought up in the Undergraduate seminar (AA 496), which all juniors must take. These courses are required of all department students.

All department students satisfy the program criteria for astronautical engineering. Where possible, required department classes include material from both aeronautical and astronautical engineering, and faculty make special effort to discuss examples and assign problems from both areas. Thus, the topic of attitude determination and control appears in the following courses: Orbital Mechanics (AA 310), Flight Mechanics (AA 440), and Controls in Aerospace Systems (AA 447), space structures appears in the structures courses (AA 331, AA 332), and rocket propulsion in the propulsion course (AA 360). All students must take orbital mechanics (AA 310). The space environment is covered in the following courses: Gas Dynamics (AA 400), Heat Transfer (AA 419), and Plasma Dynamics (AA 405), and is also covered in the capstone Spacecraft and Space Systems design course (AA 420, AA 421) and in the undergraduate seminar (AA 496). Similarly, telecommunications is covered in AA 420 and AA 421, and also AA 496. Space propulsion is further covered in Rocket Propulsion, AA 462.

In their senior year students must select a capstone design course sequence in either aircraft design (AA 410 and AA 411) or spacecraft and space system design (AA 420 and AA 421). These courses provide extensive design experience, and integrate most of the material the students have already learned in the other courses.

5.A.6 Major Design Experiences

All students in the department must choose a capstone design course in order to graduate. They must select either AA 410-AA 411, Airplane Design or AA 420-AA 421, Spacecraft and Space Systems Design. These courses are offered during the winter and spring quarters of the senior year.

In order to complete these intense two-quarter design sequences, a student must have the accumulated knowledge of two years of engineering topics. This consists of 16 quarter credits of engineering fundamentals and 58 credits of departmental required courses. In addition, 15 credits of department technical electives are required to be completed over the three academic quarters of the senior year. During two of these quarters students concurrently take one of the two capstone design courses. Students typically choose some of their technical electives based on which design sequence they are taking. Each design group is separated into teams that are responsible for different aspects of the project.

In order to be admitted to the program students must have completed two years of engineering topics, as shown on Table 5.2. The common junior year courses in the major address the engineering sciences fundamental to aerospace engineering. Some design content appears through lectures and assignments with open-ended content. An example is when an engineering objective is posed for which there maybe a number of valid solutions, and the compromise involved in choosing one is discussed or worked on. In addition, some courses, such as AA 302, Incompressible Aerodynamics, include specific design projects that require oral and written reports. This process culminates in the winter quarter of the senior year, when the students must begin either the aircraft design or spacecraft and space systems design sequence (AA 410 and AA 411 or AA 420 and AA 421).

By the start of the capstone design experience there has been sufficient preparation in engineering fundamentals to allow a meaningful integrated design experience on an overall aerospace system. The students are usually split into groups that pursue different aspects of a design and report back to the class. Five formal contact hours per week assures sufficient time with the instructor to accomplish class objectives and student outcomes, but considerable time is devoted by the instructors to the students outside the classroom, as well. Students are encouraged to think about the real world in which their design must function. While the emphasis, of necessity, is on engineering, other issues such as economic reality, environmental constraints, manufacturability, safety, ethics, and social and political aspects are considered as well. These topics are also touched on in various other program classes. In particular, the undergraduate seminar (AA 496), addresses these topics.

It should be pointed out that both the airplane design sequence and the spacecraft design sequence are nationally recognized for their quality. The airplane design sequence provides a complete, integrated design experience that involves, design, construction, wind tunnel testing, and ultimately flight of a subscale aircraft that meets requirements developed in collaboration with industry (typically Boeing) or government (typically DARPA). The following is quoted directly from the conference paper on the course that was presented at the 50th AIAA Aerospace Sciences Meeting in Nashville, TN, in January 2012:

> *The capstone airplane design course at the University of Washington, two academic quarters long, has evolved in recent years to cover the airplane design experience from market and needs studies through conceptual design, preliminary design, and detail design, and up to the construction, ground testing, and flight testing of complex research-type small UAVs. Significant engineering resources are devoted to this effort including substantial CAD, CFD-based aerodynamics, NASTRAN-based structural analysis, as well as performance, and stability and control simulations. Wind tunnel tests of commercial quality models at the University of Washington's Kirsten wind tunnel are carried out, plus structural static and modal tests, airframe / propulsion system integration tests, together with systems and system integration testing. An emphasis is placed on test / simulation correlation assessment and the development in students of the appreciation of alternative numerical / analytic modeling methods, their strengths and limitations, advantages and disadvantages. The course emphasizes teamwork, communication skills, leadership, initiative, and innovation. It runs with tight budget and schedule constraints which the students must meet. Each year a new design challenge is pursued leading to new and unique research UAVs. The program leverages the University's own wind tunnel labs, local flight test locations, and the availability of experienced mentors. Significant support from the Boeing Company and from Aeronautical Testing Service, Inc. (Arlington, Washington), allows the students access to, and interaction with, world class experts in the various areas airplane design has to* cover.

The space systems design sequence also provides the students with a very high quality design experience, covering not only the technical aspects of the design and the system integration but also emphasizing teamwork, communication skills, leadership, initiative, and innovation, and involves broader societal and ethics issues. The 2012 design team was invited to participate in NASA's RASC-AL* design competition at the Kennedy Space Center in Florida in June of last

* RASC-AL: Revolutionary Aerospace System Concepts – Academic Linkage

year, and won first prize in the undergraduate category. The topic of the design study was a lunar mining base and operation to mine platinum group and rare-earth elements, two substances in high demand on Earth. The following is quoted directly from an article in The Daily, the UW's student newspaper:

> *Most teams competing focused specifically on designing a habitat, but the UW's 2012 Space Systems Design Team went a step further. In addition to creating a sustainable settlement, the students created a detailed lunar mining concept to mine platinum group metals and rare Earth elements from the moon, two substances in high demand on Earth.*
>
> *Pushing its idea even further, the team's proposal included a David versus Goliath type slingshot that would catapult elements from the moon to land in the Pacific Ocean. Team lead Bryan Hopkins said the slingshot, used in place of a rocket engine, would be able to use alternative energy methods such as solar power.*
>
> *"It allows for giant savings in fuel," he said.*
>
> *Other parts of the proposal were also outlined with cost savings in mind.*
>
> *The UW team's paper included a description of a fully reusable single-stage-to-orbit vehicle, plans to rent out research space at its lunar outpost, and a reusable lunar lander. In addition, under the team's proposal, profits from the platinum and rare Earth elements would serve to fund future space missions.*
>
> *"Other groups were focused on doing a science mission for NASA, and we were going to the moon to make a profit," team member Adam Hadaller said. "That was our entire goal."....*
>
> *"Students in the past would optimize to come up with the best technical solution, whereas students this year were taught, 'What does a customer want, and how do we best get there?'" faculty advisor Dana Andrews said. "In this case, we had to do it very low cost – in real life as an engineer, the lowest cost solution is often the right answer."*

As winners in the competition, the team was invited to presented its concept at the AIAA Space 2012 Conference in Pasadena, CA, in September 2012.

5.A.7 Co-operative Education

The College of Engineering's Co-Op Program gives students the opportunity to work in their field while earning credit at the same time. Students are eligible for Co-op if they have completed at least one academic quarter at UW, are matriculated and are enrolled full-time (12 credits for undergraduates), have a GPA of 2.5 or above at UW, and are currently enrolled in or have completed Math 126 and Physics 121 **or** Math 126 and Chemistry 142. There are requirements on employers, too.

Students in the Co-Op Program are registered by the course administrator in ENGR 321 while they are working. The quarter after the work period ends, students are registered in ENGR 322. Credit for both ENGR 321 & ENGR 322 is earned after requirements for both are completed. These requirements include a written Co-Op report and a post-work self-assessment report by the student, and a report from the employer. The grading scale is Credit/No Credit. Credits earned depend on hours worked. Full-time work earns two credits in ENGR 321; part-time work earns one credit per quarter.

Historically, very few students have opted to enroll for Co-Op because our program does not allow the Co-Op credits to count toward the 180 credits required for graduation. Because of this fact, there is no faculty involvement in the assignment of credit. Normally, a Co-Op requires six months to complete, which requires a participating student to extend his/her time to graduation by at least one academic quarter or possibly as long as one year, depending on when the student does the Co-Op. Instead of Co-Ops, students have typically opted for internships during the summer.

5.A.8 Materials Available for Review During ABET Visit

The materials available for review during the visit will be:

- Textbooks
- Examples of published class notes
- Examples of homework assignments and exams
- Examples of student work – homework, exams, project reports (high, medium, and low scores).

B. Course Syllabi

The course syllabi are presented in Appendix A.

CRITERION 6. FACULTY

A. Faculty Qualifications

All 17 faculty members (16 full-time and one part-time) in the Aeronautics & Astronautics department hold PhD degrees in an engineering discipline, with the majority of these in Aerospace (eight faculty) or Mechanical (two faculty) Engineering. Other PhD degrees held in the Department include Electrical Engineering and Physics, those degrees being directly relevant to aerospace controls and plasma physics, respectively. Leading engineering universities represented by the degrees of the faculty include Caltech, Princeton, MIT, UC Berkeley, Harvard, and Imperial College of London. Of the 17 faculty six (more than one third) have significant previous industrial or governmental experience as employees. Several other faculty have had, and currently have, substantial consulting relationships with aerospace industry.

The expertise of our faculty effectively covers all of the subject areas included in our undergraduate program, broadly categorized as being aerospace controls (two faculty), aerodynamics and aeropropulsion (six), plasma physics and space propulsion (five), and aerospace structures (four). All faculty members maintain currency in their respective fields by conducting related research, in many cases with industrial collaborators (these collaborations are particularly strong in controls and structures). All faculty take their substantial classroom teaching responsibilities seriously. Further, teaching is assigned equal weight with research in both the Department's and College's promotion and tenure processes.

All faculty are members of professional societies, including the American Institute of Aeronautics and Astronautics (AIAA), American Society of Mechanical Engineers (ASME), the American Physical Society (APS), the latter in both the division of Fluid Dynamics (CFD) and Plasma Physics (PPD), the Institute of Electrical and Electronics Engineers (IEEE), the Society for Industrial and Applied Mathematics (SIAM), the American Society for Engineering Education (ASEE), and others. Such membership in professional societies is typically aligned with the faculty members' teaching expertise, as well as being reflected by their discipline group within the Department. Eighteen percent of the faculty are fellows or associate fellows in professional societies, which serves as one indication of their accomplishments, expertise, and high level of involvement in aerospace engineering.

In addition, faculty act as advisors to the student chapters of the AIAA, our country's leading professional society for aerospace, and Sigma Gamma Tau, the national aerospace honor society. These societies and our interactions offer students leadership opportunities, outreach, outside speakers, and field trips. The Department Chair takes specific responsibility to ensure that each society is led by a qualified and active faculty member. The Department annually provides financial support for the student activities of these professional societies.

The Department has, among its many student project efforts, capstone senior design sequences in both aircraft and space systems design. These outstanding, award-winning programs are led by teams of faculty and visiting experts from the aerospace industry.

Table 6.1 summarizes the faculty qualifications.

Table 6-1. Faculty Qualifications

Aeronautics & Astronautics

Faculty Name	Highest Degree Earned- Field and Year	Rank[1]	Type of Academic Appointment[2] T, TT, NTT	FT or PT[3]	Years of Experience			Professional Registration/ Certification	Level of Activity[4] H, M, or L		
					Govt./Ind. Practice	Teaching	This Institution		Professional Organizations	Professional Development	Consulting/summer work in industry
Dana G. Andrews	PhD, A & A, 1974	L	NTT	PT	45	2	2		H	M	M
Robert Breidenthal	PhD, Aeronautics, 1979	P	T	FT		30	33		M	L	H
Adam P. Bruckner	PhD, Mechanical & Aerospace Engr., 1972	P	T	FT	N/A	41	41		M	L	L
Dana Dabiri	PhD, Aerospace Engr., 1992	ASC	T	FT		11	11		L	L	L
Antonino Ferrante	PhD, Mechanical & Aerospace Engr., 2004	AST	TT	FT		3	3		M	M	L
Raymond Golingo	PhD, Aeronautics and Astronautics, 2003	L	NTT	PT		3	10		L	M	L
James C. Hermanson	PhD, Aeronautics,	P	T	FT	9	20	13		L	M	L

	1985										
Keith Holsapple	PhD, Aeronautics & Astronautics, 1965	P	T	FT	3	48	48	PE	H	L	M
Carl Knowlen	PhD, Aero & Astro Engr., 1991	L	NTT	FT	25	13	13		L	M	L
Mitsuru Kurosaka	PhD, Mechanical Engineering, 1968	P	T	FT	12	36	26		L	H	L
Kuen Y. Lin	PhD, Aeronautics & Astronautics, 1977	P	T	FT	6	29	29		M	H	M
Eli Livne	PhD, Aerospace Engr., 1990	P	T	FT	10	23	23		H	L	H
Mehran Mesbahi	PhD, Electrical Engineering, 1996	P	T	FT	6	13	10	PE/EE	H)	(H)	4
Kristi Morgansen	PhD, Engineering Sciences, 1999	ASC	T	FT		13	10		H	L	L
Uri Shumlak	PhD, Nuclear Engineering, 1992	P	T	FT	4	14	18		H	M	M

1. Code: P = Professor ASC = Associate Professor AST = Assistant Professor I = Instructor A = Adjunct O = Other
2. Code: T = Tenured TT = Tenure Track NTT = Non Tenure Track
3. Code: FT = Full-time PT = Part-time Appointment 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.

B. Faculty Workload

The workload expectations for faculty involve the three categories of teaching, research, and service. The department chair conducts annual merit reviews of all faculty, as well as meets with them to discuss their future plans and goals. From the information gleaned in these processes, the chair makes the teaching appointments for the following academic year, also taking into account each faculty member's teaching history of the previous five years, their teaching preferences, and other factors, such as major service or research commitments.

For a faculty member who is engaged in productive, externally funded research, the normal teaching load is one course (undergraduate or graduate) each academic quarter, i.e., three courses per academic year. Faculty less engaged in research or service are typically assigned four or more courses per year, and some have on occasion taught as many as six per year. Faculty with significant service activities, such as the chairs of the undergraduate and graduate program committees, and the associate chair for research, are given release time from teaching that is also a function of the sizes of their research programs. The associate chair for research is granted one full quarter of release time, whereas the UPC and GPC chairs are considered to devote 0.25 FTE to these activities, thus somewhat lowering their teaching loads.

For merit and promotion and tenure reviews, the three categories of work are weighted as follows: Teaching, 40%; Research, 40%; Service, 20% (service includes both UW and external activities). However, in any given academic quarter or year, the actual workload distributions of the faculty are typically different, with teaching ranging from 20% to 50% and research from 10% to 80%, as can be seen in the following table. Some faculty have particularly heavy service assignments, while new young faculty have light service assignments; thus, service can range between zero and 80% (the latter figure applies to the department chair). The data presented in Table 6.2 document the information presented in this paragraph. (Note that only those faculty are listed who have taught undergraduate courses in at least one academic quarter.)

(This space left intentionally blank; Table 6.2 follows.)

Table 6-2. Faculty Workload Summary

Aeronautics & Astronautics

Faculty Member (name)	PT or FT[1]	Classes Taught (Course No./Credit Hrs.) Term and Year[2]	Program Activity Distribution[3]			% of Time Devoted to the Program[5]
			Teaching	Research or Scholarship	Other[4]	
Dana G. Andrews	PT	AA 420 / 4 cr, Wi 2013 AA 421 / 4 cr, Sp 2013	100%	0%	0%	100%
Robert Breidenthal	FT	AA 501 / 3 cr, Au 2012 AA 400 / 3 cr, Wi 2013 AA 441 / 3 cr, Sp 2013 AA 508 / 3 cr, Sp 2013	50%	40%	10%	100%
Adam P. Bruckner	FT	AA 320 / 3 cr, Au 2012 AA 321 / 3 cr, Wi 2013 AA 496 / 1 cr, Wi 2013 AA 322 / 3 cr, Sp 2013	50%	10%	40%	100%
Dana Dabiri	FT	AA 419 / 3 cr, Wi 2013 AA 507 / 3 cr, Wi 2013 AA 302 / 4 cr, Sp 2013	60%	30%	10%	100%
Antonino Ferrante	FT	AA 543 / 3 cr, Wi 2013 AA 544 / 3 cr, Sp 2013 AA 402 / 3 cr, Au 2012	30%	60%	10%	100%
Raymond Golingo	PT	AA 210 / 4 cr, Au 2012 AA 331 / 4 cr, Wi 2013 Phys 122 / 4 cr, Sp 2013	40%	60%		100%

James C. Hermanson	FT	AA 310 / 4 cr, Au 2012	10%	10%	80% (Dept. Admin)	100%
Keith Holsapple	FT	On sabbatical	0	95%	5%	100%
Carl Knowlen	N/A	AA 198 / 5 cr, Au 2012 AA 311 / 4 cr, Au 2012 AA 210 / 4 cr, Wi 2013 AA 462 / 3 cr, Sp 2013	40%	60%		100%
Mitsuru Kurosaka	FT	AA 461 / 3 cr, Au 2012 AA 301 / 4 cr, Wi 2013 AA 360 / 4 cr, Sp 2013 AA 504 / 3 cr, Sp 2013	60%	30%	10%	100%
Lin, Kuen Y.	FT	AA 530 / 3 cr, Au 2012 AA 432 / 3 cr, Wi 2013 AA 532 / 3 cr, Wi 2013 AA 332 / 4 cr, Sp 2013	40%	50%	10%	100%
Eli Livne	FT	AA 516 / 3 cr, Au 2012 AA 410 / 4 cr, Wi 2013 AA 411 / 4 cr, Sp 2013	45%	45%	10%	100%
Mehran Mesbahi	FT	AA 510 / 4 cr, Au 2012 AA 528 / 3 cr, Wi 2013	20%	70%	10% (service)	100%
Kristi Morgansen Hill	FT	AA 312 / 4 cr, Wi 2013 AA 549 / 3 cr, Sp 2013	30%	60%	10%	100%
Uri Shumlak	FT	AA 405 / 3 cr, Au 2012 AA 545 / 3 cr, Sp 2013	20%	60%	20%	100%

1. FT = Full Time Faculty or PT = Part Time Faculty, at the institution
2. For the academic year for which the self-study 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.

C. Faculty Size

Although the size of the faculty is adequate for the current needs of the undergraduate program, significant additional faculty are needed to allow for program growth. Since the last ABET review the Department has seen the departure of three faculty (U.L. Ly, A.T. Mattick, and R. Rysdyk) but has gained two (A. Ferrante and S. You). Two new faculty were recently hired (A. Siddarth and J. Yang) and will join the department in August 2013. Furthermore the new Dean of Engineering, Michael Bragg, who will officially begin his duties on July 15, 2013, will also become a member of the Aeronautics & Astronautics faculty. There are plans to hire additional faculty over the next five years. Those additional hires will be critical to replace upcoming faculty retirements and to allow for continued program growth.

The current size of the faculty is sufficient to provide for mentoring of undergraduate students. This mentoring to date has been primarily through the undergraduate faculty and staff advisors and by other faculty associated with the design projects, as well as independent research projects. We are currently exploring ways to possibly expand and broaden the undergraduate mentoring and increase the faculty involvement associated with it.

D. Professional Development

Professional development opportunities in education available to our faculty include consulting services and workshops offered by the UW Center for Teaching and Learning (CTL) and the Center for Engineering Learning and Teaching (CELT). The latter organization is within the College of Engineering, while the former is University-wide. Our faculty also take part in workshops and conferences hosted by the ASEE and other professional organizations. In addition, the College of Engineering conducts workshops on diversity and other matters for faculty and department chairs. The University offers similar activities.

Other professional development opportunities include regular UW workshops on developing and managing grants, workshops on commercialization topics (e.g., patents, intellectual property, forming a start-up company and working with industry) hosted by the UW Center for Commercialization (C4C). There is also an annual Faculty Field Tour to allow new UW faculty to become familiar with industry and the economy throughout Washington State.

Finally, the UW offers a Faculty Fellows Program. This program orients new faculty to the University campus community. The Program is facilitated by a number of campus educators, including those who have received campus-wide teaching awards. Presenters and facilitators actively engage our new faculty members on a number of topics such as effective teaching methods and techniques, balancing the demands of successful teaching and research, etc.

The professional-development items mentioned here are basically non-financial in nature – faculty development programs that are intended to bring funding directly into faculty research efforts are presented under Criterion 8, Section E.

E. Authority and Responsibility of Faculty

The ultimate responsibility for the effective execution of the Department's undergraduate program rests with our faculty. The Department's governance is centered on the faculty, led by the Chair. Faculty decisions are generally made by vote or consensus. Administrative and policy decisions are made by the chair in consultation with faculty and staff. The undergraduate program is coordinated by the Department's Undergraduate Committee, which consists of five faculty and the staff advisor. The Committee provides for direct oversight of the undergraduate program, including admissions, curriculum, requirements, student outcomes, and plans for continuing improvements and program growth. The Undergraduate Committee regularly reports to the faculty at large, which addresses all major issues relevant to the undergraduate program. The Department in turns works with the Associate Dean for Academic Affairs in the College of Engineering to ensure that the educational program in our department fully supports the undergraduate needs of the College of Engineering, as well as coordinates, where appropriate, with other Engineering Departments at the UW.

CRITERION 7: FACILITIES

A. Offices, Classrooms and Laboratories

Introduction

The William E. Boeing Department of Aeronautics and Astronautics is headquartered in Guggenheim Hall, in which it occupies three floors. The department's additional facilities include the Aerospace and Engineering Research Building (AERB), in which the department occupies ¾ of the assignable space, the Aerodynamics Laboratory Building, and the Kirsten Wind Tunnel Building. Guggenheim Hall and AERB are described briefly below; the two wind tunnel facilities are described in Appendix C.

Guggenheim Hall

In 1928, the Guggenheim Foundation donated funds for the construction of an aeronautics building, one of seven similar grants made nationwide. Instruction in the building began in October 1929, and the University dedicated the Daniel Guggenheim Hall of Aeronautics in 1930. The first baccalaureate degrees in aeronautical engineering were awarded that same year. This building serves as the department's headquarters and houses the classrooms used by the program, as well as some of its laboratories and its computing facilities. After many years of requests to renovate the building, the State Legislature approved funding for the endeavor in 2003. Planning started soon thereafter and construction began in April 2006. The renovation was completed in August 2007, and the refurnishing of its offices was completed the following year.

Figure 7.1 Guggenheim Hall

Aerospace and Engineering Research (AERB) Building

In 1967, the department received a grant from NASA for the construction of the Aerospace Research Laboratory, a new research facility building. Construction was completed in 1969 and the building was dedicated in 1970. The building was re-named the Aerospace and Engineering Research Building (AERB) in 1975. Although designed as a College-wide facility, this building was the result of the concerted efforts of Aeronautics and Astronautics faculty members. About 75% of its 40,000 ft^2 is occupied by AA professors, their students, research staff, and laboratories. The building is a laboratory and office building with no formal classrooms.

Figure 7.2 Aerospace and Engineering Research Building (AERB)

Offices

All faculty, staff, and teaching assistants are housed in offices that meet or exceed state guidelines for square footage. Faculty and staff are housed in individual offices in Guggenheim Hall and AERB, and teaching assistants are housed in a dedicated communal TA office in Guggenheim Hall. Typical office furnishings include a desk, chairs, and bookcases, and every faculty and staff member has either a desktop or laptop computer (only the staff are issued computers by the department; faculty are responsible for acquiring their own, either through their research programs or with personal funds). Every office is also equipped with a telephone.

Classrooms and associated equipment

The Department of Aeronautics and Astronautics has made major strides in improving lab, computer and classroom equipment, particularly through the renovation of Guggenheim Hall that took place in 2006-2008. Prior to the renovation, funds for improvements came from various internal and external sources. The Guggenheim renovation was funded largely by the State, with some infusion from private donors and the University.

Guggenheim Hall has three classrooms, having capacities of 65, 34, and 20 students, and one large auditorium that has a capacity of 347. These rooms are under the control of the University's Classroom Services Office, and are available to all departments on campus, but our department is designated as the primary user of the 65-set and 34-seat classrooms (which are located on the main (2nd) floor of the building. In addition, the building features a department-specific Seminar Room on the 3rd floor, which is used to teach smaller classes (up to 20 students), hold tutorial sessions by teaching assistants, hold project group meetings, etc.

The three main classrooms in Guggenheim Hall are equipped with advanced A/V systems that handle all modern projection and sound requirements.

Laboratory facilities

The renovation of Guggenheim Hall also resulted greatly improved laboratory spaces, which are located on the first floor (structures and composites, and fluids labs) and the main floor (AA 320/321/322 and AA 448 lab, and computer lab). One side benefit of the renovation of the building was that the machine shop formerly located in the basement of AERB was consolidated into the Guggenheim machine shop, thus freeing about 1500 ft^2 of space that was refurbished for use as the department's new Space Systems Laboratory. This lab is also used to support AA 420/421, the capstone space systems design course, and independent student projects. Space for AA 410/411, the capstone airplane design course, has been made available in the Kirsten Wind Tunnel Building. Aerodynamics experiments are performed in our 3'x3' wind tunnel, which is the centerpiece of the department's Aerodynamics Laboratory Building (see Appendix C).

The Aerospace Instrumentation course, AA 320, features 10 electronic workstations in Guggenheim 205, where students build and test electronic circuits and instrumentation for course assignments. Some of the workstations are also used for AA 448, Control Systems Sensors and Actuators. Aerospace Lab I and II (AA 321 and AA 322) have undergone a transition over the past decade. Many old experiments were either replaced or eliminated, and new equipment was purchased. In several labs, data are gathered with LabVIEW-based data acquisition systems. Table C.1 in Appendix C provides a list of laboratory equipment available to the program.

B. Computing Resources

Departmental Computing Resources

The department's computer laboratory occupies a dedicated space in Room 212 of Guggenheim Hall with 42 general-use PCs and 3 additional restricted-use PCs, the latter reserved for students of the department's capstone design courses. The computer room is accessible by students on a 24-hour basis. Because the program's computing facilities amply meet our students' needs on campus and because most students have their own personal laptop or desktop computers, they rarely have a need to access any other computing facilities at the UW.

The computing infrastructure in the renovated Guggenheim Hall is a significant improvement over the past, as it features a single, large space for the computer lab, as well as support for remote Windows sessions and high-performance cluster computing. The computer hardware is continuously upgraded every 3 to 4 years, using funds obtained through the UW's Student Technology Fee system.

Students have access to many engineering software tools. They perform 3D modeling with SolidWorks, ANSYS, and FEMAP/Nastran for structures and heat transfer problems, Star-CCM+ for aerodynamic modeling, and STK for orbital mechanics and space dynamics problems.

For particularly demanding analyses, computing can be performed remotely on the department's 11-node, 272-core Linux-based compute cluster. Students are introduced to computer data acquisition using LabVIEW in their Aerospace Laboratory classes, and learn MATLAB in one of the prerequisite courses, AMATH 301, taught by the Applied Mathematics Department. A detailed listing of the equipment and software available in the computing laboratory facilities is given in Appendix B.

College of Engineering Computing Resources

Computing has a large presence in the academic departments and diversity programs within the College. There are more than 500 computers located in departmental and program laboratories and classrooms. Many of the computer labs are available to students, faculty and staff within the department/program on a drop-in basis or can be reserved by instructors for course presentations or workshops. Specialized computing labs, such as the Instructional Programming Lab (CS&E) and the Electrical Properties Lab (MS&E), focus on providing computing resources for specific course related needs. The computing laboratories throughout the College include various installations of Macintosh, Windows and UNIX/Linux workstations, often linked to lab or departmental data/email/application/web servers and laser-quality printing.

The College of Engineering provides common data storage, database, and web services for COE central services, employing Intel-based Windows and UNIX/Linux systems supported by COE Computing Services. A central web site, www.engr.washington.edu, provides a portal to College resources, news and special events, and links to all College academic departments and diversity/professional programs. A central Oracle database maintains links to various campus data resources such as those from Planning & Budget, Admissions and Capital and Space Planning offices and provides decision support applications (searches, reports, etc.) for use throughout the College.

The College of Engineering Computing Services staff includes one manager/director, 7 full-time and 3 part-time technical staff that provide installation, configuration and maintenance for all desktop computers and servers in the office of the Dean, selected academic departments (Industrial Engineering, Materials Sciences and Engineering) and several diversity/professional programs (CELT, CWD, and MESA). The Computing Services staff also provides 2nd-tier support to technical personnel in many other College departments, assisting with server installation/configuration, Internet security, network technology upgrades, etc. Each department has one or more technical staff personnel providing computing support for their faculty, staff, students and laboratories.

The Committee for Information and Technology Exchange (CITE) is a College-wide group of computing support personnel. CITE meets quarterly to discuss a wide range of computing and networking issues, announcements and future technologies. A mailing list also links all CITE members and is used to distribute announcements, special offers (licenses, grants, etc.) and technical application notes.

The Computer Resource, Infrastructure and Strategic Planning (CRISP) process is responsible for the distribution of computing supports funds to College departments and programs and establishing priorities for technology initiatives in College facilities.

University Computing Resources

The University has computer laboratories established mainly in the Odegaard Undergraduate Library (OUGL). There are approximately 397 General Access Workstations with Dell and Apple iMac computers. The 34 Video Editing Workstations are comprised of HP Z220 and Apple MacPro Dual-Monitor.

The three Collaboration Studio and Collaboration Pods facilitate in-person, interactive, small group projects or meetings.

The Center for Teaching, Learning and Technology is designed to provide walk-in assistance to UW faculty, staff and students who have questions about educational technology.

The Digital Presentation Studio (DPS) is a space to practice presentations and record those sessions for later review.

UW-IT's Videoconferencing Services provide access across the state or around the world, feature professional studio spaces and provide support.

ViDA (**Vi**rtual **D**esktop **A**ccess) gives students 24/7 remote access to high-end software normally available only in technology spaces on campus.

Internet connectivity

Each workstation is connected to the campus network with a TCP/IP Ethernet connection (1000baseT in Odegaard Undergraduate Library, 100baseT in Mary Gates Hall.) The campus network then is connected to the rest of the Internet via multiple DS3 circuits.

Internet connectivity is provided into many campus classrooms, enabling instructors and students to interact with course materials available through the web and other sources. The College and many of the departments make computer projection (LCD projectors and overhead displays) available for classroom use. Specifically configured classrooms in AA, EE, CSE and Sieg Hall include built-in computer projection equipment and Internet connectivity.

Classroom Support Services

Classroom Support Services (CSS) provides comprehensive media support and services to students, faculty and staff at the University of Washington. The department offers a full range of audio and video expertise to the campus community while also working with students, faculty and staff to enhance classrooms with new technologies for improved information presentations and student learning outcomes.

SpaceScout

This is an internet application available to run on a smart phone which enables students to find study spots on campus

Tegrity Lecture Capture and Tegrity Manager

Available to all UW students, faculty, and staff, Tegrity allows you to record any audio and video, such as a lecture, and make it available to others. For instructors teaching an official for-credit UW course, the faculty's courses automatically appear in Tegrity, ready for lecture capture, with no action required. Tegrity provides unlimited space for recordings and requires minimal hardware.

Visualization

The Health Sciences Academic Services and Facilities provides equipment, facilities and services for making visualization products such as large-format color print images, still photography, movies, computer animations and interactive graphical presentations in several formats.

Campus Data Network

Internet connectivity, 10Mb, 100Mb, and 1000Gb technologies, is provided into every office and laboratory in each of the College buildings. The University's Information Technology(UW-IT) department provides centralized support for the campus-wide Internet inter-building and intra-building backbone and the campus connections to the Internet, Internet2 and vBNS national networks. By employing standard 100TX/1000TX network technologies for distribution throughout each building and fiber optics service to each building from one of several campus routing centers, UW-IT provides a robust and reliable connection to the Internet for all College and campus computing resources.

The University-wide, centrally managed wireless service initiative has expanded wireless access throughout all three UW campuses including: central 24x7 management and support of the wireless network as an integral extension of the wired data network; a single point of contact for customer service; consistent security and access controls; and ongoing maintenance and operations support, including upgrades, for all three campuses.

Payment for Computing Services:

All UW students contribute quarterly to a Student Technology Fee (http://techfee.washington.edu). Funds from this program are distributed annually, based on proposal requests, to UW-IT, and university departments and programs.

All registered students must create a personal UW NetID, enabling their access to general-use-computing resources. None of the University computing labs or College computing labs charge a fee for using the facilities or equipment. Per-page fees are charged for printed output in the University facilities and pricing schedules are regularly updated at the UW web site.

Many College of Engineering departments create local student accounts for their majors and students enrolled in department courses that permit the use of laboratory equipment and facilities. Some of the College departments have established quotas on student accounts limiting disk space usage and printed output (number of pages). Account quotas are often established and adjusted based on course enrollment and instructional requirements.

C. Guidance

Students working in laboratories, whether for instructional or research purposes are instructed in the safe operation of equipment and tools, as needed. Laboratory courses provide safety information at the beginning of the quarter. In addition, the machine shop provides frequent classes on machine shop safety and on the proper operation of machine tools. When students begin their junior year they attend an orientation session in which they are given material describing the rules and policies governing the use of the computer laboratory. The students have to acknowledge they have read the document by signing and submitting a response sheet. Department safety is overseen by a Safety Committee (see Section 7.F).

D. Maintenance and Upgrading of Facilities

The tools, equipment, and laboratories used by students in the program are closely monitored by the department's Research Scientist/Engineer and by the Machine Shop Manager, who is also a Research Scientist/Engineer. These staff members provide technical support for the educational and research laboratories. They work closely with the instructional faculty who use the lab facilities for their classes and also with faculty performing research in these and other labs, to determine maintenance needs and identify necessary purchases to replace and update equipment and tools. The technical staff meet regularly with the department chair to apprise him of specific needs in the labs or the machine shop. Faculty also meet with the department chair, usually in concert with one or both technical staff to discuss maintenance or purchase of equipment and tools. There is also an Instructional Laboratory Committee that meets as needed, to review the status of the instructional laboratories and make recommendations to the department chair.

Computing and information technology support to the department is provided by two Senior Computer Specialists. These staff members upgrade the computer hardware continuously, every 3 to 4 years, using funds obtained through the UW's Student Technology Fee system. In addition, they keep the department's software up to date and purchase new software as needed to serve the department's and program's needs.

E. Library Services

The University of Washington Libraries (Libraries) provides library and information services that support the teaching, learning, research, and clinical needs of the tri-campus University community – UW Seattle, UW Bothell and UW Tacoma. The Dean of University Libraries is the chief administrator, is a member of the University's Board of Deans and Chancellors and reports directly to the Provost.

The Seattle campus consists of our five "anchor" libraries: Suzzallo and Allen, Odegaard Undergraduate, Health Sciences, Engineering, Foster Business, and seven smaller subject libraries. A large off-site collections facility is located nearby. The Libraries have extensive on-site and online collections and user-centered services. Students and faculty can go online at http://www.lib.washington.edu/ to search and request books, journals, etc. Electronic periodicals can be searched at http://uwashington.worldcat.org/. The Association of Research Libraries (ARL) investment index ranks the University of Washington Libraries 20th among the top 115 academic research libraries in North America and 10th among U.S. publicly funded universities.

Teaching, learning, and research at the University of Washington are supported by one of the premier library collections in North America, consisting of more than 7 million volumes (ranked 14th among ARL libraries) and sizeable numbers of microforms, manuscripts, technical reports, maps, architectural drawings, photographs, and audio-visual materials. Approximately 88% of the 120,000 current periodical titles are available online, and, when combined with 500,000 e-books extends access beyond the physical collection. These electronic resources are available to the UW community anywhere and anytime. More than seventy librarian liaison subject specialists are active in collection development and work closely with academic programs to select and provide access to information resources needed for the curriculum and research.

Nearly 90% of the Libraries' currently subscribed serial titles are available electronically. Significant funding, much of it from endowment income, has gone into purchase of electronic journal backfiles. The Libraries has made a strong commitment to expedited delivery of information resources directly to students faculty and staff through interlibrary borrowing, scanning of locally-held print journal articles on demand which are sent as PDF files, and office delivery of books to faculty and staff.

F. Overall Comments on Facilities

The department has a Safety Committee which oversees the safe operation of all department facilities. The members of this committee represent the various research and instructional laboratories, machine shop, wind tunnels, and other facilities. Students working in laboratories, whether for instructional or research purposes are instructed in the safe operation of equipment. In addition, the machine shop provides frequent classes on machine shop safety and on the proper operation of machine tools.

On an annual basis, the UW's Office of Environmental Health and Safety (EH&S) conducts inspections of all the department's facilities. In addition, the Seattle Fire Department also conducts regular inspections of the facilities to assure compliance with fire safety codes.

CRITERION 8. INSTITUTIONAL SUPPORT

A. Leadership

Governance in the Department of Aeronautics & Astronautics is centered on the faculty, led by the Department Chair. Responsibility for the undergraduate program lies primarily with the Undergraduate Committee, which is headed by the Committee Chair and supported by the Manager of Undergraduate Programs. The Undergraduate Committee handles all routine aspects of the undergraduate program. Significant changes to the undergraduate program involving, for example, changes to the curriculum, new degree programs, requirement changes, and measures to accommodate program growth are normally brought to the faculty by the Undergraduate Committee for faculty decision, which is generally made by vote or consensus. The management of the undergraduate program is adequate to ensure the quality and continuity of the program.

B. Program Budget and Financial Support

1. Program budgeting process

As is the case in all units at the University of Washington, the academic program budget for the Department of Aeronautics and Astronautics is determined biennially by the University, based on allocations from the State of Washington. The state budget (General Operating Fund) accounts for only 33% of the department's total operating budget, with the remaining 77% coming primarily from federal grants and contracts, private donations, and other sources, a situation which is typical of most departments in the College of Engineering. In the 2011-2013 biennium the department's state and local budget allocations were $5.3 Million, including benefits. The state and local allocations fund the salaries of 15 regular faculty (plus one vacant position), 8 administrative and 3 technical staff, and approximately 11 teaching assistants per quarter. These state funds do not include allocations for general operations.

The state budget for the department does not contain any specific allocations for equipment acquisition, replacement, or repair; nor for faculty travel, publications, staff development, or other necessary activities, thus, we rely on, revenue from the delivery of distance learning through the UW's Professional and Continuing Education (PCE) program, from two graduate certificate programs that we offer, from indirect cost fund recoveries from grants and contracts, and from private donations and endowments to achieve some of our program goals. Some additional funding from the College of Engineering has been received annually for computer and other operations, but not at a level sufficient to fully maintain the existing computer infrastructure or purchase needed upgrades. For several years, however, we have been successful in obtaining additional funds for computer hardware upgrades through proposals to the UW's Student Technology Fee program.

Supplemental funding to support the department's undergraduate program is provided through the College of Engineering's Activity-Based Budgeting (ABB) process, introduced in FY2013. In short, ABB is a method of budgeting in which the activities that incur costs in every functional area are accounted for, analyzed, and then linked to the mission and strategic goals of the institution. The full costs of programs and services are then more transparent, and these data are available to help with planning, budgeting and decision making. ABB funding is supplemental to the State General Operating Fund (GOF) funds mentioned above, and amounted to $172,400 in 2012. The Department also received a proviso funding supplement of $207,500 in 2012 through the Washington State intitiative to increase enrollment in Engineering.

2. Support of teaching in terms of graders, teaching assistants, teaching workshops, etc.

Teaching Assistants (TAs) are normally assigned to all undergraduate courses with an enrollment exceeding approximately 30 students. All courses in the Junior year and AA447 (Controls) in the Senior year are thus fully covered by TAs. Other undergraduate courses with significant enrollment are often supported by the assignment of part-time graders, who provide similar support to that of TAs but do not normally provide office-hour help or substitute lectures. We expect to be able to increase the number of TAs in coming years as revenue into the Department (primarily though the new MAE master's degree program) increases.

Pedagogical guidance for TAs is provided by the Center for Engineering Learning & Teaching. Specific goals include helping TAs provide high-quality learning experiences, as well as facilitating their professional development. Departments in the College of Engineering vary widely with respect to TA responsibilities and training. CELT's program complements existing training resources such as the UW Center for Teaching and Learning's annual, university-wide TA conference, which some departments require their TAs to attend. Based on a study of each department's current TA-related practices, policies, and needs, CELT provides TAs a variety of engineering-specific training workshops and peer-support opportunities. It also facilitates the sharing of departmental best practices related to TA duties. This effort is led by a CELT staff member with engineering teaching and education research experience, supervised by CELT's assistant director and lead faculty developer.

There is no formal program and no funding available, at the University or in the College of Engineering, to address the professional development of faculty. Such professional development takes place on an ad-hoc basis in each department. In our department, it consists primarily of mentoring faculty at all levels, by encouraging them to apply for grants and contracts, participate actively in professional societies, attend teaching workshops and seminars, and do all that is required to advance in their careers. This mentoring comes from the department Chair, from senior faculty, and from peer faculty. In addition, the department has a formal process in place for the peer evaluation of teaching. As all departments in the University, our department also has a well-established set of criteria for promotion and tenure, and for the review of faculty performance on an annual basis.

3. Resources to acquire, maintain, and upgrade infrastructures, facilities, and equipment

The College of Engineering (CoE) works with the University of Washington administration to obtain Minor Modification Funds as needed. These funds are allocated on a biennium basis. Prior to the funding cycle, the CoE infrastructure group requests renovation proposals from each department. The proposals are reviewed by the infrastructure group and the funding request is made to the Office of Planning and Budgeting within the Office of the Provost. Once allocated, these funds are used to upgrade and renovate facilities in the selected CoE buildings in partnership with the relevant departments..

In addition to this funding mechanism and cycle, the CoE infrastructure group works with individual departments to secure staffing and, in some cases, will oversee individual renovation projects. These projects are requested on an individual basis. Priorities for these projects are set by the individual departments with CoE support.

4. Adequacy of resources

The resources outlined in this section are fully adequate to allow undergraduate students to attain all student outcomes currently expected for this program. However, the Department is continually working to further strengthen and grow the undergraduate program. Further program growth will depend on the resources required to increase the size of the faculty, the number of teaching assistants and support staff, and increased capacities in classrooms and laboratories.

C. Staffing

The department is directly supported by a staff of 16, broadly grouped into administrative, fiscal, academic advising, technical support, computing, and Wind Tunnel. Additional staff support the new Washington State Joint Center for Aerospace Technology Innovation (JCATI). Each category is discussed below.

1. Administrative: The department Chair is directly supported by a Chair's Assistant and the department Administrator. Part-time student assistants are also employed for receptionist and general office support duties. The adequacy of the administrative staff is excellent.
2. Fiscal: The fiscal staff of the Department currently consists of a Budget/Fiscal Analyst Lead, one full-time Fiscal Specialist 2, and one half-time Fiscal Specialist 2. The Budget Fiscal Analyst Lead supervises the other fiscal staff and reports to the department Administrator. (We plan to hire a Grant Manager in the near future. This position will take over fiscal staff supervision and significantly increase the office's capabilities in pre- and post-award administration of grants and contracts.) These staff provide fiscal support to the department, including pre- and post-award administration, purchasing, travel, equipment inventory and insurance, and more. The adequacy of the fiscal staff at present is good. With process improvement activities planned for the reorganized staff, we expect this assessment to become "excellent" by year's end.
3. Academic Advising: The undergraduate and graduate programs each have dedicated advisors, specifically the Manager, Undergraduate Programs, and Assistant Director, Academic Services (responsible for the graduate program). In addition, the expanding graduate program is assisted by a full-time Academic Advisor, Professional & Distance Learning Programs. While the adequacy of academic advising is very good, the growing undergraduate program points to a possible need to increase the size of the undergraduate advising staff.
4. Technical Support: Technical support for the department's education and research functions is provided by two Research Scientist/Engineer staff, one of whom does

production work in the department's machine shop. These staff provide technical support for the research and educational laboratories in the department. The adequacy of the technical support staff is good. One of the two positions (the one not associated with the machine shop) is currently vacant but a replacement search is underway; this position is shared with the Wind Tunnel.

5. Computing: Computing and information technology support to the Department is provided by two Senior Computer Specialists. The adequacy of the computing/IT support is excellent.
6. Wind Tunnel: The Kirsten Wind Tunnel is served by a Business Manager (classified as a research scientist/engineer), who is in turn supported by an Operations Manager (also classified as a research scientist/engineer). These two staff supervise the operations crew, which consists entirely of students (typically 8-14, depending on the time of year). The Business Manager also oversees all the technical and computing staff in the department. The adequacy of the Wind Tunnel support personnel is excellent.
7. JCATI: Washington State's Joint Center for Aerospace Technology Innovation (JCATI), housed in our department, is supported by a dedicated Program Operations Specialist staff member. The adequacy of this support is excellent.

Staff Retention

Currently, the UW is under salary and wage increase restrictions. However, the College of Engineering has implemented a critical retention process for staff who are identified to be potential retention risks. One staff member in the department received such a retention raise in 2012. The College of Engineering has offered staff opportunities to telework, which enhances staff satisfaction and productivity, ultimately impacting morale and retention in the midst of wage restrictions.

Training

The University of Washington Professional & Organizational Development organization has a comprehensive course catalog and offers numerous opportunities for staff training. The department strongly supports employees' ongoing training, both for current duties and for career development.

D. Faculty Hiring and Retention

The normal sequence for new faculty hiring in Aeronautics & Astronautics consists of the following steps:

1. The faculty, working with the Department Chair identifies new area(s) or vacant position(s) targeted for faculty hiring, consistent with the long-term hiring plan submitted to the College.
2. Approval for the new hire(s) is obtained from the College of Engineering.
3. A Search Committee is appointed by the Department Chair.

4. The Search Committee and Department Chair compose advertisement(s) for the new position(s) and the ad or ads are placed (usually in a national print journal) soliciting applications for a faculty position.
5. Candidates submit their applications, which are reviewed by the departmental Search Committee.
6. A short list of top candidates is developed and the candidates are interviewed.
7. The Chair and Department faculty discuss all finalists and vet the final candidate(s).
8. The successful candidate(s) are contacted and the Chair discusses terms of the formal offer(s).
9. The formal offer(s) are submitted to the College for approval before being sent to the candidate(s).
10. Should the candidate(s) accept the formal offer, the Department submits appointment paperwork to the Dean's Office. The Dean reviews the appointment(s) and offers his/her support of the new faculty member(s) to the Provost.
11. The Provost and Board of Regents review and approve the new appointment(s).
12. The Provost's Office notifies the new faculty member(s) that their appointment has been approved and welcomes them to the UW.

Strategies employed by the College of Engineering to retain current qualified faculty members include:

1. <u>Retention Salary Adjustments</u> – Upon application and recommendation by the department Chair, the Dean may request retention salary adjustments for qualified faculty through the Office of the Provost. Retention salary adjustments receive case-by-case review. As a general principle, retention salary adjustments are expected to provide a minimum 5% salary increase. Generally, an individual may not receive a retention salary adjustment for a period of three years from the effective date of the most recent retention adjustment.

2. <u>A/B Retention Salary Adjustments</u> - The fundamental purpose of the A/B Salary Policy for Faculty Retention is to ensure the retention of qualified UW tenured and tenure-track faculty by providing for a significant salary-enhancement mechanism, consistent with the University of Washington Faculty Salary Policy. An A/B salary is comprised of an annual base salary with an A salary component and a B salary component. The A component is the state-committed salary support associated with tenure that is matched with an institutional expectation of teaching, research, and service contributions. The B component supplements the base salary from non-state appropriated sources (e.g., grants, contracts, and self-sustaining income). The B component is contingent upon the faculty member's ability to generate funding from grants, contracts, or other applicable sources. All A/B salary arrangements are proposed by the department Chair, subject to approval by the Dean and Provost.

E. Support of Faculty Professional Development

The University of Washington and the College of Engineering have extensive faculty professional development programs. Many of them focus on new faculty but some are for all faculty. Such programs include:

1. The University of Washington's Faculty Fellows Program – This program orients new faculty to the University campus community. The Program is facilitated by a number of campus educators, including those who have received campus-wide teaching awards. Presenters and facilitators actively engage our new faculty members on a number of topics including, but not limited to, effective teaching methods and techniques, balancing the demands of successful teaching and research, etc.

2. The University of Washington's Royalty Research Fund – The UW awards grants of up to $40,000 to faculty to advance new directions in research, in particular:
   - in disciplines for which external funding opportunities are minimal;
   - for faculty who are junior in rank;
   - in cases where funding may provide unique opportunities to increase the applicant's competitiveness for subsequent funding.

   Funded projects often lead to new creative activities or scholarly understandings, new scholarly materials or resources, and significant data or information that increase a faculty member's chances of obtaining new external funding.

3. Bridge Funding – The University of Washington Provost's Office provides bridge funding to support faculty to span the gap in critical research programs. Under this program faculty can receive up to $50,000 (with a required 1:1 match from the department or College to give a total of up to $100,000) to help them maintain research productivity during gaps in external funding while they seek to obtain external funding for their research.

There are a number of additional faculty professional development programs run by the College of Engineering, including:

1. Center for Engineering Learning & Teaching (CELT)

   CELT supports the College of Engineering's mission by taking a leadership role in developing and supporting engineering instructional excellence. The CELT faculty development program employs an integrated multi-pronged agenda for improving engineering learning and teaching, which includes working with individual faculty members, conducting teaching workshops and seminars, providing teaching resource materials, and active participation in strategic-level initiatives. The CELT approach to professional faculty development begins with meeting and resolving the immediate concerns of faculty members. Simultaneously CELT helps faculty members place their improvement efforts within a larger cycle of ongoing improvement, implementation, and assessment. Workshop topics and specific instructional development activities and resources are identified through close cooperation with engineering faculty members. CELT services are available to all faculty members in the College of Engineering. For more information on CELT services see the CELT description in Table D-4 *Non-academic Support Units.*

2. ADVANCE: Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers

   The University of Washington received a $3,750,000 National Science Foundation (NSF) ADVANCE Institutional Transformation grant in 2001 to increase the participation and advancement of women in academic science and engineering careers. With the grant, it formed the ADVANCE Center for Institutional Change (CIC) which is housed in the College of Engineering. The vision of the CIC is a campus in which all science, technology, engineering, and mathematics (STEM) departments are thriving, all faculty are properly mentored, and every STEM faculty member is achieving his or her maximum potential. The UW believes that cultural changes that are designed to help underrepresented groups invariably help all groups and improve the environment for everyone.

   The CIC implements programs designed to eliminate existing barriers and to precipitate cultural change at both the departmental and the institutional level. One of the successful strategies the ADVANCE program has employed to impact departmental culture and climate are quarterly leadership workshops for department chairs, deans, and emerging leaders. Prior to ADVANCE, department chairs received little or no professional development beyond their initial orientation to the department chair position. The ADVANCE workshops provide those in leadership positions with a better understanding of the structural, psychological, and behavioral barriers to the advancement of faculty. For each half-day workshop, the department chairs are encouraged to invite an emerging leader so that other faculty can be exposed to academic leadership issues. These workshops have served as a forum for cross-college networking and professional development, and are the only regular department chair professional development gatherings on campus. The workshops help develop the next set of department chairs in STEM departments. Department chairs have stated these workshops are the “boot camp” they never got and evaluations of the workshops have been uniformly high.

   The UW ADVANCE program has had great impact. The ASEE 2011 reports that the UW has 20.6% women faculty in engineering compared to a national average of 13.9%. Further, the UW ranks seventh for number of women faculty in engineering, but the first six institutions have 38-73% more faculty in their engineering colleges.

PROGRAM CRITERIA

The satisfaction of applicable program criteria for aerospace engineering is described in section 5.A.5.

APPENDIX A – Course Syllabi

A.1 Supporting/Prerequisite Courses in Other Departments/Programs

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Math 124-Spring 2013

Important Information

- A note to the student.

- What you need to purchase:
  - The textbook for the course is "Calculus" by Stewart, vol.1 available in the UW bookstore. This is a portion of the hardbound text "Calculus, 7th Edition, Early Transcendentals" by Stewart. Either text will work. The custom version vol. 1 covers Math 124/125 at UW. The custom version vol. 2 covers Math 126/324 at UW.
  - In addition to the textbook, you will need a "WebAssign access code"; see link below. You can purchase this code (which includes the ebook) bundled with the textbook at the bookstore OR you can purchase a standalone access code which includes the ebook (if you already have the textbook or locate a used copy) directly from the publisher at this website for $70:

    http://www.cengagebrain.com/micro/uwmathcalc

- How to use Webassign.

- **All homework is accessible and turned in online using WebAssign. Homework is NOT posted on the course website.**

- **Math 124/5/6 Grade Policy.** Beginning Autumn 2012, the department of mathematics has adopted a grade policy for this course. The final median course grades for each lecture section of Math 124/5/6 taught during the regular academic year will fall within the range of 2.9 +/- 0.2. This policy does not apply to the honors sections of Math 124/5/6.

- **What if the Calculus class I wish to add is closed?**
  1. You should be persistent in frequently checking for openings online, which are filled on a first-come/first-served basis. During the first week, the enrollment status of a class can change hourly; it really pays off to check frequently. There are no overloads or waiting lists. In most quarters almost all persistent students who want to take the course will find an opening sooner or later (but after the first week there may be a late fee).
  2. Whether or not you are officially enrolled, you should choose a class and start attending both lectures and quiz sections from the very first day. You should do any worksheets or quizzes. You will NOT be able to access homework until you are officially enrolled in the class.
  3. Important material is covered in the first week, and it is necessary to be in class and do the work during this period. All students are graded in the same way, and no student is excused from the first week's work.

- Here is a **pdf file with all of the worksheets** for the quarter together in one file. Please download and print out this file, and bring all of them with you to every quiz section meeting. AllWorksheets124

- Final Exam: Date, Ground Rules and Rooms.
  Special Note: Some instructors will use assigned seating for the final exam. Consult with

your course instructor for more details.

Outline

Week	Outline/Study Guide	Exam Archive	Topics and Textbook Sections
1: April1-5	• Worksheet • Worksheet Solution • Parametric Equations Supplement.		• Tangents to circles • Sec. 10.1 or supplement reading on parametric equations • Sec. 2.1-Tangents and velocity • Sec. 2.2-Limits
2: April8-12	• Worksheet • Worksheet Solution • Parametric Equations Supplement.		• Sec 2.3-Calculating Limits • Sec.2.5-Continuity • Sec.2.6-Asymptotes
3: April15-19	• Worksheet • Worksheet Solution		• Sec. 2.7-Derivatives • Sec. 2.8-Derivative Function • Chapter 2 wrapup • Sec. 3.1-Derivative rules
4: April22-26	• Worksheet • Worksheet Solution • Sinusoidal functions supplement		• Sec. 3.2-More derviative rules • Sec. 3.3-Trig derivatives • Sec. 3.4-Chain rule
5: April29-May3	• **Midterm #1** April30 in TA section	MIDTERM #1 ARCHIVE	• Midterm Review • Midterm #1 • Sec. 3.4-More chain rule • Sec. 10.2-Derivatives and parametrized curves
6: May6-10	• Worksheet • Worksheet Solution		• Sec. 3.5-Implicit differentiation • Sec. 3.6-Logarithmic differentiation • Sec. 3.9-Related rates
7: May13-17	• Worksheet • Worksheet Solution		• Sec. 3.10-Linear approximation • Sec. 4.1-Basics on min and max values

8: May20-24	• **Midterm #2** May21 in TA section.	MIDTERM #2 ARCHIVE	• Midterm Review • Midterm #2 • Sec. 4.3-Derivatives and shape of a curve • Sec. 4.4-L'hospital's rule
9: May27-31	• No class May 27 (Memorial Day) • Worksheet • Worksheet Solution		• Sec. 4.4-L'hospital's rule • Sec. 4.5-Curve sketching • Sec. 4.7-Optimization
10: June3-7	• Worksheet • Worksheet Solution • **Final Exam** SATURDAY June8	FINAL EXAM ARCHIVE	• Sec. 4.7-More Optimization • Final Exam Review • Final Exam

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Math 125 Materials Website

NEW: Read the instructions on the cover page of the Spring 2013 Math 125 Final Exam before the exam.

Important Information

- A note to the student.

- What you need to **purchase:**
  - The **textbook** for the course is "Calculus" by Stewart, vol.1 available in the UW bookstore. This is a portion of the hardbound text "Calculus, 7th Edition, Early Transcendentals" by Stewart. Either text will work. The custom version vol. 1 covers Math 124/125 at UW. The custom version vol. 2 covers Math 126/324 at UW.

  - In addition to the textbook, you will need a "**WebAssign access code**"; see link below. You can purchase this code (which includes the ebook) bundled with the textbook at the bookstore OR you can purchase a standalone access code which includes the ebook (if you already have the textbook or locate a used copy) directly from the publisher at this website for $70:

    http://www.cengagebrain.com/micro/uwmathcalc

    IMPORTANT: If you are taking Math 125 and you need to purchase a WebAssign access code, be sure to get a code for "Calculus, 7th Edition, Early Transcendentals" by Stewart, NOT the 6th Edition. If you took Math 124 in Autumn 2011 or more recently, you probably have already purchased an LOE (lifetime of edition) access code for the 7th Edition. If you took Math 124 before Autumn 2011, you may have already purchased an LOE (lifetime of edition) access code for the 6th Edition. A 6th Edition Early Transcendentals LOE access code can be updated to a 7th Edition Early Transcendentals LOE access code at no cost to you; please contact your instructor to request the update.

- **Homework:** All homework is accessible and turned in online using WebAssign.

  - To sign in to WebAssign, do NOT go to the main WebAssign website.
    You must enter through the

    Official WebAssign site for UW,

    a special WebAssign portal designed specifically for the University of Washington.
    You will use your UW Net ID to sign in: How to use WebAssign.

  - You can sign in to WebAssign as soon as you are enrolled and your instructor has posted homework assignments, even before you have purchased an access code. There is a two-week grace period at the beginning of the quarter for you to get your access code and enter it into WebAssign. After the grace period, you will not be able to sign in to WebAssign until you have entered a valid access code.

- **Worksheets:** Here is a **pdf file with all of the worksheets** for the quarter together in one file. Please download and print out this file, and bring all of them with you to every quiz section meeting. AllWorksheets125Spr2013.pdf

- **Final Exam:** There is a common final exam, given at 1:30pm - 4:20pm on Saturday afternoon, the day immediately after the last day of class.
  See Date, Ground Rules, and Rooms for more information.
  Calculator policy: A basic scientific calculator is allowed and may be needed on the final exam, but no calculators with any graphing, programming, or calculus capabilities are allowed.

- **Math 124/5/6 Grade Policy.** Beginning Autumn 2012, the Department of Mathematics has adopted a grade policy for this course. The final median course grades for each lecture section of Math 124/5/6 taught during the regular academic year will fall within the range of 2.9 +/- 0.2. This policy does not apply to the honors sections of Math 124/5/6.

- **What if the Calculus class I wish to add is closed?**
  1. You should be persistent in frequently checking for openings online, which are filled on a first-come/first-served basis. During the first week, the enrollment status of a class can change hourly; it really pays off to check frequently. There are no overloads or waiting lists. In most quarters almost all persistent students who want to take the course will find an opening sooner or later (but after the first week there may be a late fee).
  2. Whether or not you are officially enrolled, you should choose a class and start attending both lectures and quiz sections from the very first day. You should do any worksheets or quizzes. You will NOT be able to access homework until you are officially enrolled in the class.
  3. Important material is covered in the first week, and it is necessary to be in class and do the work during this period. All students are graded in the same way, and no student is excused from the first week's work.

Outline

Week	Outline/Study Guide	Quiz/Exam Archive	Topics and Textbook Sections
1	Outline 1	Week 1 Quizzes	Antiderivatives, Areas and Distances and the Definite Integral. (Sec. 4.9, 5.1, 5.2)
2	Outline 2	Week 2 Quizzes	The Fundamental Theorem of Calculus, Indefinite Integrals and Total Change, the Technique of Substitution. (Sec. 5.3, 5.4, 5.5)
3	Outline 3	Week 3 Quizzes	Areas between Curves, Computing Volume: Washers and Shells. (Sec. 6.1, 6.2, 6.3)
4	Outline 4	Week 4 (MIDTERM #1)	Applications: Work and Average Value of a Function. Midterm #1 (Sec. 6.4, 6.5)
5	Outline 5	Week 5 Quizzes	Techniques of Integration: Integration by Parts, Trigonometric Integrals and Trigonometric Substitution. (Sec. 7.1, 7.2, 7.3)
			More Techniques: Partial Fractions and

6	Outline 6	Week 6 Quizzes	Combining Techniques. Approximation of Integrals. (Sec. 7.4, 7.5, 7.7)
7	Outline 7	Week 7 Quizzes	Improper Integrals and the Length of a Curve. (Sec. 7.8, 8.1)
8	Outline 8	Week 8 (MIDTERM #2)	More Applications: Center of Mass. Midterm #2 (Sec. 8.3)
9	Outline 9	Week 9 Quizzes	Introduction to Differential Equations: Separable Equations and Exponential Growth and Decay. (Sec. 9.1, 9.3, 3.8, [9.4 optional])
10	Outline 10	Week 10 Quizzes / OLD FINAL EXAMS	Final Exam Review.

Math 126 Materials Website

This page contains information for instructors and students of Math 126.

- Note to the students.
- **Math 124/5/6 Grade Policy:** Beginning Autumn 2012, the department of mathematics has adopted a grade policy for this course. The final median course grades for each lecture section of Math 124/5/6 taught during the regular academic year will fall within the range of 2.9 +/- 0.2. This policy does not apply to the honors sections of Math 124/5/6.
- **Required Materials:**
  - All students need an access code for *Webassign*. If you purchased an access code for Math 124/5, you **do not need** a new code. If you need to buy *Webassign* access, you may purchase it, along with an electronic copy of the text, directly from the publisher at this website for $70: http://www.cengagebrain.com/micro/uwmathcalc.
  - If you want a physical copy of the text, purchase "Calculus" by Stewart, vol. 2, from the UW bookstore. This is a portion of the hardbound text "Calculus, 7th Edition, Early Transcendentals" by Stewart. The custom version vol. 1 covers Math 124/125 at UW. The custom version vol. 2 covers Math 126/324 at UW.
  - At the end of the quarter, we will work from these Taylor Notes.
- **Homework:**
  - All homework is assigned and collected via *Webassign*. Log in here: UW *Webassign* login page.
  - If you are new to *Webassign*, here's some info on how to use *Webassign*.
- **Exams and Quizzes:**
  - All sections will have two midterms and one (commonly written) final exam during the quarter.
  - During exams, students may use a scientific calculator and one sheet (8.5x11-inches, both sides) of hand-written notes. (A scientific calculator includes sin, cos, tan, and ln buttons and no more than two-line display. Graphing calculators and programmable calculators are not allowed. The bookstore carries a few scientific calculators that are $10-$15: TI-30XIIs, TI-30Xa, and Sharp EL 500, for example.)
  - Instructors may also give quizzes. Individual instructors may set their own policies for notes and calculators on quizzes.
  - Archive of Old Exams:
    - Old 1st Midterms
    - Old 2nd Midterms
    - Old Final Exams
- **Worksheets:** Instructors may have students work on worksheets during some quiz sections.
  (This directory of worksheets contains some worksheets that were used in previous quarters. The syllabus has changed significantly since these were created---if an instructor wishes to use these worksheets, they will need to be modified for timing and content.)
- Here are some additional materials from previous instructors.

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MATH 307 SYLLABUS

Prerequisite: Math 125; Math 126 strongly recommended.

Text: *Elementary Differential Equations and Boundary Value Problems* by Boyce-DiPrima (Custom 9th ed.);

Note: *The number of lectures allotted to each topic is meant as a guideline only. If you have questions or suggestions concerning the syllabus, please contact Brooke Miller (3-6830).*

Review of First Order Equations - 8 lectures

Boyce-DiPrima: Chapter 2

§2.1-2.5, 2.7
§2.6 and 2.8 (optional)

Second Order ODE's - 12 lectures

Boyce-DiPrima: Chapter 3

§3.1 (1-2 lectures)
§3.2-§ (optional)
§3.3
§3.4, 3.5 (3 lectures)
§3.6 (optional)
§3.7, 3.8 (6 lectures)

Laplace Transforms - 6 lectures

Boyce-DiPrima: Chapter 6

§6.1-§:6.4

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MATH 308 SYLLABUS

Prerequisite: Math 126

Text: *Introduction to Linear Algebra* by Johnson, Riess and Arnold, 5th ed. **Note:** Although the Student's Solutions Manual for the textbook will not be ordered by the University Bookstore, students may be able to locate their own copy. This contains detailed solutions to all odd-numbered exercises.

Math 308 is an introductory linear algebra course and it is assumed that students have a higher level of mathematical maturity. Math 308 is not supposed to be a course in abstract vector spaces.

Math 308 should stress some difficult abstract ideas in concrete form (e.g., linear dependence, subspace) but there should also be substantial time spent on examples of applications of linear algebra. The applications which are found in Johnson and Riess are included in the syllabus below; some instructors may wish to pick applications from other sources, such as *Applications of Linear Algebra* by Rorres and Anton.

Note: Please contact Brooke Miller, 3-6830, if you have questions or suggestions concerning the syllabus.

SYLLABUS FOR 26 LECTURES

This syllabus refers to sections of the textbook.

§1 - **Matrices and Systems of Linear Equations** (9 lectures):

§1.1-1.4: Gaussian Elimination (3 lectures)

.§1.5,1.6: Matrix operations (2 lectures)

§1.7: Linear independence (1 lecture)

§1.9: Data Fitting (1 lecture)

If time is limited, just do the first interpolation application on pp. 76-81; introducing students to the idea of interpolation should help them be prepared for the later section on least squares approximation. These pages also provide a good example of linear independence.

§1.9: Matrix inverses (2 lectures)

§2 - **Chapter 2** is a review of material that the students should have learned in Math 126. Remind the students that they should review the material.

§3 - **$\mathbf{R}^n$** (11 lectures):

§3.1-3.3: Subspaces (3 lectures)

§3.4-3.5: Bases and dimension (3 lectures)

§3.6-3.7: Orthogonal bases and linear transformations (3 lectures)

§3.7 is not really a good place to try to teach abstract linear transformations, but one can teach how to construct the matrix representations of geometric transformations such as rotations and reflections.

§3.8,3.9: Least Squares (2 lectures)

§4 - **Eigenvalues and eigenvectors** (6 lectures)

§4.1-4.3: Introduction to eigenvalues and determinants (2 lectures)

§4.4-4.5: Eigenvalues, characteristic polynomial, eigenspaces. (2 lectures)

§4.8: Applications (2 lectures)

This section can be integrated with the prior eigenvalue sections to furnish further examples of eigenvalue problems.

§4 - **More on eigenvalues** (optional)

§4.6,4.7: Complex eigenvalues, similarity, diagonalization

These ideas are clearly very important for linear algebra, so it would round out the course if this material could be introduced at some level. However this part of the theory will be introduced and studied in Math 309 preparatory to the study of systems of linear differential equations, so these sections are made optional here. Perhaps one could show how diagonalization works in simple cases here, without going into detail about the fine points.

Updated 10-6-04

Here is the syllabus for Math 324. The material in the first four sections of Chapter 15 is review (see the Math 126 syllabus). The material in Chapter 14.5 and 14.6 is used only in Chapter 16, so sections 14.5 and 14.6 have been placed between Chapters 15 and 16.

The text is "Multivariable Calculus - Custom Edition (Early Transcendentals)", 7th Edition by James Stewart.

Chapter	Section	Topics	Comment
		Math 324	
15	1	Double Integrals over Rectangles	
	2	Iterated Integrals	
	3	Double Integrals over General Regions	
	4	Double Integrals in Polar Coordinates	
	5	Applications of Double Integrals	
	6	Surface Area	
	7	Triple Integrals	
	8	Triple Integrals in Cylindrical Coordinates	
	9	Triple Integrals in Spherical Coordinates	
	10	Change of Variables in Multiple Integrals	
14	5	The Chain Rule	
	6	Directional Derivatives and the Gradient Vector	
16	1	Vector Fields	
	2	Line Integrals	
	3	The Fundamental Theorem for Line Integrals	
	4	Green's Theorem	
	5	Curl and Divergence	
	6	Parametric Surfaces and Their Areas	
	7	Surface Integrals	
	8	Stokes' Theorem	
	9	The Divergence Theorem	
	10	Summary	

Search

AMath 301: Beginning Scientific Computing

APPLIED MATHEMATICS
UNIVERSITY of WASHINGTON

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Course Offered:

Autumn, Winter, Spring

Course Description

Introduction to the use of computers to solve problems arising in the physical, biological and engineering sciences. Application of mathematical judgment, programming architecture, and flow control in solving scientific problems. Introduction to MATLAB routines for numerical programming, computation, and visualization. Prerequisite: either MATH 125, Q SCI 292, MATH 128, or MATH 135.

__Department of Applied Mathematics__, University of Washington, Guggenheim Hall #414, Box 352420, Seattle, WA 98195-2420 USA

***Email** 'info' (at amath.washington.edu) **Phone** 206-543-5493 **Fax** 206-685-1440*

Physics 121A, Fall 2012

Mechanics

General

- Welcome to PHYS 121A, the third of a three-quarter sequence of introductory physics courses for science and engineering majors. You should find this course challenging and stimulating, and I hope that you also find it interesting and enjoyable. You should ask questions if you do not understand something. If it is inconvenient to interrupt, make a quick note to yourself and inquire later.

- The course consists of lecture, tutorial, and laboratory components. Each component provides a different way of learning the material. The three elements are carefully coordinated, but are not necessarily synchronized.
NOTE: Concurrent enrollment in 121 tutorial and lab is mandatory

- We will use the following textbooks for this class:
    - Tipler, "Physics for Scientists and Engineers", special UW edition volume 1, or standard 6th edition volume 1
    - "Tutorials in Introductory Physics", Lillian C. McDermott, Peter S. Shaffer, and the Physics Education Group, Updated Preliminary Second Edition. This edition is available only at the UW bookstore.
    - PHYS 121 Lab Manual.

  You will need to purchase separate WebAssign access for both the lab and lectures. These are sometimes packaged with new textbooks, but this only provides access to the lecture homework. It is the recommendation of previous instructors that students buy a secondhand textbook, or one without WebAssign access and use the website to purchase all access necessary. There are instructions for accessing WebAssign here.

- MATH 124 (Calculus I) is a prerequisite/co-requisite for this class. It is the opinion of many instructors that students who have already completed MATH 124 are at a considerable advantage in PHYS 121. Hence, although it is possible to take the PHYS 121-3 and MATH 124-6 as simple co-requisites (i.e. P121 with M124, etc.), students who have no prior experience with either calculus or physics should seriously consider getting 'one quarter ahead' in the MATH 124-6 sequence with respect to the PHYS 121-3 sequence.

- Be aware that many technical majors have a minimum grade requirement for a core of lower-division technical classes including the PHYS 121-2-3 sequence. Therefore, each student is **strongly** urged to discuss departmental entry requirements with their undergraduate or departmental advisors, and plan their course loads accordingly.

Administrative support

- This website provides links to other 12x sites.

- This website provides general Phys 12x policies, TA contacts, etc.

- If you need assistance with registration, please contact:

  Susan Miller
  Email: susanh82@phys.washington.edu
  Office: Physics and Astronomy building C136
  Phone: 206-543-4982

- If you wish to talk with an academic counselor about becoming a physics major or minor, or have general questions about the physics program, please contact the physics department undergraduate advisor:

  Margot Nims
  Email: margot@phys.washington.edu
  Office: Physics and Astronomy building C139
  Phone: 206-543-2772

Grading Policy

- Concurrent enrollment in PHYS 121 lecture, tutorial and lab is mandatory. Students will receive a combined grade for lecture, tutorial and lab. The final course grade is based on the following grade weighting:

Midterm exams (best 2 of 3)	35%
Final exam	24%
Lab section	13%
Tutorial section	9%
Lecture homework	9%
Pre-lectures & Checkpoints	5%
In-class quizzes	5%

- A summary of the grading policy for this course is available in this link, under Grading Allocation.

- Your midterm with the lowest score will be dropped.

- Lab and tutorial grading policies will be explained in your lab and tutorial sections. **Completion of most of the lab and tutorial work is required in order to pass the course.** If you complete fewer than six labs during the quarter, and do not make up the work, or score less than 60% of the available points for the quarter, your grade for the entire course will be 0.0! Only completing seven or six of the eight labs will reduce your grade significantly (about 0.6 or 1.2 grade points, respectively). Do not skip these important activities!

- **Your responsibility**: Check your grades on the WebAssign system every week or two and report any problems to both the lecture instructor and the relevant TAs (and/or lab/tutorial faculty) immediately. Lab, tutorial and exam grades should be recorded for your review within one week from the date of completion of your work. WebAssign homework grades should be recorded within 24 hours of submission. In-class quiz grades shall be recorded at the instructor's discretion. Grading problems that are reported in a timely fashion will be investigated and, if action is warranted, corrected. The lecture, lab and tutorial instructors may choose to ignore grading complaints that are not reported in a timely fashion. The instructions for WebAssign can be found here.

Lectures

- I will be your lecture instructor for PHYS121A. You can find out a little about me at my homepage. You will have different professors in charge of the tutorial and laboratory components, but I will be in charge of the overall class. My contact information is:

  Name: Kazumi Tolich
  Email: ktolich@u.washington.edu
  Anonymous email (no reply possible)
  Office: Physics and Astronomy building B221

- Lectures will be on MWF 9:30am-10:20am, in lecture hall A102 of the Physics and Astronomy Building auditorium wing.

- The following is a tentative weekly course schedule. This will be followed as closely as possible, and changes will be announced as necessary.

Week	Date	Day	Lecture Topic	SmartPhysics	Text reading
1	24-Sep	M	Overview & Motion Concepts	-	1-1 to 1-5
	26-Sep	W	1-D Motion	1. 1-D Kinematics	2-1 to 2-4
	28-Sep	F	2 & 3-D Motion & Vectors	2. Vectors and 2-D Kinematics	1-6 & 7 & 3-1
2	1-Oct	M	Projectiles & More	-	3-2
	3-Oct	W	Relative & Circular Motion	3. Relative and Circular Motion	3-1 to 3-3
	5-Oct	F	Newton's Laws	4. Newton's Laws	4-1 to 4-3 & 4-7
3	8-Oct	M	Analysis of Forces: FBDs	5. Forces, Free Body Diagrams	4-4 to 4-8
	10-Oct	W	Friction, Strings & Pulleys	6. Friction	5-1 to 5-2
	12-Oct	F	**No Class**	-	-
4	15-Oct	M	Circular Dynamics	-	5-3 to 5-4
	17-Oct	W	Work & Review	7. Work and Kinetic Energy	6-1 to 6-3
	18-Oct	Th	**EXAM 1** from 5:00pm to 5:50pm in Kane Hall	-	-
	19-Oct	F	Energy	8. Conservative Forces, Potential Energy	6-4 to 7-1
5	22-Oct	M	Conservation of Energy	9. Work and Potential Energy II	7-2 to 7-5
	24-Oct	W	Systems of Particles & Center of Mass	10. Center of Mass	5-5 & 8-2
	26-Oct	F	Momentum & Impulse	11. Conservation of Momentum	8-1 to 8-3
6	29-Oct	M	Elastic Collisions	12. Elastic Collisions	8-3
	31-Oct	W	Collisions & Explosions	13. Collisions	8-4 to 8-5
	1-Nov	Th	**EXAM 2** from 5:00pm to 5:50pm in Kane Hall	-	-
	2-Nov	F	Rotational Kinematics	14. Rotational Kinematics	9-1 to 9-2
7	5-Nov	M	Rotational Energy & Inertia	15. Parallel Axis Theorem & Torque	9-2 to 9-3
	7-Nov	W	Torque & Rotational Dynamics	16. Rotational Dynamics	9-4 to 9-6
	9-Nov	F	**No Class**	-	-
8	12-Nov	M	**HOLIDAY**	-	-
	14-Nov	W	Torque & Static Equilibrium	17. Rotational Statics	12-1 to 12-3
	16-Nov	F	Angular Momentum	19. Angular Momentum	10-1 to 10-2
9	19-Nov	M	Conservation of Angular Momentum	20. Angular Momentum Vector	10-3 to 10-4
	21-Nov	W	**No Class**	-	-
	23-Nov	F	**HOLIDAY**	-	-
10	26-Nov	M	Universal Gravitation	(revire prelecture #8)	11-1 to 11-2
	28-Nov	W	Review & Extension	-	-
	29-Nov	Th	**EXAM 3** from 5:00pm to 5:50pm in Kane Hall	-	-
	30-Nov	F	More Gravity	-	11-3 to 11-5
11	3-Dec	M	Fluids I	21. Fluid Statics	13-1 to 13-3
	5-Dec	W	Fluids II	22. Moving Fluids	13-4
	7-Dec	F	Review & Extension	-	-
12	12-Dec	W	**FINAL EXAM** from 8:30am to 10:20am in PAA102	-	-

Homework

- Lecture Homework will be assigned and collected weekly through the WebAssign system.
- The homework will be due at 10:59pm each Wednesday. The first homework will be due on the 3rd of October.
- The instructions for WebAssign can be found here.

Pre-lectures & Checkpoints

- We will use Pre-lectures and Checkpoints from SmartPhysics. Access cards can be purchased at the bookstore or online. The bookstore is a better deal, BUT try online first since if you have already purchased 2 quarters of SmartPhysics, you may get this third quarter for free. The course access key for SmartPhysics: UWPhys121A
- Pre-lectures and Checkpoints will be due at 8:00am on the day of the lecture that covers the particular topic.
- Homework from smartPhysics is an optional assignment that does not count toward your grade.

In-Class Quizzes

- I will ask a few questions per lecture where you can respond using an TX3100 RF transceiver (Clicker), which are available from the University Bookstore. **The infrared system that was used in previous years will not work.**
- Your clicker's channel should be configured to channel 01. Instructions to configure your clicker can be found in this link.
- For the in-class quiz component of the supplemental part of your grade, two thirds will come from attempting to answer, and the other third will come from having the correct answer.
- You are encouraged to discuss your answers with your classmates.
- You are required to register your clicker here for your responses to be counted toward your grade.
- If your clicker is not working during an in-class quiz, you can submit a piece of paper with your name, student ID, and your answer written on it **during the in-class quiz** to get credit for it. You cannot turn in the paper after the class. You can do this up to 5 times during the quarter.

- The in-class quizzes and their answers will be posted on the discussion board.

Exams

- **Note that there will be no make-up exams in PHYS 121A.** Students with outside professional, service, or career commitments (i.e. military service, ROTC, professional conference presentation, NCAA sports, etc.) conflicting exactly with the exam dates must contact the instructor *early in the quarter* to establish alternate examination procedures. Students who miss an exam without making prior arrangements with the lecture instructor will drop that exam score.

- **Midterm Exam procedure:**
  - The exam room at Kane Hall will be unlocked until 4:45 pm.
  - Once the doors are unlocked, students will enter the room and pick up the exam from their designated TA.
  - An announcement to begin the exam will be made no later than 5:00pm.
  - Students with questions during the exam should raise their hands. Should access by an instructor prove not feasible, students must come to the end of their row.
  - The exam period shall be 50 minutes.
  - When time expires, students will move toward the exit and deposit their exams. The exam sheets and bubble sheets will be collected separately.

- **Exam Re-grades:** If you believe that the points on the examination were incorrectly totaled, or if there is a gross error in the grading, you may return an exam for regrading. To do so, you must resubmit the examination no later than at the beginning of the lecture following the one in which the exams are returned. You must use this form and attach it to the front page of the exam explaining the possible error in the grading. You must return it to Susan Hong in the physics and astronomy building room C136. **Do not make any changes or marks on the other pages of the examination.** Note that each examination is scanned before being returned. You should be aware that any request for a regrade may result in your total score increasing or decreasing.

Tutorials

- The following website gives more information on the tutorial section. If you have any questions on the tutorial section, you should contact the instructor in charge of that section:

  Prof. Peter Shaffer
  Email: shaffer@phys.washington.edu
  Office: Physics and Astronomy building C218
  Phone: 206-543-6705

- Tutorial homework will be assigned and collected in each tutorial section.

- There will also be weekly tutorial pretests.

- The following table is a list of the tutorials to be completed each week.

Week	Date	Tutorial
1	24-Sep & 25-Sep	**No Tutorial**
2	2-Oct to 4-Oct	1-D Acceleration
3	9-Oct to 11-Oct	Forces
4	16-Oct to 18-Oct	Newton's Laws
5	23-Oct to 25-Oct	Work and Kinetic Energy
6	30-Oct to 1-Nov	Energy Conservation
7	6-Nov to 8-Nov	Conservation of Momentum
8	13-Nov to 15-Nov	Rigid Bodies
9	20-Nov to 22-Nov	**No Tutorial**
10	27-Nov to 29-Nov	Conservation of Angular Momentum
11	4-Dec to 6-Dec	Pressure

Labs

- The following website gives more information on the laboratory section. If you have any questions on the laboratory section, you should contact the instructor in charge of that section:

  Gordon Watts
  Email: gwatts@uw.edu
  Office: Physics and Astronomy building B203
  Phone: 206-543-4186

- The following table is a list of the labs to be completed each week.

Week	Date	Tutorial
1	24-Sep & 25-Sep	**No Lab**
2	2-Oct to 4-Oct	1-D Kinematics
3	9-Oct to 11-Oct	Free Fall & Projectiles
4	16-Oct to 18-Oct	1-D Dynamics
5	23-Oct to 25-Oct	Newton's Laws & Tension
6	30-Oct to 1-Nov	Work & Energy
7	6-Nov to 8-Nov	Momentum & Collisions
8	13-Nov to 15-Nov	Rotaional Kinematics
9	20-Nov to 22-Nov	**No Lab**
10	27-Nov to 29-Nov	Rotational Dynamics
11	4-Dec to 6-Dec	Makeup Labs

Getting help

- **Study Center:**
  - Students are encouraged to gather and work cooperatively in small groups in the Physics Study Center located in room AM018 of Physics and Astronomy building.
  - To reach the Physics Study Center, go down the stairs that circle behind the Foucault pendulum and proceed toward the end of the hall.

- Teaching assistants will be available for consultation during many portions of the day if your study group needs assistance, but staffing levels will not support much individual attention.
- The Study Center is staffed from approximately 9:30am to 4:30pm on weekdays. A schedule of who is staffing the physics study center can be found here: Study Center Hours.

- **Office hours:**
  - You are strongly encouraged to visit me regularly during office hours, which I will hold in the study center on Fridays from 10:30am to 12:30pm.
  - You can also arrange a meeting with me if you cannot come to my office hours.
  - Our teaching assistant is also holding office hours on Mondays and Wednesdays from 8:30am to 11:20am.
  - I will attempt to answer questions by email in a timely manner.

- **Discussion forum:**
  - There will be a discussion board for PHYS121.
  - You are encouraged to ask your fellow students for help with homework, or to organize study groups, etc.

UW SafeCampus

- Preventing violence is everyone's responsibility. If you're concerned, tell someone.
- Always call 911 if you or others may be in danger.
- Call 206-685-SAFE (7233) to report non-urgent threats of violence and for referrals to UW counseling and/or safety resources. TTY or VP callers, please call through your preferred relay service.
- Don't walk alone. Campus safety guards can walk with you on campus after dark. Call Husky NightWalk 206-685-WALK (9255).
- Stay connected in an emergency with UW Alert. Register your mobile number to receive instant notification of campus emergencies via text and voice messaging. Sign up online here
- For more information visit the SafeCampus website.

Physics 122 Winter 2013   Prof. David Hertzog

Last Update: 12/30/12 2:42 PM

Week	Day	Date	Lecture topic	Text	SmartPhysics	Tutorial	lab
1	M	7-Jan	Charge & Coulomb's Law	21-1 to 21-3	Coulomb's law	No tutls 1st week	No lab 1st week
	W	9-Jan	Electric Field Vectors & Lines	21-4 to 21-5	Electric Field		
	F	11-Jan	Electric Fields Act on Charges	21-5 to 21-6	**No SP today**		
2	M	14-Jan	E for Continuous Chg Distrib.	22-1 to 22-2	Electric Flux	Charge	Electrostatics
	W	16-Jan	Flux & Gauss' Law	22-2 to 22-3	Gauss' law		
	F	18-Jan	Gauss' Law Applied	22-4 to 22-6	Elec Potl Energy		
3	M	21-Jan	**HOLIDAY**	-		E-Field & Flux	Electric Fields
	W	23-Jan	Electric Potential Energy		**No SP today**		
	Th	24-Jan	**EXAM 1**				
	F	25-Jan	Electric Potential	23-1 to 23-2	Elec Potential		
4	M	28-Jan	E from V and V for Chg. Distrib.	23-3 to 23-4	**No SP today**	Gauss' Law	DC Circuits I
	W	30-Jan	Equipotentials & Potl. Energy	23-5 to 23-6	Conductrs & Capacitance		
	F	1-Feb	Capacitance & Energy	24-1 to 24-2	Capacitors		
5	M	4-Feb	Dielectrics & Combined Caps	24-3 to 24-5	**No SP today**	Electric Pot. Difference	DC Circuits II
	W	6-Feb	Current, Voltage & Resistance	25-1 to 25-2	Electric Current		
	F	8-Feb	Energy, Resistors & Kirchhoff	25-3 to 25-5	Kirchhoff's Rules		
6	M	11-Feb	Multiloop & RC Circuits	25-5 to 25-6	RC Circuits	Circuits III	Capacitors & RC Circuits
	W	13-Feb	Review & Extension	-	**No SP today**		
	Th	14-Feb	**EXAM 2**	-			
	F	15-Feb	Magnetic Fields & Forces	26-1 to 26-2	Magnetism		
7	M	18-Feb	**HOLIDAY**	-		Mag Interactions	Electronic Devices
	W	20-Feb	Charges & Currents in B Fields	26-2 to 26-4	Forces & Torques		
	F	22-Feb	Biot Savart Law	27-1 to 27-2	Biot-Savart		
8	M	25-Feb	Gauss' Law for B, Ampere's Law	27-3 to 27-4	Ampere's Law	Ampere's Law	Magnetic Fields & Forces
	W	27-Feb	Motional EMF	28-1 to 28-3	Motional EMF		
	F	1-Mar	Faraday's Law, Lenz' Law, Eddy Currents	28-4 to 28-5	Faraday's Law		
9	M	4-Mar	Inductance, Energy & RL Circuits	28-6 to 28-8	Induction, RL Circuits	Lenz' Law	EM Induction
	W	6-Mar	Review & Extension	-	**No SP today**		
	Th	7-Mar	**EXAM 3**				
	F	8-Mar	AC Circuits I	29-1 to 29-4	LC and RLC Circuits		
10	M	11-Mar	AC Circuits II	29-5 to 29-6	AC Circuits	Faraday's Law	Make-up Labs
	W	13-Mar	Displacement Current & Maxwell's Eqns	30-1 to 30-2	Resonance		
	F	15-Mar	Maxwell's Equations & EM Waves	30-2 to 30-4	**Displacement Current & EM Waves**		
11	**M**	**18-Mar**	**FINAL Exam for 122 C (only)**	**8:30 - 10:20**	**ROOM A118**		
	W	**20-Mar**	**FINAL Exam for 122 A (only)**	**8:30 - 10:20**	**ROOM A102**		

Syllabus: PHYS 123 A and C, Spring 2013

- Lecture Instructor: Prof. Daryl Pedigo

  e-mail: rdp3@uw.edu

  Office: PAB C138 Phone: (206) 543-4983

- Tutorial Instructor: Prof. Peter Shaffer shaffer@phys.washington.edu
- PHYS 123 Lab Instructors: Prof. Bob Van Dyck vandyck@phys.washington.edu and Prof. David Pengra dbpengra@uw.edu
- Course WWW: http://courses.washington.edu/pedigo/phys123spr13/
- **Prof. Pedigo's Office Hours** in the Study Center: **Mondays 2:50-3:50 pm, Tuesdays 11 am - noon.**
- Also available by appointment in my office.

- Lecture Hall: Section A and C: room A102, in the auditorium wing of the Physics and Astronomy Building.
- Lecture schedule: section A = MWF 9:30- 10:20, Section C = MWF 10:30-11:20.
- Holiday: Monday May 27. Also lecture canceled Friday April 19. See Schedule below for more information

- Course Texts: BOTH Volumes of Tipler, "Physics for Scientists and Engineers", 6th edition; McDermott and Shaffer "Tutorials in Introductory Physics"; PHYS 123 Lab Manual.
- NOTE: Concurrent enrollment in 123 Lab and tutorial is **mandatory**
- WebAssign Homework will be due as announced.

- Tentative Weekly Course Schedule: {Note: One canceled lecture day during this spring quarter.}
  - The schedule for Phys 123 A & C is available here: **Phys 123 Schedule**
  - This will be followed as closely as possible, and changes will be announced as necessary.

Lecture Instructor's Comments

- Welcome to PHYS 123, the last of a three-quarter sequence of introductory physics courses for physics and engineering majors. You should find this course challenging and stimulating, though perhaps it will not fit your preconceptions of what a university physics course should be. I hope that you also find it to be interesting and enjoyable. Have a great quarter! Lecture sections A and C will use the Pre-lectures and Checkpoints from SmartPhysics. Access cards can be purchased at the bookstore or online (the bookstore is a better deal, BUT try online first-- if you have already purchased 2 quarters of SmartPhysics, you should get this third quarter for free).
- The course design is a cooperative effort of many faculty, each of whom is deeply concerned with providing the most effective learning experience for every student. Each element of the course (lecture, lab and tutorial) is essential to your mastery of physics. The three elements are carefully coordinated, but are not necessarily synchronized. Research has shown that presenting

material in cycles, so that the same topic is approached more than once from different viewpoints, is a very effective means of encouraging deeper understanding and long-term retention of ideas.

- You are strongly encouraged to visit with me and/or my TA regularly during office hours, by appointment, by e-mail, by phone, etc. Get used to the idea of seeing the Professor outside of class during the quarter; it will pay off for you in many ways as the years go by! This will not happen unless YOU take the initiative, and now is a great time to start.
- Memorization of material is not particularly helpful in this class. Your goal in this class should be to understand how each new topic is related to all of the previous material, and how the concepts, rules and formulae can be applied to solve real-world problems. Never let anything go by if you do not understand. Generally, ask questions immediately. If it is inconvenient to interrupt, make a quick note to yourself and inquire later.

General Comments

- Each quarter, the UW Office of Educational Assessment conducts surveys of undergraduate courses. For many years, the PHYS121-2-3 courses have been among the courses reportedly requiring the most hours of work per week outside of class. A typical course will show a span from 5 hours per week to 20 hours of study per week outside of class. Many courses claim to require at least two hours outside of class for each hour in class; PHYS 121-2-3 delivers.
- Note that MATH 126: (Calculus III) is a prerequisite for this class. But also note that this class will require considerably <u>less</u> calculus than PHYS 122, so if you made it through PHYS 122 you should be in fine shape for this course, math-wise.
- Be aware that many technical majors have a minimum grade requirement for a core of lower-division technical classes including the PHYS121-2-3 sequence. Therefore, each student is **strongly** urged to discuss departmental entry requirements with their undergraduate or departmental advisors, and plan their course loads accordingly. The course grading policy is detailed below.

Grading Policy

Concurrent enrollment in PHYS123 lecture, tutorial and lab is mandatory; students will receive a combined grade for lecture, tutorial and lab. The final course grade is based on the best two of three midterms, the final exam, the WebAssign lecture HW, tutorial participation and HW, supplemental assignments and lecture exercises (using the H-ITT classroom "clicker" response system), and lab participation and pre- and post-lab exercises. A summary of the grading policy for this course may be found in the **<u>12X Grading Policy Statement</u>**.

- **Midterm exams**: There will be three closed-book midterm exams administered on Thursday afternooons in Kane Hall or other locations to be announced. Each midterm will emphasize recent material, but may include questions dealing with topics from far earlier in the course. The exams will include both multiple choice and essay-style questions. Only the best two of three exam scores will count toward the final course grade, but note that all midterm scores are first renormalized so that the class average across both lecture sections is 66%. Your lowest midterm score (relative to the mean) will be dropped, and the resulting average of "best 2 midterms" is likely to be slightly above 70%. The best 2 midterms will contribute 35% to your final raw grade. On each midterm, a list of equations from the relevant chapters will be attached to the exam. Calculators are permitted. Cell phones, radios, etc. are <u>not</u> permitted. Computers or devices with internet access are <u>not</u> permitted, and the use of the text-storage capability now available on many calculators is <u>not</u> permitted. Exams are to be your own work; you are <u>not</u> permitted to collaborate with any other person. The Physics department reserves the right to ask for valid identification from any student just before, during, or just after examinations.

- **Note that there will be no make-up exams in PHYS 123**. Students with outside professional, service, or career commitments (i.e. military service, ROTC, professional conference presentation, NCAA sports, etc.) conflicting exactly with the exam dates must contact the instructor *early in the quarter* to establish alternate examination procedures. Students who miss an exam without making prior arrangements with the lecture instructor will drop that exam score. Except for extreme circumstances, a final grade of 0.0 may be assigned to any student who misses two midterm exams.
- **Final Exam**: A two-hour closed-book comprehensive final exam worth 24% of the final course grade will take place on Wednesday, June 12, from 8:30-10:20 am for Section A, and on Monday, June 10, from 8:30-10:20 am for section C, in either the usual physics lecture room or a room to be announced. This examination will cover material from the entire course. For the final exam a list of equations from the relevant chapters will be attached to the exam. Calculators are permitted. Cell phones, radios, etc. are <u>not</u> permitted. Computers or devices with internet access are <u>not</u> permitted, and the use of the text-storage capability now available on many calculators is <u>not</u> permitted. Exams are to be your own work; you are <u>not</u> permitted to collaborate with any other person. The Physics department reserves the right to ask for valid identification from any student just before, during, or just after the final examination. A final grade of 0.0 may be assigned, at the instructor's discretion, to any student who does not take the final exam.
- **Exam Re-grades**: If you believe that the points on the examination were incorrectly totaled or if there is a gross error in the grading, you may return an exam for regrading. To do so, you must resubmit the examination no later than at the beginning of the lecture following the one in which the exams are returned. You must write a brief note **on separate paper** explaining the possible error in the grading, and attach it to the relevant hand graded portion of the exam . **Do not make *any* changes or marks on any pages of the examination.** Portions of each examination are scanned or photocopied. You should be aware that any request for a regrade may result in a regrading of the entire exam (therefore your total score may increase or decrease).
- **Labs and Tutorials:** Grading policies will be explained in your lab and tutorial section. Please note that grades for lab and tutorial form a significant percentage of your overall grade for the course. Also, **completion of most of the lab and tutorial work is <u>required</u> in order to pass the course**. For example, if you complete fewer than six labs during the quarter, and do not make up the work, your grade for the entire course will be 0.0 ! The same is true of you score less than 60% of all possible lab points for the quarter. Even completing six of the eight labs and barely 60% of the points will reduce your grade significantly. Do not skip these important activities!
- **Homework**:
    1. Lecture homework will be assigned and collected weekly through the WebAssign system.
    2. Tutorial homework will be assigned and collected in each tutorial section. A portion of each assignment will be graded in detail, and will contribute to your score for tutorials.
    3. Pre-and post-lab exercises require access to WebAssign as well. There may also be computer projects assigned in the tutorial sections. Computers are available in the Physics Study Center from 8:30 am-5:20 pm on weekdays and at various other locations around campus.
    4. Pre-Lectures and Checkpoints also require web access, but count separately from homework.
- **Your responsibilty**: Check your grades on the WebAssign system every week or two and report any problems to both the lecture instructor and the relevant TAs (and/or lab/tutorial faculty) immediately. Lab, tutorial and exam grades should be recorded for your review within one week from the date that papers are submitted for grading. WebAssign homework grades should be recorded within 24 hours of submission. Clicker scores and other supplemental assignments may be recorded only once (or a few times) during the quarter, at the discretion of the instructor. Grading problems that are reported in a timely fashion will be investigated and, if action is warranted, corrected. **The lecture, lab and tutorial instructors may choose to ignore grading complaints that are not reported in a timely fashion.**

The Physics Study Center

Students are encouraged to gather and work cooperatively in small groups in the Physics Study Center located in room AM018 of PAB. (to reach the Physics Study Center, go down the stairs that circle behind the Foucault pendulum and proceed toward the end of the hall). Teaching assistants will be available for consultation during many portions of the day if your study group needs assistance, but staffing levels will not support much individual attention. The Study Center is staffed from approximately 9:30am to 5:30pm on weekdays.

CHEMISTRY 142A (SLN 11820), SPRING 2013

SYLLABUS

Lectures: M, W, F 8:30 AM – 9:20 AM in Kane 120

Course Web Site: https://canvas.uw.edu/

Add or Drop: Go to Bagley 303 (Chemistry Department's undergraduate services).

Course Instructor: **Dr. Andrea D. Carroll**

Office: BAG 219 Telephone: 206-616-5319 Email: ageddes@uw.edu
Office hours: Wed 10:00 AM -12:00 PM, or by appointment

Lab Instructor: **Dr. Andrea D. Carroll**
Email: ageddes@uw.edu
Office hours: by appointment

Teaching Assistants:

Name	Email	Sections
Marissa Wood	marissw@uw.edu	AA, AC
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Christiane Stachl	stachl5@uw.edu	AK
Alexandra Taipale	ataipale@uw.edu	AL

MATERIALS

Except where indicated, all items are required and available from the University Bookstore:

- ***Chemical Principles, 7th ed.,*** Steven Zumdahl (custom-split Chem 142 version contains Chapters 1-8 and the complete Student Solutions Manual).
- ***Study Guide, Chemical Principles, 7th ed.,*** Zumdahl/Kelter (*optional*).
- ***UW General Chemistry 142 Laboratory Manual, Autumn 2012-Summer 2013*** (Hayden McNeil)
- **UW Chemistry Laboratory Notebook** with numbered pages and carbonless duplicate pages. (Hayden McNeil)
- **Lab coat and safety goggles** (*NO* safety glasses or any other type of goggles).
- **Scientific calculator.**
- **ALEKS access**. Purchase online at: www.aleks.com (*see ALEKS document and links on the front page of the course website for more information and instructions for registering).*
- **Standard (purple) Scantron forms for exams.**

LEARNING OBJECTIVES

The central focus of this course is to develop quantitative problem solving skills. You will:

1. Learn to clearly define a problem and develop solutions for that problem including the use of central and auxiliary equations and conversion factors.
2. Learn to acquire and analyze data and correctly report experimental results (e.g., using an appropriate number of significant figures) in solutions to problems.
3. Develop a detailed understanding of the following fundamental chemistry topics:
    - The atomic nature of matter
    - Stoichiometry
    - Gases
    - Chemical equilibrium
    - Applications of aqueous equilibria to acid/base and solubility chemistry
4. Conduct laboratory exercises that:
    - Explore the concepts introduced in lectures.
    - Develop laboratory, data analysis, and scientific communication skills.

COURSE COMPONENTS AND GRADING

The course consists of:

- 3 lectures per week
- 1 discussion section per week
- 1 three-hour laboratory session certain weeks of the quarter (6 labs total – see the Lab Resources page of the course website for details)
- Daily work in the ALEKS online learning environment
- Online pre-lab and paper-based post-lab assignments

GRADING

The point distribution for the evaluative components of the course is as follows:

2 Midterm exams (45 minutes each)	40%
Final exam (1 hour 45 minutes)	30%
Discussion section participation	5%
ALEKS Objectives & Last Assessment	10%
Laboratory	15%
TOTAL	**100%**

Grade Distribution. The final mean GPA in Chemistry 142 generally falls within the range 2.6 +/- 0.2. It is the Chemistry Department's policy not to make grade changes of 0.1 after final class grades are submitted to the UW Registrar.

Your scores for the various assignments, reports, and exams will be recorded using the online Gradebook in Canvas.

DEPARTMENT OF CHEMISTRY
UNIVERSITY *of* WASHINGTON

Lab Courses

Time Schedule
Choosing Intro Courses
Choosing Organic Courses
Duplication Guidelines
Study Center
Student Lab Account
Student Lab Attire
Lab Safety Protocols
Add / Drop Class

Chem 142 Labs

What do you need to do to prepare for lab? What should you do if you miss lab? The answers to these and other important questions can be found here:
Frequently Asked Questions for Gen Chem Labs

Grading rubric for lab notebook pages (pdf, rev 10/3/12)

Exp 1. **Chemical Composition of Compounds**
Exp 2. **Stoichiometry I**
Exp 3. **Stoichiometry II**
Exp 4. **Reactivity Trends**
Exp 5. **Molar Mass of a Low Boiling Liquid**
Exp 6. **Calibration Curves and an Application of Beer's Law**

Important!! Don't forget to complete the UG Stockroom Contract in Catalyst by 11:30am on Monday, October 8th. This assignment may be accessed using the link on the Laboratory page on your course website.
Chem 142A (Reid)
Chem 142B (Bryant)
Chem 142C (Carroll)
Chem 142D (Marchlewicz)

CEE 220—Introduction to Mechanics of Materials

Catalog Description:	Introduction to the concepts of stress, deformation, and strain in solid materials. Development of basic relationships between loads, stresses, and deflections of structural and machine elements such as rods, shafts, and beams. Load-carrying capacity of these elements under tension, compression, torsion, bending, and shear forces. Prerequisite: minimum grade of 2.0 in AA 210; cannot be repeated if achieved a minimum grade of 2.5. Offered: WSpS
Credits:	4
Contact Hours:	5
Lab/Quiz Section:	true
Text:	*Mechanics of Materials*, UW edition, Hibbeler, R.C., Prentice-Hall, New Jersey, 2010.
Coordinator(s):	Gregory Miller, Dorothy Reed
Required/Selected Elective:	Required

Learning Objectives

- Each student will demonstrate a basic working knowledge of the fundamental concepts and problem-solving techniques associated with stress, strain, simple constitutive theory, and with applications involving axial loading, pressure vessels, torsion, and bending, including introductory-level statically indeterminate systems. This will result in students being able to solve well-posed problems with reasonable speed and accuracy.
- Students will have accumulated practice in solving a variety of application problems individually and in group settings.
- Students will have gained experience in generating and presenting suitable solutions to open-ended problems involving course concepts in combination with other general considerations.
- Students will be able to carry on technical discussions involving the concepts in the course.

Course Topics

1. Stress: basic concepts (load intensity, normal and shear components) and tensorial aspects of stress states (2D transformation equations, Mohr's circle (2D and 3D), standard representations). (3 weeks)
2. Strain: basic concepts and tensorial fundamentals. Strain gauge rosettes. (1 week)
3. Constitutive Behavior: stress-strain aspects of material behavior (stress-strain curves, isotropic Hooke's law, strain energy); simple failure theories (Von Mises, Tresca, Rankine, Mohr-Coulomb) (2 weeks)
4. Applications: axial loading, pressure vessels, torsion, bending, and combined loading. Determination of stresses and deformations using equilibrium, kinematics, and constitutive relations for statically determinate and indeterminate problems. (5 weeks)

Relationship of course to ABET student outcomes:

Directly addresses the following outcomes:

a) an ability to apply knowledge of mathematics, science, and engineering appropriate to the discipline;
c) design a system, component or process; and
e) identify, formulate and solve problems._________________________

ME 230 Kinematics and Dynamics

Course Coordinator: B. Fabien Interest Group SDD

Catalog Description: Kinematics of particles, systems of particles, and rigid bodies; moving reference frames; kinetics of particles; systems of particles; and rigid bodies; equilibrium; energy, linear momentum, angular momentum. (4 cr)

Course Overview: Dynamics is the understanding and description of various quantities involved in the motion of bodies. Dynamics has many practical applications and is fundamental to advanced topics such as fluid mechanics, structural dynamics and vibrations. Challenges in the course include the difficulty in visualizing how particles move, encountering problems that do not seem related to theories and finding out that everything learned in statics, except the free body diagrams will not work in dynamics.

Course Prerequisites: AA 210 Statics

Textbook: *Engineering Mechanics: Dynamics*, 13th Ed., Hibbeler, R.C., Prentice-Hall, 2012.

Course Objectives: By the end of this course, the student will be able to:

1) Outline the procedure to solve for displacement and velocity through the use of Newton's laws.
2) List the important dynamic quantities
3) Identify system for which dynamic quantities are conserved.
4) Identify conserved dynamical quantities in a given dynamical system
5) Apply appropriate kinematic principles to express velocities and accelerations in a dynamical system.
6) Construct free body diagrams for mechanical systems.
7) Derive mathematical models for dynamical systems.
8) Calculate dynamic quantities such as kinetic and potential energy, linear momentum and angular momentum of a dynamical system

Topics Covered:

1) Rectilinear and Curvilinear
2) Equations of Motion –
3) Rectangular, polar and normal/tangential coordinates –
4) Circular motion, relative motion –
5) Newton's Law –
6) Work-energy, potential energy, conservation of energy
7) Relative motion: velocity and acceleration –
8) Impulse and momentum

Class/laboratory schedule: Three 1-hr lectures and one 2-hr recitation each week.

Contribution of Course to Professional Component: Satisfies preparation for engineering practice by incorporating basic engineering science, engineering/professional standards, and technical communication.

Relationship of course to program Outcomes: Directly addresses the following programmatic outcomes:

a) An ability to apply knowledge of mathematics, science, and engineering appropriate to the discipline.________________________

A.2 Core Program Courses (Including our Prerequisites)

AA 198 SPECIAL TOPICS IN AERONAUTICS AND ASTRONAUTICS

EARLY FALL START

CREDITS AND CONTACT HOURS: 1-5 credits, 10 credits max. 2 to $2^1/_2$ hours per day for 4 or 5 days a week for 4 weeks.

COORDINATOR: C. Knowlen, Research Scientist/Engineer and Lecturer

TEXTBOOK: None

SUPPLEMENTAL MATERIALS: Varies depending on instructor.

CATALOG DATA: SPECIAL TOPICS IN AERONAUTICS AND ASTRONAUTICS
Introduces the field of Aeronautics and Astronautics. Topics include aircraft flight, rocket propulsion, space travel, and contemporary space missions. May include hands-on activities. For non-majors. Offered: Early Fall Start.

PREREQUISITES BY TOPIC: None

OUTCOMES:
1) Introduce aerospace technology related topics.
2) Develop a general awareness and interest in advances in science.

RELATIONSHIP TO STUDENT OUTCOMES:

a) An ability to apply knowledge of mathematics, science, and engineering.
h) The broad education necessary to understand the impact of engineering solutions in a global and societal context.
i) A recognition of the need for, and an ability to engage in life-long learning.
j) A knowledge of contemporary issues.

TOPICS: Various may include:

1. Aircraft flight
2. Rocket propulsion
3. Space travel
4. Others

AA 210 STATICS (Prerequisite)

AUTUMN, WINTER AND SUMMER QUARTERS

CREDITS AND CONTACT HOURS*:* 4 credits*,* Three 50 minute lectures per week and one 50 minute quiz section.

COORDINATOR: C. Knowlen, Research Scientist/Engineer and Lecturer

TEXTBOOK: *Engineering Mechanics Statics and Dynamics*, Bedford, Anthony M. and Fowler, Wallace 5th Edition, 2007

SUPPLEMENTAL MATERIALS: None

CATALOG DATA: ENGINEERING STATICS, Required
Vector analysis applies to equilibrium of rigid body systems and subsystems. Force and moment resultants, free body diagrams, internal forces, and friction. Analysis of basic structural and machine systems and components. Prerequisites: either MATH 126, MATH 129, or MATH 136, PHYS 121.

PREREQUISITES BY TOPIC: Calculus and Physics

OUTCOMES:

1) Students will understand basic concepts of vectors and vector operations and be able to apply these tools to the analysis of forces and torques acting on a body.
2) Students will be able to formulate and solve a system of equations for the forces and torques necessary to maintain equilibrium of various 2D and 3D systems by applying Newton's First and Third Laws.
3) Students will gain experience with the concept of the centroid and moments of inertia.
4) Students will develop Confidence in analyzing the internal forces and moments acting throughout a given structure.
5) Students will be able to analyze the behavior of simple systems involving static and kinetic friction.

RELATIONSHIP TO STUDENT OUTCOMES:

a) An ability to apply knowledge of mathematics, science, and engineering.
e) An ability to identify, formulate and solve engineering problems.
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:

1) Overview of statics. Vectors: addition, components, dot product
2) Type of forces; equilibrium; free-body diagrams.
3) Forces and moments; moment as cross-product; couples; equivalent systems of forces.
4) Equilibrium of supported bodies; types of supports; 2-D and 3-D applications.
5) Analysis of common structures - tresses and frames.
6) Centers of mass; distributed forces.

7) Moments of inertia; applications of theorems for computation.
8) Internal forces; shear and bending moments.

AA 260 THERMODYNAMICS (Prerequisite)

SPRING AND SUMMER QUARTER

CREDITS AND CONTACT HOURS: 4 credits**,** Four 50-minutes meeting times per week one 50 minute time may be used for recitation review or quiz section.

COORDINATOR: C. Knowlen, Research Scientist/Engineer and Lecturer

TEXTBOOK: *Thermodynamics; An Engineering Approach*, Cengel, Y.A. Boles, M.A., 7th Edition, McGraw-Hill, N.Y. 2010

SUPPLEMENTAL MATERIALS: None

CATALOG DATA: THERMODYNAMICS, Required
Introduction to the basic principles of thermodynamics from a macroscopic point of view. Emphasis on the First and Second Laws and the State Principle, problem solving methodology, air-standard cycles. Prerequisites: CHEM 142 or CHEM 145; either MATH 126, MATH 129, or MATH 136; and PHYS 121. Offered Sp, S

PREREQUISITES BY TOPIC:
1) Calculus and analytic geometry
2) General Chemistry
3) Calculus based physics (mechanics)

OUTCOMES:
1) Students will understand the *P-V-T* behavior of pure substances as determined by analytical equations of state and tabulated properties.
2) Students will understand first law of thermodynamics and its application to closed and open systems under steady and transitory conditions.
3) Students will understand second law of thermodynamics and its application to analysis of closed and open systems and energy conversion mechanisms.
4) Students will understand vapor and gas power cycles and refrigeration.

RELATIONSHIP TO STUDENT OUTCOMES:
a) An ability to apply knowledge of mathematics, science, and engineering
e) An ability to identify, formulate, and solve engineering problems
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

TOPICS:
1) Introduction
   a. Concepts of units and dimensions, pressure, temperature, heat, work.
2) Macroscopic Properties of Substances
   a. P-V-T relationships for simple substances including ideal gas law and steam tables.
3) First Law of Thermodynamics
   a. Principles of first law analysis for closed systems.

b. Principles of Energy Analysis: Procedure for energy analysis of closed and open systems, including flow work and shaft work concepts.

4) Second Law of Thermodynamics
   a. Definition and concepts of the second law of thermodynamics in its macroscopic form. Consequences of the second law of thermodynamics for open and closed systems and engineering devices.
5) Power and Refrigeration Cycles;
   a. Vapor power, gas power, and refrigeration cycles. One cycle (instructor's choice) is covered in depth either the remaining two being introduced. Chapters 8, 9, and 10 in the current book (2 weeks).
6) Instructor's Choice: To expand on previous topics or introduce a new topic (1 week)

AA 299 UNDERGRADUATE RESEARCH

AUTUMN, WINTER, SPRING, SUMMER QUARTERS

CREDIT AND CONTACT HOURS: 1-5 credits, Independent Study

COORDINATOR: Various faculty

TEXTBOOK: None

REFERENCES: None

CATALOG DATA: UNDERGRADUATE RESEARCH, Elective
Investigation of a special project by the student under the supervision of a faculty member. For freshman and sophomore students.

PREREQUISITES BY TOPIC: Depends on project.

OUTCOMES:

RELATIONSHIP TO STUDENT OUTCOMES:

a) An 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.
c) An ability to design a system, component, or process to meet desired needs….
d) An ability to function on multi-disciplinary teams.
e) An ability to identify, formulate, and solve engineering problems.
f) An understanding of professional and ethical responsibility.
g) An ability to communicate effectively.
h) The broad education necessary to understand the impact of engineering solutions in a global and societal context.
i) A recognition of the need for, and an ability to engage in life-long learning.
j) A knowledge of contemporary issues.
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS: Vary with each project.

AA 301 COMPRESSIBLE AERODYNAMICS

WINTER QUARTER

CREDITS AND CONTACT HOURS: 4 credits, Four 50-minute lectures per week.

COORDINATOR: M. Kurosaka, Professor of Aeronautics and Astronautics

TEXTBOOK: *Fundamentals of Aerodynamics*, John Anderson, 5th Ed., McGraw Hill, 2010.

SUPPLEMENTAL MATERIALS: None

CATALOG DATA: COMPRESSIBLE AERODYNAMICS, Required
Aerodynamics as applied to the problems of performance of flight vehicles in the atmosphere. Kinematics and dynamics of flow fields. Thin airfoil theory; Compressible fluids; one-dimensional compressible flow; two-dimensional supersonic flow. Prerequisite: either AA 260 or ME 323. Offered: W.

PREREQUISITES:
1) Vector analysis
2) Physics (mechanics)

OUTCOMES:
1. Students will understand the effects of compressibility on fluid flow.
2. Students will be able to solve problems with shock waves and expansions.
3. Students will be able to solve one-dimensional, compressible flow problems.
4. Student will be able to calculate the performance of supersonic airfoils.
5. Student groups will be able to design a supersonic nozzle.

RELATIONSHIP TO STUDENT OUTCOMES:
a) An ability to apply knowledge of mathematics, science, and engineering.
e) An ability to identify, formulate, and solve engineering problems
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:
1) Dimensionless parameters, magnitude of force and movement coefficients (3 lectures)
2) Continuity and momentum laws in 3-D (4 lectures)
3) Shock and expansion waves (6 lectures)
3) One-dimensional flow fundamentals (10 lectures)
4) Linear equations with application to airfoils (10 lectures)
5) Method of characteristics and application to 2D, supersonic flows (7 lectures)

AA 302 INCOMPRESSIBLE AERODYNAMICS

SPRING QUARTER

CREDITS AND CONTACT HOURS: 4 credits**,** Four 50-minute lectures per week.

COORDINATOR: M. Kurosaka, Professor of Aeronautics and Astronautics

TEXTBOOK: *Fundamentals of Aerodynamics*, Anderson, John M.,5th Ed., McGraw Hill 2010

SUPPLEMENTAL MATERIALS: None

CATALOG DATA: INCOMPRESSIBLE AERODYNAMICS, Required
Aerodynamics as applied to the problems of performance of flight vehicles in the atmosphere. Kinematics and dynamics of flow fields; incompressible flow about bodies. Thin airfoil theory; finite wing theory. Prerequisite: minimum grade of 1.7 in AA 301; PHYS 123; either AMATH 351, MATH 136, or MATH 307; MATH 324. Offered: Sp.

PREREQUISITES BY TOPIC:

1) Vector analysis
2) Physics (mechanics)

OUTCOMES:

1) Students will understand basic properties of fluids.
2) Be able to develop the mass and momentum conservation laws.
3) Be able to calculate velocity fields, streamlines, vorticity and circulation.
4) Have the ability to solve airfoil problems using superposition.
5) Be able to calculate the lift and induced drag of a 3D wing.

RELATIONSHIP TO STUDENT OUTCOMES:

a) An ability to apply knowledge of mathematics, science, and engineering.
c) An ability to design a system, component, or process to meet desired needs….
e) An ability to identify, formulate, and solve engineering problems.
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:

1) Forces and Moments, Coefficients & its eqns + center of pressure; Buckingham PI theorem, Flow similarity; Line, surface, volume integrals; continuity eqn; (3 lectures)
2) Conservation laws in 3-D, substantial derivatives (3 lectures)
3) Flow visualization, vorticity, streamlines, strain rates (2 lectures)
4) Circulation; stream function; Velocity potential (1 lecture)
5) Bernoulli Eqn; venturi & pitot tube, Pressure coefficient; Laplace eqn. (1 lecture)
6) Potential flow (6 lectures)
7) 2D airfoil theory (5 lectures)
8) Finite wing (5 lectures)

9)	Axisymmetric 3D flow	(1 lecture)
10)	Horizontal stability	(1 lecture)
11)	How to use VLAERO by AMI	(one 2 hr lecture)
12)	Project lecture by Boeing Employee	(two 2 hr lectures)
13)	Lecture from one of last year's projects	(one 2 hr lecture)
14)	Performing project	(7 lectures)
15)	Mid-project review	(1 lecture)

AA 310 ORBITAL AND SPACE FLIGHT MECHANICS

AUTUMN QUARTER

CREDITS AND CONTACT HOURS: 4 credits**,** Four 50-minutes lectures per week.

COORDINATOR: J. Hermanson, Professor of Aeronautics and Astronautics

TEXTBOOK: *Orbital Mechanics: For Engineering Students*, H. Curtis, Butterworth-Heinemann, Second Edition, Elsevier, 2004.

SUPPLEMENTAL MATERIALS: *Fundamentals of Astrodynamics*, R. Bate, D. D. Mueller, and J. E. White, Dover, 1971.

CATALOG DATA: ORBITAL MECHANICS, Required
Newton's law of gravitation. Two-body problem, central force motion, Kepler's laws. Trajectories and conic sections. Position and velocity as functions of time. Orbit determination and coordinate transformations. Rocket dynamics, orbital maneuvers, Hohmann transfer. Interplanetary trajectories, patched conics. Planetary escape and capture. Gravity assist maneuvers. Prerequisite: M E 230. Offered: A.

PREREQUISITES BY TOPIC:

1) Calculus and analytic geometry
2) Differential equations
3) Engineering dynamics

OUTCOMES:

1) Students will have a general understanding of space flight systems and how different engineering disciplines contribute to the success of missions, both in near-Earth orbit and interplanetary orbits.
2) Students will understand the application of Newton's laws for particles and show skill in applying them to model spaceflight trajectories.
3) Students will understand the application of modern computational tools for the calculation of spacecraft motion.

RELATIONSHIP TO STUDENT OUTCOMES:

a) An ability to apply knowledge of mathematics, science, and engineering
e) An ability to identify, formulate, and solve engineering problems
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

TOPICS:

1) Introduction to space missions and systems, two-body problem, Newton's laws.
2) Trajectories, conic sections.
3) Orbital elements, coordinate systems.
4) Kepler's Equation
5) Orbit determination.
6) Orbital maneuvers, rocket dynamics
7) Interplanetary trajectories, patched conics.

AA 311 ATMOSPHERIC FLIGHT MECHANCIS

AUTUMN QUARTER

CREDITS AND CONTACT HOURS: 4 credits, Three 50-minutes lectures per week. One 50 minute period review.

COORDINATOR: R. Breidenthal, Professor of Aeronautics and Astronautics

TEXTBOOK: *Introduction to Flight*, Anderson, J.M., McGraw Hill, 7th Ed. 2011

SUPPLEMENTAL MATERIAL: Aerodynamics, Aeronautics and Flight Mechanics, McCormick, B.W., John Wiley, New York, 1995 (2nd Edition).

CATALOG DATA: ATMOSPHERIC FLIGHT MECHANICS, Required
Applied aerodynamics, aircraft flight "envelope," minimum and maximum speeds, climb and glide performance. Range and endurance, take-off and landing performance, using both jet and propeller power plants. Longitudinal and dynamic stability and control, wing downwash, stabilizer and elevator effectiveness, power effects. Lateral and directional stability and control. Prerequisite: Junior Standing. Offered: A.

PREREQUISITES BY TOPIC:
1) Calculus and analytic geometry
2) Differential equations
3) Engineering dynamics

OUTCOMES:
1) Student will understand the hydrostatics of the atmosphere.
2) Student will understand the physical basis of parasite and induced drag of 3D airplane configurations and estimate the drag polar and maximum lift.
3) Students will be able estimate the drag, and then the thrust, and power required for level flight.
4) Students will be able to read performance charts and use them for analysis.
5) Students will be able estimate aircraft neutral points and calculate required control surface positions from engineering data.
6) Student will be able to estimate longitudinal stability parameters.

RELATIONSHIP TO STUDENT OUTCOMES:
a) An ability to apply knowledge of mathematics, science, and engineering
e) An ability to identify, formulate, and solve engineering problems
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

TOPICS:
1) Applied aerodynamics for lift and drag evaluation
2) Introductory propulsion for propeller and jet airplanes
3) Airplane performance
4) Static Stability and control
5) Dynamic Stability and control

6) Problems of airplane design
7) Reviews, quizzes

AA 312 STRUCTURAL VIBRATIONS

WINTER QUARTER

CREDITS AND CONTACT HOURS: 4 credits , Four 50-minute lectures per week.

COORDINATOR: K. Morgansen Assistant Professor of Aeronautics and Astronautics

TEXTBOOK: *Engineering Vibration*, Inman, D.J., 4th Edition, Prentice Hall, Englewood Cliffs, NJ, 2013.

SUPPLEMENTAL MATERIALS: Last two chapters of *Engineering Mechanics: Dynamics*, 13th Ed., Hibbeler, R.C., Prentice-Hall, 2012.

CATALOG DATA: STRUCTURAL VIBRATIONS Required Vibration theory. Characteristics of single and multi-degree-of-freedom linear systems with forced inputs. Approximate methods for determining principal frequencies and mode shapes. Application to simple aeroelastic problems.
Prerequisites: ME 230 Offered: W.

PREREQUISITES BY TOPIC:
1) Sophomore level dynamics - ME 230.
2) Vector analysis

OUTCOMES:
1) Students will know how to develop and solve single degree-of-freedom systems in free vibration.
2) Students will be able to solve single degree-of-freedom general forced vibration problems.
3) Students will be able to model analytically and numerically systems with multiple degrees-of-freedom.
4) Students will be able to model and compute vibration of continuous system

RELATIONSHIP TO STUDENT OUTCOMES:
a) An ability to apply knowledge of mathematics, science, and engineering.
e) An ability to identify, formulate, and solve engineering problems.
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:
1. Single-degree-of-freedom systems: modeling, free vibration of undamped and damped systems.
2. Forced vibration of single-degree-of-freedom systems subject to harmonic excitation: Laplace transform.
3. Forced vibration of single-degree-of-freedom systems subject to general dynamic excitation: convolution integral, integration method.
4. Multiple degree-of-freedom systems: lumped-parameter models, Lagrange's equations to lumped-parameter models.

5. Free vibration of multiple degree-of-freedom systems: normal frequencies and modes, Rayleigh method.
6. Eigenvalues and eigenvectors: matrix orthogonality, numerical computation.
7. Forced vibration of multiple degrees-of-freedom systems.
8. Distributed-parameter systems: modeling, longitudinal and torsional vibrations, transverse beam vibration, vibration of plates and membranes.

AA 320 AEROSPACE INSTRUMENTATION

AUTUMN QUARTER

CREDITS AND CONTACT HOURS: 3 credits, Two 50-minute lectures and one 1-hour-50-minute laboratory.

COORDINATOR: A. Bruckner, Professor of Aeronautics and Astronautics

TEXTBOOK: None (class notes prepared by instructors)

REFERENCES: *Principles and Applications of Electrical Engineering*, Rizzoni, G., 5th ed., McGraw Hill, 2007.

Foundations of Electronics, Cogdell, J.R., Prentice Hall, 1999.

CATALOG DATA: AEROSPACE INSTRUMENTATION, Required
Hands-on laboratory experience for understanding the design and function of electronic circuits and instrumentation utilized in aerospace engineering. Topics include Ohm's law, Kirchhoff's laws, DC and AC circuits, passive and active components, op-amps and comparators, sensors, signal conditioning, electromechanical systems and actuators, digital systems, and data acquisition.

PREREQUISITES BY TOPIC: Junior standing in A&A department.

OUTCOMES:

1) Students will be able to use and understand passive an active circuit components and sensors, and their characteristics.
2) Students will be able to design power supplies and simple circuits for aerospace instrumentation.
3) Students will understand sensors and signal conditioning as applied to wind tunnels and other aerospace systems.
4) Students will understand digital data systems, A/D and D/A conversion, control feedback and stability, and electromechanical actuators

RELATIONSHIP TO STUDENT OUTCOMES:

a) An ability to apply knowledge of mathematics, science, and engineering.
b) An ability to design and conduct experiments, as well as to analyze and interpret date.
e) An ability to identify, formulate, and solve engineering problems.
g) An ability to communicate effectively
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:

1. Overview of electronic systems in aerospace.
2. Basic concepts: voltage, current, Ohm's law, Kirchhoff's laws, resistors and resistor networks. Use of digital multimeter.
3. Capacitors, RC circuits, temporal behavior; Wheatstone bridge, filters. Use of oscilloscope and function generator.
4. Inductors, transformers, diodes, RL and RLC circuits, rectification, DC power

supplies for aerospace applications.

5. Active components: transistors, op-amps, comparators; gain and feedback. Switches, amplifiers, comparators, analog integrators and differentiators, signal conditioning for aerospace sensors.
6. Sensors for wind tunnel and other aerospace applications: pressure sensors, strain gages, thermocouples, inclinometers. Sensor characteristics: signal level, dynamic range, accuracy.
7. Light sensors and optical communication, current-to-voltage converter.
8. Electromechanical systems and actuators, DC motor characteristics, control systems.
9. Digital systems and data acquisition and control, A/D converter and D/A converter.

AA 321 AEROSPACE LABORATORY I

WINTER QUARTER

CREDITS AND CONTACT HOURS: 3 credits, One 50 minute lecture and one 2-hour-20-minute laboratory.

COORDINATOR: Adam Bruckner, Professor of Aeronautics and Astronautics

TEXTBOOK: None

SUPPLEMENTAL MATERIAL: *Experimental Methods for Engineers*, Holman, J.P., 7th ed. McGraw-Hill, New York, 2000.

CATALOG DATA: AEROSPACE LABORATORY I, Required
The design and conduct of experimental inquiry in the fields of aeronautics and astronautics. Laboratory experiments on supersonic flow, structures, vibrations and material properties, and other topics. Theory, calibration, and use of instruments, measurement techniques, analysis of data, report writing.

PREREQUISITES BY TOPIC: Junior standing in department.

OUTCOMES:
1) Students will be able to perform wind tunnel tests and reduce wind tunnel data.
2) Students will be able to test materials, apply strain gauges, and measure stresses.
3) Students will understand how to take data on dynamic systems in vibration.
4) Students will be able to perform supersonic wind tunnel tests and reduce the resulting tunnel data.
5) Students will know how to write good lab reports.

RELATIONSHIP TO STUDENT OUTCOMES:
a) An 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.
e) An ability to identify, formulate, and solve engineering problems.
g) An ability to communicate effectively
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:
1) Wind Tunnel q-calibration
2) Sphere drag
3) 2-D wing
4) Stress analysis with strain gages
5) Propeller performance
6) Materials testing
7) Lift and drag of finite wings
8) Stress concentration

9) Beam bending and vibration
10) Supersonic flow

AA 322 AEROSPACE LABORATORY II

SPRING QUARTER

CREDITS AND CONTACT HOURS: 3 credits, One 50-minute lecture and one 2-hour-20 minute laboratory.

COORDINATOR: Adam P. Bruckner, Professor of Aeronautics and Astronautics

TEXTBOOK: None

SUPPLEMENTAL MARTERIALS: Various: books, journal and conference papers, technical reports, web sources, etc.

CATALOG DATA: AEROSPACE LABORATORY II, Required
The design and conduct of experimental inquiry in the field of aeronautics and astronautics. Student groups propose, design, build, and conduct laboratory experiments in one of the following broad topic areas: aerodynamics, structures, propulsion, or energetics. The results are presented in written and oral reports. Prerequisite: minimum grade of 1.7 in AA 321. Offered: Sp.

PREREQUISITES BY TOPIC: Junior standing

OUTCOMES:

1) Students will be able to propose, design, build, and perform experiments on a topic of their choice.
2) Students will be able to utilize aerospace instrumentation and equipment to perform experiments.
3) Students will know how to take, reduce, and analyze experimental data.
4) Students will know how to write good lab reports and make good oral presentations.

RELATIONSHIP TO STUDENT OUTCOMES:

a) An 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
c) An ability to design a system, component, or process to meet desired needs….
e) An ability to identify, formulate, and solve engineering problems.
g) An ability to communicate effectively
i) A recognition of the need for, and an ability to engage in life-long learning.
j) A knowledge of contemporary issues.
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS: Various, depending on specific projects; typical examples include but are not limited to:

1) Pulsed cold-gas rocket (static)
2) Vertical wind turbine
3) Plasma thruster

4) Electrothermal rocket (static)
5) Morphing wing aerodynamics
6) Aerodynamic decelerators
7) CubeSat prototype lofted by weather balloon
8) Rocket-boosted glider
9) Aerodynamics of an annular wing
10) Characteristics of a tailless airplane

AA 331 AEROSPACE STRUCTURES I

WINTER QUARTER

CREDITS AND CONTACT HOURS: 4 credits, Four 50-minute lectures per week.

COORDINATOR: K.Y. Lin, Professor of Aeronautics and Astronautics

TEXTBOOK: *Aircraft Structures for Engineering Students*, 3rd Ed., Megson, T.H.G., Butterworth-Henemann, 2012

SUPPLEMENTAL MATERIAL:

1. *Aerospace Structural Analysis*, Allen, D.H. & Haisler, W., John Wiley & Sons, 1985
2. *Aircraft Structures*, 2^{nd} ed., Peery, D.J. & Azar, J.J, McGraw-Hill, 1982
3. *Analysis of Aircraft Structures*, 2^{nd} ed., Donaldson, B. K., Cambridge *University Press*, 2012
4. *Advanced Strength and Applied Stress Analysis*, 2^{nd} ed, Budynas, R.G. McGraw-Hill, 1999

CATALOG DATA: **AEROSPACE STRUCTURES I**, Required

Analysis and design of aerospace structures. Review concepts of stress, strain, and and equations of elasticity. Plane stress and plane strain. Applications to aerospace structural elements including general bending and torsion of rods and beams, and open and closed thin-walled structures and box beams. Prerequisite: CEE 220.

PREREQUISITES BY TOPIC: Mechanics of Materials, Statics.

OUTCOMES:

1. Students will have an understanding of the concepts involved in the theory of linear elasticity.
2. Students will understand stresses and deformations in rods, trusses, beams and thin plates.
3. Students will understand stress analysis methods for thin-walled structures subjected to bending and torsion.
4. Students will understand how to apply these analysis methods and results to real-world aerospace structural problems.

RELATIONSHIP TO STUDENT OUTCOMES:

a) An ability to apply knowledge of mathematics, science, and engineering
e) An ability to identify, formulate, and solve engineering problems
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:

1. Review of statics, free-body diagram, supports, reactions. Determinate and indeterminate structures. Forces and stresses, Deformation and strains. Hooke's Law in 2-D and 3-D solids (4 lectures)
2. Equilibrium equations for stresses. Cauchy's formula. Compatibility

equations for strains. Transformation of stresses and strains, Mohr's circles. 2-D and 3-D principal stresses and strains. (8 lectures)

3. Axial Loading, Torsion, Bending of beams, Sectional properties. Simple and multi-axial bending. Beam deflections (10 lectures)
4. Plane stress, plane strain. Airy stress function. Simple elasticity solutions (6 lectures).
5. Shear stresses in solid beams and thin-walled structures of open and closed sections. Shear flow analysis. Shear center (10 lectures).
6. Mid-terms exams (2 classes)

AA 332 AEROSPACE STRUCTURES II

SPRING QUARTER

CREDITS AND CONTACT HOURS: 4 credits, Four 50-minute lectures per week.

COORDINATOR: K.Y. Lin, Professor of Aeronautics and Astronautics

TEXTBOOK: *Advanced Strength and Applied Stress Analysis*, 2nd ed, Budynas, R.G., McGraw-Hill 1999

SUPPLEMENTAL MATERIALS:

1. *Aerospace Structural Analysis*, Allen, D.H., and Haisler, W., John Wiley & Sons, 1985
2. *Aircraft Structures*, 2nd ed., Peery, D.J. & Azar, J.J, McGraw-Hill 1982
3. *Analysis of Aircraft Structures*, Donaldson, B. K., Cambridge Univ. Press, 2012
4. *Advanced Strength for Engineering Students*, 3rd Edition, THG Megson, John Wiley & Sons, 1999

CATALOG DATA: AEROSPACE STRUCTURES II**,** Required
Shear flow in multi-cell thin walled sections. Bending of rectangular and circular plates. Buckling analysis of beams and plates. Energy principles in elasticity. Introduction to the finite element method. Elements of fracture mechanics and fatigue. Prerequisite: AA 331 with a minimum grade of 1.7. Offered: Sp.

PREREQUISITES BY TOPIC: Structures

OUTCOMES:

1) Students will be able to analyze shear flow in practical aerospace structures.
2) Students will be able to calculate buckling loads for beams and plates.
3) Students will be able to understand Principle of Minimum Potential Energy and apply the theorem to solve a variety of structural problems.
4) Students will be able to derive finite element equations for truss and beams.

RELATIONSHIP TO STUDENT OUTCOMES:

a) An ability to apply knowledge of mathematics, science, and engineering
e) An ability to identify, formulate, and solve engineering problems
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:

1. The bending of plates and shells.
2. Buckling analysis for thin structures in compression.
3. Energy principles in linear elasticity: minimum potential energy.
4. Introduction to the finite element method.
5. Strength and damage characteristics of ductile and brittle metals.
6. Strength and general nature of composite materials.
7. Elements of fracture mechanics and fatigue.

AA 360 PROPULSION

SPRING QUARTER

CREDITS AND: CONTACT HOURS: 4 credits, Four 50-minute lectures per week.

COORDINATOR: M. Kurosaka, Professor of Aeronautics and Astronautics

TEXTBOOK: *Elements of Propulsion*, Mattingly, J.D., AIAA, 2006.

SUPPLEMENTAL MATERIALS:

Aerothermodynamics of Gas Turbine and Rocket Propulsion, Oates, G.C., AIAA, 1997.

Rocket Propulsion Elements, Sutton, G.P., and Biblarz, O., 8th Ed., Wiley, 2010.

Mechanics and Thermodynamics of Propulsion, Hill, P.C., and Peterson, C.R., 2nd Ed., Addison-Wesley, 1992.

An Introduction to Combustion, 3rd Ed., Turns, S.R., McGraw-Hill**,** 2011.

CATALOG DATA: PROPULSION, Required
Study of the aero- and thermodynamics of jet and rocket engines. Air-breathing engines as propulsion systems. Turbojets, turbofans, turboprops, ramjets. Aerodynamics of gas-turbine engine components. Rocket vehicle performance. Introduction to space propulsion. Prerequisite: minimum grade of 1.7 in AA 301.

PREREQUISITES BY TOPIC:

1) Thermodynamics
2) Compressible flow

OUTCOMES:

1) Students will understand the aerodynamics and thermodynamics of jet and rocket engines.
2) Students will understand the fundamentals of turbojets, turbofans, turboprops, ramjets, scramjets, and hybrid engines.

RELATIONSHIP TO STUDENT OUTCOMES:

a) An ability to apply knowledge of mathematics, science, and engineering
e) An ability to identify, formulate, and solve engineering problems
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:

1) Overview
2) Review of thermodynamics/one-dimensional compressible flow
3) Thrust equation for air breathing engines
4) Thermal and propulsive efficiencies
5) Air breathing propulsion cycles: ideal performance of turbojets, turbofans, turboprops, ramjets, advanced engine cycles
6) Effects of losses and component efficiencies
7) Rocket equation; velocity increment, specific impulse
8) Staging; series and parallel

9) Nozzle flow fundamentals
10) Chemical/non-chemical rockets

AA 400 GAS DYNAMICS

WINTER QUARTER

CREDIT AND CONTACT HOURS: 3 credits, Three 50 minutes lectures per week.

COORDINATOR: R. Breidenthal, Professor of Aeronautics and Astronautics

TEXTBOOK: *Elements of Gasdynamics*, Liepmann & Roshko, 2002

SUPPLEMENTAL MATERIAL: *Introduction to Physical Gas Dynamics*, Vincenti & Kruger,
The Feynman Lectures on Physics, Feynman, Leighton, and Sands

CATALOG DATA: GAS DYNAMICS, Selected Elective
Introduction to kinetic theory and free molecule flow. Review of thermodynamics. One-dimensional gasdynamics, one-dimensional wave motion. Combustion waves. I deal and real gas application. Prerequisites: ChemE/Engr 260, or permission of instructor.

PREREQUISITES BY TOPIC:

1) Thermodynamics
2) Introductory compressible aerodynamics

OUTCOMES:

1) Understand pressure, temperature, internal storage, mean free path and transport properties from a molecular point-of-view.
2) Be able to calculate aerodynamics of bodies in free-molecular flow.
3) Be able to apply the law of mass action.
4) Be able to calculate and contrast 1-D ideal and real gas flows.
5) Understand non-steady waves and be able to predict performance of test devices that operate with non-steady 1D gas dynamics.
6) Be able to calculate combustion waves.

RELATIONSHIP TO STUDENT OUTCOMES:

a) An ability to apply knowledge of mathematics, science, and engineering
e) An ability to identify, formulate, and solve engineering problems
i) A recognition of the need for, and an ability to engage in life-long learning.
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:

1) Kinetic theory: model, wall collisions, temperature and equation of state, mean free path, transport properties. (5 lectures)
2) Free molecule flow: model, surface collisions, forces and heat transfer. (3 lectures)
3) Thermodynamics: law of mass action, applications, thermodynamics of air. (4 lectures)
4) One-dimensional flow: review steady 1-D flow, real gas flows, re-entry flow (5 lectures)

5) One-dimensional wave motion: propagating waves, Riemann Invariants, applications, explosion waves. (5 lectures)
6) Additional applications: nozzles and diffusers, hypersonic flow. (2 lectures)

AA 402 FLUID MECHANICS

AUTUMN QUARTER

CREDITS AND CONTACT HOURS: 3 Credits, Three 50-minute lectures per week.

COORDINATOR: A. Ferrante, Assistant Professor of Aeronautics and Astronautics

TEXTBOOK: *Basic Fluid Mechanics*, Wilcox, D.C., 4th Edition, DCW Industries, 2010.

SUPPLEMENTAL MATERIALS:
Viscous Fluid Flow, White, F.M., McGraw-Hill, 1991.
Boundary-Layer Theory, Schlichting, H., McGraw-Hill, 1979.
An Introduction to Fluid Dynamics, Batchelor, G.K., Cambridge University Press, 1967.
Fluid Mechanics, Kundu P..K., and Cohen, I.M., 4th Edition, Academic Press, 2008.
Fluid Mechanics, White, F. M., 7th Edition, McGraw-Hill, 2008.

CATALOG DATA: FLUID MECHANICS, Selective Elective
Introduction to fluid mechanics, dimensional analysis, effects of gravity on pressure, kinematics, conservation of mass & momentum, control-volume method, conservation of energy, vorticity and viscosity, viscous effects, Navier-Stokes solutions, boundary layers. Prerequisite: MATH 324; AA 302 or equivalent.
Offered: A

PREREQUISITES BY TOPIC:
1) Thermodynamics
2) Introductory incompressible and compressible aerodynamics (AA301 and 302)
3) Differential equations and Advanced calculus (MATH 307 and MATH324)

OUTCOMES: The students completing this course in good standing will be able to:
1. Apply dimensional analysis.
2. Explain and calculate the effects of gravity on pressure.
3. Calculate vorticity, circulation, streamlines, streaklines and pathlines.
4. Apply conservation of mass, momentum and energy.
5. Derive and apply Navier-Stokes solutions.
6. Derive and apply boundary layer equations.

RELATIONSHIP TO STUDENT OUTCOMES:
a) An ability to apply knowledge of mathematics, science, and engineering.
e) An ability to identify, formulate, and solve engineering problems.
i) A recognition of the need for, and an ability to engage in life-long learning.
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS
1. Introduction to fluid mechanics, Fluids properties and flow classification, Dimensional analysis (3 lectures).

2. Effects of gravity on pressure, Buoyancy and Hydrostatic Forces on Plane Surf.,
Buoyancy and Hydrostatic Forces on Plane Surf. (3 lectures).
3. Kinematics, Reynolds Transport Theorem (3 lectures).
4. Conservation of mass & momentum, Navier-Stokes, Euler and Bernoulli's Eq. (3 lectures).
5. Control-volume method (3 lectures).
6. Conservation of energy (1 lecture).

7. Vorticity and viscosity, viscous effects (3 lectures).
8. Lift and drag (1 lecture).
9. Navier-Stokes solutions (2 lectures).
10. Boundary layers, turbulence (4 lectures).

AA 405 INTRODUCTION TO AEROSPACE PLASMAS

AUTUMN QUARTER

CREDITS AND CONTACT HOURS: 3 Credits, Three 50-minute lectures per week**.**

COORDINATOR: U. Shumlak, Assistant Professor of Aeronautics and Astronautics

TEXTBOOK: *Physics of Space Plasmas*, Parks, G.K., Westview Press, 2003.
Introduction to Plasma Physics and Controlled Fusion, Chen, F.F., Springer, 1984.

SUPPLEMENTAL MATERIALS: Classical Electrodynamics, J. D. Jackson, Wiley, 1998.
Electromagnetic Fields and Waves, P. Lorrain and D. R. Corson, W.H. Freeman & Co. Ltd, 1970.

CATALOG DATA: INTRODUCTION TO AEROSPACE PLASMAS, Selective Elective
Development of introductory electromagnetic theory including Lorentz force and Maxwell's equations. Plasma description. Single particle motions and drifts in magnetic and electric fields. Derivation of plasma fluid model. Introduction to plasma waves. Applications to electric propulsion, magnetic confinement, and plasmas in space and Earth's outer atmosphere. Prerequisite: PHYS 123; MATH 324.

PREREQUISITES BY TOPIC:
1) Working knowledge of vector algebra
2) Some electromagnetism theory is helpful but not required

OUTCOMES:
1) Students will be able to calculate the electric and magnetic fields for a given electrode and current geometry.
2) Students will be able to predict charged particle motion in the presence of electric and magnetic fields.
3) Students will be able to apply the single fluid magneto hydrodynamic plasma model to solve plasma physics problems.
4) Students will be able to perform scoping designs of mission specific electric plasma thrusters.
5) Students will be able to explain the basic principles of magnetic confinement fusion.

RELATIONSHIP TO STUDENT OUTCOMES:
a) An 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
e) An ability to identify, formulate, and solve engineering problems solutions in a global and societal context
i) A recognition of the need for, and an ability to engage in life-long learning.
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:

1) Overview of space and laboratory plasma applications; quick review of electromagnetic theory
2) Basic plasma properties: Lorentz force equation; Debye shielding; magnetic fields and mapping of field lines
3) Single particle trajectories: convective drift motions, curvature and gradient drifts
4) Plasmas as fluids: derivation of the Magnetohydrodynamics (MHD) equations; frozen-in-fields; application to magnetospheric structure; laboratory equilibrium
5) Waves in plasmas: phase speeds, group speeds, polarization of various waves including Langmuir waves, sound waves, Alfven waves

AA 410 AIRCRAFT DESIGN I

WINTER QUARTER

CREDITS AND CONTACT HOURS: 4 Credits, Three 2 hour lectures and group work sessions and two 50 minute lectures per week.

COORDINATOR: E. Livne, Professor of Aeronautics and Astronautics.

TEXTBOOK: *Aircraft Design: A Conceptual Approach*, Daniel Raymer, 5th Edition, AIAA, 2012.

SUPPLEMENTAL MATERIALS:
Fundamentals of Aircraft and Airship Design, AIAA Education Series, Nicolai, L. and Carichner, G., AIAA, 2010.
Airplane Design, Roskam, J., Roskam Aviation and Engr. Corp., Vols. 1-8, 1985-1990.
Synthesis of Subsonic Airplane Design, Torenbeek, E., Delft University Press, 1982.

CATALOG DATA: AIRCRAFT DESIGN I, Required
Conceptual design of a modern airplane to satisfy a given set of requirements. Estimation of size, selection of configuration, weight and balance, and performance. Satisfaction of stability, control, and handling qualities requirements. Prerequisite: AA 302. Offered: W.

PREREQUISITES BY TOPIC:
1) Aerodynamics
2) Dynamics
3) Propulsion
4) Flight mechanics
5) Structures

OUTCOMES:
1) Students will be able to carry out conceptual design and sizing of airplane systems.
2) Students will understand the interaction between key relevant disciplines, and the trade-offs, in airplane systems design.
3) Students will understand the function of aircraft components and subsystems and how they might be designed.
4) Students will understand systems engineering issues as they relate to mission goals and requirements.
5) Students will experience self-organization, delegation, teamwork, communication to peers and visitors, fiscal and schedule maintenance.
6) Students will experience hands-on prototyping and testing of their chosen design and supporting coupons and models.

RELATIONSHIP TO STUDENT OUTCOMES:
a) An 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.

c) An ability to design a system, component, or process to meet desired needs….
d) An ability to function on multi-disciplinary teams.
e) An ability to identify, formulate, and solve engineering problems.
f) An understanding of professional and ethical responsibility.
g) An ability to communicate effectively.
h) The broad education necessary to understand the impact of engineering solutions in a global and societal context.
i) A recognition of the need for, and an ability to engage in life-long learning.
j) A knowledge of contemporary issues.
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:

1) The design process: its creative/qualitative and analytical/quantitative aspects
2) Organization, milestones and schedule of the airplane design process
3) Discussion of Ethics in design.
4) Design oriented applied aerodynamics
5) Design oriented applied mission analysis
6) Design oriented weight estimation and design oriented stability and control.
7) Wind design
8) Cabin and fuselage design
9) Tail design
10) Airframe/engine integration
11) Landing gear and systems design.
12) Design to meet regulations.
13) Cost and manufacturing.
14) Automated, computerized design and design optimization.
15) Case studies in airplane design: the analysis of design failures.

AA 411 AIRCRAFT DESIGN II

SPRING QUARTER

CREDITS AND CONTACT HOURS: 4 Credits, Three 2 hour group work sessions plus two 50 minute lectures/ project review sessions per week.

COORDINATOR: E. Livne, Professor of Aeronautics and Astronautics

TEXTBOOK: *Aircraft Design: A Conceptual Approach*, Daniel Raymer, 5th Edition, AIAA, 2012.

SUPPLEMENTAL MATERIALS:
Fundamentals of Aircraft and Airship Design, AIAA Education Series, Nicolai, L. and Carichner, G., AIAA, 2010.
Airplane Design, Roskam, J., Roskam Aviation and Engr. Corp., Vols. 1-8, 1985-1990.
Synthesis of Subsonic Airplane Design, Torenbeek, E., Delft University Press, 1982.

CATALOG DATA: AIRCRAFT DESIGN II, Required
Preliminary design of a modern airplane to satisfy a given set of requirements. Estimation of size, selection of configuration, weight and balance, and performance. Satisfaction of stability, control, and handling qualities requirements. Prerequisite: AA410. Offered: Sp.

PREREQUISITES BY TOPIC:

1) Aerodynamics
2) Dynamics
3) Propulsion
4) Flight mechanics
5) Structures

OUTCOMES:

1) Students will be able to carry out conceptual design and sizing of airplane systems.
2) Students will understand the interaction between key relevant disciplines, and the trade-offs, in airplane systems design.
3) Students will understand the function of aircraft components and subsystems and how they might be designed.
4) Students will understand systems engineering issues as they relate to mission goals and requirements.
5) Students will experience self-organization, delegation, teamwork, communication to peers and visitors, fiscal and schedule maintenance.
6) Students will experience hands-on prototyping and testing of their chosen design and supporting coupons and models.

RELATIONSHIP TO STUDENT OUTCOMES:

a) An 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.
c) An ability to design a system, component, or process to meet desired needs….
d) An ability to function on multi-disciplinary teams.
e) An ability to identify, formulate, and solve engineering problems.
f) An understanding of professional and ethical responsibility.
g) An ability to communicate effectively.
h) The broad education necessary to understand the impact of engineering solutions in a global and societal context.
i) A recognition of the need for, and an ability to engage in life-long learning.
j) A knowledge of contemporary issues.
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:

1) Refined aerodynamic and structural modeling
2) Loads
3) Airframe Structural Synthesis
4) Drag, lift and moment estimation
5) Stability derivatives using DATCOM and CFD techniques
6) Cost and weight analysis and correlation with final weight and cost.
7) Wind tunnel model design and testing
8) Landing gear kinematics and design.
9) Stability and control: simulation, augmentation. Effects of configuration and flight conditions.

AA 419 AEROSPACE HEAT TRANSFER

WINTER QUARTER

CREDITS AND CONTACT HOURS: 3 Credits, Three 50-minute lectures per week.

COORDINATOR: D. Dabiri, Associate Professor of Aeronautics and Astronautics

TEXTBOOK: *Fundamentals of Heat and Mass Transfer,* Bergman, T.L., Lavin, A.S., Incropera, F.P., and DeWitt, D.P., 7th Edition, Wiley, 2011.

SUPPLEMENTAL MATERIALS: None

CATALOG DATA: AEROSPACE HEAT TRANSFER, Selective Elective
Fundamentals of conductive, convective, and radiative heat transfer with emphasis on applications to atmospheric and space flight.
Prerequisite: PHYS 123; MATH 307; MATH 324. Offered: W.

PREREQUISITES BY TOPIC:
1) Senior status
2) Thermodynamics
3) Gasdynamics

OUTCOMES:
1) Students will be able to derive the governing equations of heat transfer.
2) Students will be able to analytically and numerically solve problems of heat conduction and convection.
3) Students will be able to analytically solve problems of radiative heat transfer.

RELATIONSHIP TO STUDENT OUTCOMES:
a) An ability to apply knowledge of mathematics, science, and engineering.
e) An ability to identify, formulate, and solve engineering problems.
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:
1) Physical basis and governing equations of heat transfer (2 classes)
2) One-dimensional, steady-state conduction (5 classes)
3) Transient conduction-lumped capacitance model, Biot number (3 classes)
4) Equations of convection; correlation coefficients, similarity analysis (4 classes)
5) Convective heat transfer for internal flow (2 classes)
6) Free convective heat transfer (2 classes)
7) Heat Exchangers (1 class)
8) Radiative transfer, Processes & Properties (4 classes)
9) Radiative transfer, Exchange between Surfaces (2 classes)
10) Radiative transfer in gases (2 classes)

AA 420 SPACECRAFT AND SPACE SYSTEMS DESIGN I

WINTER QUARTER

CREDITS AND CONTACT HOURS: 4 credits, Five 110-minute lectures per week.

COORDINATOR: A.P. Bruckner, Professor of Aeronautics and Astronautics

TEXTBOOK: *Space Mission Engineering: The New SMAD*, Wertz, J.R., Everett, D.F., and Puschell, J.J., eds., Microcosm Press, Torrance, CA, 2011.

SUPPLEMENTAL REFERENCES: *Space Vehicle Design*, 2^{nd} ed., Griffin, M. D., and French, J. R., AIAA Education Series, Washington, DC, 2004.
NASA reports; AIAA, AAS, ASME, IEEE conference and journal papers; etc.

CATALOG DATA: SPACECRAFT AND SPACE SYSTEMS DESIGN I, Required
Design of space systems and spacecraft for advanced near-Earth and interplanetary missions. Elements of astrodynamics, the space environment, planetary environments, and space systems engineering. Mission design and analysis, space vehicle propulsion and flight mechanics, atmospheric entry and aerobraking, configuration and structural design, nuclear and solar power systems, thermal management, systems integration, advanced concepts, and other aspects of space engineering needed for general capability in space systems. Offered: W.
Prerequisite: AA 310 or permission of instructor; Recommended: AA 419.

PREREQUISITES BY TOPIC:

1) Aerodynamics
2) Orbital and atmospheric flight mechanics.
3) Dynamics of flight vehicles.
4) Structural analysis.
5) Heat transfer.

OUTCOMES:

1) Students will understand the function of spacecraft subsystems and how they might be designed.
2) Students will understand the state of the art in spacecraft system and subsystem design and the trade-offs between them.
3) Students will experience choosing and narrowing high-level mission goals and requirements into specific tasks for design.
4) Students will experience self-organization, delegation, teamwork, communication to peers and visitors, fiscal and schedule maintenance.
5) Students will experience hands-on prototyping and testing of their chosen design.

RELATIONSHIP TO STUDENT OUTCOMES:

a) An 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.
c) An ability to design a system, component, or process to meet desired needs….
d) An ability to function on multi-disciplinary teams.
e) An ability to identify, formulate, and solve engineering problems.

f) An understanding of professional and ethical responsibility.
g) An ability to communicate effectively.
h) The broad education necessary to understand the impact of engineering solutions in a global and societal context.
i) A recognition of the need for, and an ability to engage in life-long learning.
j) A knowledge of contemporary issues.
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:

1)	Introduction to space systems engineering.	(2 lectures)
2)	Definition of design problem and creation of design teams.	(4 lectures)
3)	Discussion of ethics in design	
4)	The space environment.	(3 lectures)
5)	Launch vehicles: Earth-to-orbit launch trajectories.	(5 lectures)
6)	Atmospheric entry and aerobraking	(3 lectures)
7)	Elements of spacecraft configuration and design.	(7 lectures)
8)	Solar and nuclear power systems; thermal management.	(4 lectures)
9)	System integration.	(2 lectures)

AA 421 SPACECRAFT AND SPACE SYSTEMS DESIGN II

SPRING QUARTER

CREDITS AND CONTACT HOURS: 4 Credits, Three 50-minute lectures and one 2 hour group design session per week

COORDINATOR: A.P. Bruckner, Professor of Aeronautics and Astronautics

TEXTBOOK: *Space Mission Engineering: The New SMAD*, Wertz, J.R., Everett, D.F., and Puschell, J.J., eds., Microcosm Press, Torrance, CA, 2011.

SUPPLEMENTAL MATERIALS: *Space Vehicle Design*, 2nd ed., Griffin, M. D., and French, J. R., AIAA Education Series, Washington, DC, 2004.
International Reference Guide to Space Launch Systems, 4th ed., Isakowitz, S.J., AIAA, Washington, DC, 2004.
NASA reports; AIAA, AAS, ASME, IEEE conference and journal papers; etc.

CATALOG DATA: SPACECRAFT AND SPACE SYSTEMS DESIGN II, Required
Continuation of AA 420. Course content varies from year to year and is dependent on the design topic chosen for AA 420. Offered: Sp. Prerequisite: AA 420.

PREREQUISITES BY TOPIC: Preliminary system design developed in AA 420.

OUTCOMES:

1) Students will understand the function of spacecraft subsystems and how they might be designed.
2) Students will understand the state of the art in spacecraft system and subsystem design and the trade-offs between.
3) Students will experience choosing and narrowing high-level mission goals and requirements into specific tasks for design.
4) Students will experience self-organization, delegation, teamwork, communication to peers and visitors, fiscal and schedule maintenance.
5) Students will experience hands-on prototyping and testing of their chosen design.

RELATIONSHIP TO STUDENT OUTCOMES:

a) An 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.
c) An ability to design a system, component, or process to meet desired needs.
d) An ability to function on multi-disciplinary teams.
e) An ability to identify, formulate, and solve engineering problems.
f) An understanding of professional and ethical responsibility.
g) An ability to communicate effectively.
h) The broad education necessary to understand the impact of engineering solutions in a global and societal context.
i) A recognition of the need for, and an ability to engage in life-long learning.

j) A knowledge of contemporary issues.
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:

1) Special topics relevant to design project (6 class hours)
2) Continuation, refinement, and finalization of design (25 class hours)
3) Oral reports (5 class hours)
4) Preliminary design review (4 class hours)
5) Preparation of final report and summary report (10 class hours)

AA 430 FINITE ELEMENT ANALYSIS IN AEROSPACE

AUTUMN QUARTER

CREDITS AND CONTACT HOURS: 3 credits, Three 50 minute lectures per week.

COORDINATOR: K.A. Holsapple, Professor of Aeronautics and Astronautics

TEXTBOOK: *A First Course in the Finite Element Method*, 5th Ed., Logan, D.L., Cengage Learning, Independence, KY, 2011.

SUPPLEMENTAL MATERIALS: None

CATALOG DATA: FINITE ELEMENT ANALYSIS IN AEROSPACE, Selective Elective
Introduction to the finite element method and application. One-, two-, and three-dimensional problems including trusses, beams, box beams, plane stress and plane strain analysis, and heat transfer. Use of finite element software. Prerequisite: CEE 220. Offered: A.

PREREQUISITES BY TOPIC:
1) Strength of Materials (CEE/ENGR 220).
2) Matrix Algebra with Applications (Math 308)

OUTCOMES:
1) Students will understand the basic foundations of Finite Element Analysis
2) Students will learn the bases and differences of the principal Finite Element Methods
2) Students will know how FEM is used in the Aerospace Industry.
3) Students will know how to use a commercial FEM Code for the analysis of typical Aerospace Problems of Structural analysis.
4) Students will know how to use a commercial FEM Code for the analysis of Heat Transfer problems.
5) Students will know how to use a commercial FEM Code for the analysis of dynamic problems

RELATIONSHIP TO STUDENT OUTCOMES:
a) An ability to apply knowledge of mathematics, science, and engineering
c) An ability to design a system, component, or process to meet desired needs.
e) An ability to identify, formulate, and solve engineering problems
i) A recognition of the need for, and an ability to engage in life-long learning.
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:
1) Introduction
2) Element stiffness and force matrices for a bar (spring)
3) Global equations
4) Minimum potential energy

5) Trusses: bar assemblages in 2- and 3-dimensions
6) Beam bending
7) Frames and grids: beams in 2- and 3-dimensions
8) A design problem: minimum weight truss for a given load
9) Plane stress and plane strain problems
10) Analysis of box beams: assemblages of rods, beams and shear panels
11) Heat conduction and convection
12) Thermal stresses
13) Time dependent problems I: dynamic elasticity
14) Time dependent problems II: transient heat equation

AA 432 COMPOSITE MATERIALS FOR AEROSPACE STRUCTURES

WINTER QUARTER

CREDITS AND CONTACT HOURS: 3 credits, Three 50 minute lectures per week.

COORDINATOR: K.Y. Lin, Professor of Aeronautics and Astronautics

TEXTBOOKS: *Mechanics of Composite Materials*, Jones, R.M., CRC Press, 1998.

SUPPLEMENTAL MATERIALS: *Composite Materials for Aircraft Structures*, Baker, A., Dutton, S, and Kelly, D. AIAA Education Series, 2004.

CATALOG DATA: COMPOSITE MATERIALS FOR AEROSPACE
Introduction to analysis and design of aerospace structures, utilizing filamentary composite materials. Basic elastic properties and constitutive relations of composite laminates. Failure criteria, buckling analysis, durability, and damage tolerance of composite structures. Aerospace structure design philosophy and practices. Offered: W. Prerequisite: AA 332.

PREREQUISITES BY TOPIC: Junior level structural analysis courses (AA 331, 332 or equivalent)

OUTCOMES:

1. Students will understand the basic elastic properties, strengthening mechanisms and constitutive relations of fiber reinforced composites.
2. Students will understand failure criteria, buckling, stress and stiffness analysis of composite laminates.
3. Students will have an understanding of aerospace composite structures, manufacturing, analysis and design.

RELATIONSHIP TO ABET OUTCOMES:

a) An ability to apply knowledge of mathematics, science, and engineering.
e) An ability to identify, formulate, and solve engineering problems.
i) A recognition of the need for, and ability to engage in life-long learning.
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:

1) Introduction, materials and properties, composite fabricationmethods (4 classes)
2) Micromechanics, shear transfer, elastic constants, strength of a ply (3 classes)
3) Stress-strain relations of a lamina in the material and reference axes (3 classes)
4) Bending and stretching of laminated plates, analysis of ply stresses (4 classes)
5) Failure criteria and laminate strength analysis procedures (4 classes)
6) Bending and buckling of composite laminates (3 classes)
7) Environmental effects and durability (3 classes)
8) Free edge interlaminar stresses; Material property testing methods (2 classes)
9) Notched strength, damage tolerance of composite structures (2 classes)
10) Tests (2 classes)

AA 440 FLIGHT MECHANICS I

WINTER QUARTER

CREDITS AND CONTACT HOURS: 3 credits, Three 50 minute lectures per week.

COORDINATOR: R. Breidenthal, Professor of Aeronautics and Astronautics

TEXTBOOK: None

SUPPLEMENTAL MATERIALS: *Airplane Performance, Stabilty & Control*, Perkins, D, and Hage, R.E., Wiley, 1949.
Fluid Dynamic Drag, Hoerner, S.F., Hoerner, 1965.
Boundary Layer Theory, Schlichting, H., McGraw-Hill 1985.
Theory of Wing Sections, Abbott, I.H., von Doenhoff, A.E., Dover, 1959.

CATALOG DATA: FLIGHT MECHANICS I, Selective Elective
Calculation of aerodynamic characteristics of aircraft and their components including stability derivatives. Relation to wind tunnel and flight data. Vehicle equations of motion within the atmosphere, characteristics of propulsion systems and components including propellers. Prediction of performance, stability, and control characteristics for a specific aircraft.
Offered: W.

PREREQUISITES BY TOPIC:
1) Basic Aerodynamics
2) Fundamental Theorems (conservation of mass, momentum & energy; vortices)
3) Introductory Flight Mechanics

OUTCOMES: Students will show:
1. Basic understanding of the principles of atmospheric flight,
2. The ability to apply knowledge of mathematics, science, and engineering,
3. The ability to identify, formulate, and solve engineering problems,
4. The ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

RELATIONSHIP TO STUDENT OUTCOMES:
a) An ability to apply knowledge of mathematics, science, and engineering
e) An ability to identify, formulate, and solve engineering problems
i) A recognition of the need for, and ability to engage in life-long learning.
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS
1) Airplane Aerodynamics

Prediction of aerodynamic forces on airplanes and components including maximum lift and compressibility effects

2) Airplane Performance
   Characteristics of turbine and piston engines; propeller performance
   Definition of flight envelope; cruise, takeoff and landing characteristics
3) Airplane Stability and Control
   Equations of motion for aircraft in non-steady flight
   Contribution of aircraft components to stability derivatives; stability criteria.
   Control surface effectiveness, hinge moments, stick forces
   Asymmetrical flight effects

<u>AA 441 FLIGHT TEST ENGINEERING</u>

SPRING QUARTER

CREDITS AND CONTACT HOURS: 3 credits, Three 50 minutes lectures and one 4 hour flight time per week.

COORDINATOR: R. Breidenthal, Professor of Aeronautics and Astronautics

TEXTBOOK: *Introduction to Flight Test Engineering*, 3rd Ed., Ward, D., Niewohhner, R., Strganac, T.W., Kendall Hunt, 2013.

SUPPLEMENTAL MATERIALS: None

CATALOG DATA: FLIGHT TEST ENGINEERING, Selective Elective
Determination in flight of performance, stability, and control characteristics of aircraft; and comparison with predicted and wind tunnel results.
Prerequisite: AA 311; AA 440. Offered: Sp

PREREQUISITES BY TOPIC:
1) Aerodynamics
2) Performance, stability and control analysis

OUTCOMES:
1. Student teams will be able to calibrate aircraft instruments using analog and digital data.
2. Student teams will be able to produce a flight test plan based upon FAR part 25 “Airworthiness Standards: Transport Category Airplanes” requirements or Part 23 “Airworthiness Standards: Normal, Utility, Acrobatic, and Commuter
3. Students will be able to read piston engine and propeller charts and apply them to flight data.
4. Students will be able determine power required, drag estimates and efficiency from flight test data and compare to theoretical values.
5. Students will be able locate aircraft neutral points from flight data.
6. Student teams will be able to solve a variety of real-life industry-provided problems.

RELATIONSHIP TO STUDENT OUTCOMES:
a) An 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.
d) An ability to function on multi-disciplinary teams.
e) An ability to identify, formulate, and solve engineering problems.
g) An ability to communicate effectively.
i) A recognition of the need for, and ability to engage in life-long learning.
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:
1) Measurement of altitude and airspeed

2) Measurement of static source error
3) Data reduction to find C_{De} and e
4) Measurement of neutral points, stickfixed and stickfree

AA 447 CONTROL IN AEROSPACE SYSTEMS

AUTUMN QUARTER

CREDITS AND CONTACT HOURS: 4 credits, Four 50-minute lecture sessions and one-hour laboratory per week.

COORDINATOR: K. Morgansen-Hill, Assistant Professor of Aeronautics and Astronautics

TEXTBOOK: *Feedback Control of Dynamic Systems*, Franklin, G.F., Powell J.D., and Emami-Naeini, A., 6th Ed., Prentice Hall, 2009.

SUPPLEMENTAL MATERIALS: *Control System Dynamics*, Clark, R.N., Cambridge Univ. Press, 1996.

CATALOG DATA: CONTROL IN AEROSPACE SYSTEMS, Required
Overview of feedback control. Dynamic models for control systems design including ODE, transfer function, and state-space. Linearization of nonlinear models. Analysis of stability, controllability, observability, time/frequency domain techniques. Frequency response design techniques. Design of control systems via case studies. Prerequisite: ME 230, MATH 308, minimum grade of 1.7 in
AA 312. Offered: A.

PREREQUISITES BY TOPIC:
1) Differential equations
2) Engineering dynamics

OUTCOMES:
1) Learn the fundamentals of linear control systems.
2) Prepare the student to do practical control system design using computer aided control systems design tools.

RELATIONSHIP TO STUDENT OUTCOMES:
a) An ability to apply knowledge of mathematics, science, and engineering.
c) An ability to design a system, component, or process to meet desired needs….
e) An ability to identify, formulate, and solve engineering problems.
i) A recognition of the need for, and ability to engage in life-long learning.
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:
1) Modeling of dynamic systems by ordinary differential equations, state space forms, linearization, model properties.
2) Laplace transforms, transfer functions, pole-zero analysis.
3) Feedback control system configuration, closed loop transfer functions.
4) Performance specifications: time domain and frequency domain.
5) Frequency domain representation, methods of Bode and Nyquist Stability margins.
6) Design series and parallel compensators by root locus techniques.
7) Design using frequency domain techniques.

AA 448 CONTROL SYSTEMS SENSORS AND ACTUATORS

WINTER QUARTER

CREDITS AND CONTACT HOURS: 3 credits, Three 50-minutes lectures per week and two 3 hour labs per week.

COORDINATOR: K. Morgansen-Hill, Associate Professor of Aeronautics and Astronautics

TEXTBOOK: None

SUPPLEMENTAL MATERIALS:
Control Sensors and Actuators, DeSilva, C., Prentice Hall, 1989.
Noise Reduction Techniques in Electronic Systems, Ott, H.W., 2nd ed., Wiley and Sons, 1988.
Measurement Systems, Applications, and Design, Doebelin, E. O., 5th ed., McGraw-Hill, 2003.

CATALOG DATA: CONTROL SYSTEMS SENSORS AND ACTUATORS Selective Elective
Study of control systems components and formulation of their mathematical models. Discussion and analysis of amplifiers, DC servomotors-magnetic-actuators, accelerometers, potentiometers, shaft encoders and resolvers, proximity sensors, force transducers,. Experimental determination of component models and model parameters. Two three-hour laboratories per week. Prerequisite: either AA 447or EE 447. Offered: W.

PREREQUISITES BY TOPIC: Senior standing

OUTCOMES:
1. Students will know how to use electronic instrumentation and how to test controls components.
2. Students will be able to assemble and analyze component circuits for control systems.
3. Students will know how to design and analyze component circuits for control systems.
4. Students will know how to use control system software for rapid prototyping of digital controllers and real-time hardware control.

RELATIONSHIP TO STUDENT OUTCOMES:
a) An 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.
c) An ability to design a system, component, or process to meet desired needs….
d) An ability to function on multi-disciplinary teams.
e) An ability to identify, formulate, and solve engineering problems.
i) A recognition of the need for, and ability to engage in life-long learning.
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:

1) Review of electromechanical laboratory practices
2) Basic measuring and measurement recording devices
3) Elements of electromechanical system modeling
4) Analog sensors for motion measurements
5) Force, torque sensors
6) Digital transducers
7) Actuators: DC motors,
8) Software: Matlab/Simulink usage in control systems

AA 449 SPECIAL TOPICS IN CONTROL

SPRING QUARTER

CREDITS AND CONTACT HOURS: 3 - 5 credits; Contact hours to be determined, depending on number of credits offered.

COORDINATOR: Various faculty and outside speakers.

TEXTBOOK: None

SUPPLEMENTAL MATERIALS: Relevant technical papers

CATALOG DATA: SPECIAL TOPICS IN CONTROLS, Selective Elective
Topics of current interest in aerospace controls for undergraduate students in the Department of Aeronautics and Astronautics. Prerequisite: AA 447. Offered: Sp.

PREREQUISITES BY TOPIC: AA 447 or equivalent

OUTCOMES: To provide a comprehensive overview of how principles of control systems have been used and applied in aerospace industry.

RELATIONSHIP TO STUDENT OUTCOMES:

h) The broad education necessary to understand the impact of engineering solutions in a global and societal context.
i) A recognition of the need for, and ability to engage in life-long learning.
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:

1) Guest speakers from industry and academia present seminars on a variety of topics in controls and how these affect aeronautical and astronautical engineering.
2) Relevant technical papers on the presented topics are examined and discussed; students submit a report on each topic.

AA461 ADVANCED AIR BREATHING PROPULSION

AUTUMN QUARTER

CREDITS AND CONTACT HOURS: 3 credits, Three 50–minute lectures per week.

COORDINATOR: M. Kurosaka

TEXTBOOK: None

SUPPLEMENTAL MATERIALS:
Aerothermodynamics of Gas Turbines and Rocket Propulsion: Revised and Enlarged, Oates, G.C., AIAA Educational Series, 1988.
Aerothermodynamics of Aircraft Engine Components, Oates, G.C., AIAA Educational Series, 1985.
Mechanics and Thermodynamics of Propulsion, Hill, P. and Peterson, C., Addison-Wesley, 1992.
Elements of Propulsion: Gas Turbines and Rockets, Mattingly, J., AIAA Educational Series, 2006.

CATALOG DATA: ADVANCED AIR BREATHING PROPULSION, Selective Elective
Examines gas turbine engine design methodology. Covers aerodynamics or gas dynamics of air breathing engine components; inlets, compressors, turbines, and nozzles. Studies the on-design and off-design performance of gas turbine engines. Includes combustion, emissions, noise and advanced air breathing propulsion systems. Prerequisite: AA 360. Offered: A.

PREREQUISITES BY TOPICS:
1) Thermodynamics
2) One -dimensional compressible flow
3) Propulsion

OUTCOMES:
1. Students will understand the aerothermodynamics of air breathing engines.
2. Students will understand the fundamentals of compressor aerodynamics and performance.
3. Students will understand the fundamentals of turbine aerodynamics and performance.
4. Students will understand the fundamentals of the on-design and off-design performance of turbine engines and engine components.
5. Students will understand the fundamentals of inlet and exhaust nozzle performance.
6. Students will understand the basics of gas turbine emissions and noise.

RELATIONSHIP TO STUDENT OUTCOMES:
a) An ability to apply knowledge of mathematics, science, and engineering.
c) An ability to design a system, component, or process to meet desired needs.
e) An ability to identify, formulate, and solve engineering problems.
i) A recognition of the need for, and an ability to engage in life-long learning.

k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:

1. Elementary theory of compressor aerodynamics
2. Elementary theory of turbine aerodynamics
3. On and off-design performance of aircraft gas turbines
4. Inlet and exhaust nozzle aerodynamics
5. Combustion, emissions, and noise
6. Ramjets and scramjets

AA 462 ROCKET PROPULSION

SPRING QUARTER

CREDITS AND CONTACT HOURS: 3 credits, Three 50-minute lectures per week.

COORDINATORS: Undergraduate Committee, April 2013

TEXTBOOK: *Rocket Propulsion Elements*, 8th ed., Sutton, G.P., and Biblarz, O., John Wiley & Sons, Inc., New York, NY, 2010.

SUPPLEMENTAL MATERIALS: none.

CATALOG DATA: ROCKET PROPULSION, Selective Elective
Covers the physical and performance characteristics of chemical rocket propulsion systems. Includes combustion chamber thermochemistry, propellant properties and handling, and rocket system component interactions. Prerequisite: AA 360. Offered: Sp.

PREREQUISITES: BY TOPICS:
1. Calculus and analytic geometry
2. Differential equations
3. Chemistry
4. Thermodynamics
5. Fluid dynamics

OUTCOMES:
1. Students will become proficient at carrying out performance calculations for typical chemical rocket systems.
2. Reasons behind rocket component selection and design based on physical properties of propellants will be understood.

RELATIONSHIP TO STUDENT OUTCOMES:

a) An ability to apply knowledge of mathematics, science, and engineering.
c) An ability to design a system, component, or process to meet desired needs.
e) An ability to identify, formulate, and solve engineering problems.
i) A recognition of the need for, and an ability to engage in life-long learning.
j) A knowledge of contemporary issues.
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:
1. Overview and fundamentals of rocket performance
2. Chemical propellant properties: liquid, solid, gaseous
3. Materials and process engineering, component selection
4. Rocket systems: monopropellants, bi-propellants, solids, hybrids

AA 470 SYSTEMS ENGINEERING

FALL QUARTER

CREDITS AND CONTACT HOURS: 4 credits, Two 110 minute lectures per week

COORDINATOR: A.P. Bruckner, Professor of Aeronautics and Astronautics

TEXTBOOK: *Systems Engineering and Analysis*, 5th Ed., Blanchard, B. and Fabrycky, W. 2010. (Optional)

SUPPLEMENTAL MATERIALS: None

CATALOG DATA: SYSTEMS ENGINEERING, Selective Elective
Concepts of system approach, system hierarchies, functional analysis, requirements, trade studies, and other concepts used to define and integrate complex engineering systems. Introductions to risk analysis and reliability, failure modes and effects analysis, writing specifications, and lean manufacturing. Offered: jointly with
IND E 470.

PREREQUISITES BY TOPIC: Computer literacy of spreadsheets, Power Point and word processors.

OUTCOMES:

1) Students will be able to quantitatively evaluate system interfaces.
2) Students will be able to quantify risk and reliability.
3) Students will be able to write a simple component specification.
4) Students will be able to develop elements of a project plan

RELATIONSHIP TO STUDENT OUTCOMES:

a) An ability to apply knowledge of mathematics, science, and engineering.
c) An ability to define a system, component, or process to meet desired needs.
e) An ability to identify, formulate, and solve engineering problems.
g) An ability to communicate effectively
h) The broad education necessary to understand the impact of engineering solutions in a global and societal context.
i) A recognition of the need for, and an ability to engage in life-long learning.
j) A knowledge of contemporary issues.
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:

1) System Definition
2) Project Management (PERT, Gannt, WBS, Budgets, Teams)
3) Risk Assessment
4) Specialty Engineering (Reliability, Maintainability, Human Factors)
5) Engineering Requirements

6) Writing Specifications
7) Failure Modes and Effects Analysis
8) Lean Manufacturing, 6-sigma design
9) Systems Architecture

AA 480 SYSTEMS DYNAMICS

SPRING QUARTER

CLASS SCHEDULE: 3 credits**,** Three 50 minute lectures per week.

COORDINATOR: A. Bruckner, Professor of Aeronautics and Astronautics

TEXTBOOK: *Theory of Vibrations with Applications*, 5th Ed.,Thompson, W.T., and Dahleh, M.D., Prentice Hall, 1997.

SUPPLEMENTAL MATERIALS: *Introduction to Dynamics and Control*, Meirovich, L., Wiley, 1985.
Elements of Vibration Analysis, Meirovich, McGraw-Hill, 1986.

CATALOG DATA: SYSTEMS DYNAMICS, Selected Elective
Equations of motion and solutions for selected problems; natural frequencies and mode shapes; response of systems to applied loads. Prerequisite: AA 312 or senior standing.

PREREQUISITES BY TOPIC:
1) Introduction to vibration analysis (AA 312)
2) Matrix analysis methods desirable

OUTCOMES:
1. Can analyze the vibration characteristics in real world systems using concepts such as damping, frequencies, mode shapes, and isolation.
2. Can go into the laboratory, take dynamic data of a structure, convert it into frequency domain data, and interpret the results in terms of frequencies, damping, and mode shapes.
3. Can model a complex dynamic system.
4. Can apply concepts of systems dynamics to current, advanced dynamic systems problems.

RELATIONSHIP TO ABET OUTCOMES:
a) An ability to apply knowledge of mathematics, science, and engineering
e) An ability to identify, formulate, and solve engineering problems
i) A recognition of the need for, and an ability to engage in life-long learning.
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS:
1) Review of multi-degree-of-freedom discrete mass systems, Eigenvalues, Eigenvectors
2) Matrix equation form of coupled equation sets, matrix iteration, orthogonality of natural modes
3) Dependent variable transformation, modal matrix, uncoupling of equations
4) Modal analysis of forced vibrations, general solutions, expansion theorem
5) Effect of various forms of damping, analysis techniques
6) Continuous systems; Eigenvalues and Eigenvectors for simple

beams, rods and strings; orthogonality of modes

7) Approximate methods for predicting natural frequencies and modes (Eigenvalues and vectors), Rayleigh, Ritz, Galerkin, matrix iteration, matrix integration
8) Forced and damped motions of continuous systems, response-dependent forcing and damping functions, stability of response
9) Introduction to flutter analysis
10) Modeling of non-deterministic forcing functions and vibration response

AA 496 UNDERGRADUATE SEMINAR

WINTER QUARTER

CREDITS AND
CONTACT HOURS*:* 1 credit, One 1 – hour seminar per week.

COORDINATOR: A.P. Bruckner, Professor of Aeronautics and Astronautics

TEXTBOOK: None

SUPPLEMENTAL
MATERIAL: None

CATALOG DATA: UNDERGRADUATE SEMINAR, Required
Lectures and discussions on topics of current interest in aviation and space technology by guest speakers. Topics vary. Offered: W.

PREREQUISITES BY TOPIC: Undergraduate students in College of Engineering.

RELATIONSHIP TO STUDENT OUTCOMES:

f) An understanding of professional and ethical responsibility.
h) The broad education necessary to understand the impact of engineering solutions in a global and societal context.
i) A recognition of the need for, and an ability to engage in life-long learning
j) A knowledge of contemporary issues.

TOPICS: Speakers from the industry give seminars on a variety of subjects:
Topics in 2013 included:

1. History of the Jet Engine: Aviation Reinvented
2. Boeing 787: Globally Designed and Built
3. Solutions to Airplane Handling Problems: The Pilot's Perspective
4. Aerodynamic Design of the Lockheed Martin Cooperative Avionics Testbed
5. Satellite Communications
6. Space Tethers
7. Entry, Descent, and Landing Challenges for a Human Mars Mission
8. The Orion Multi-purpose Crew Vehicle
9. Why Mars is Hard
10. Asteroid Mining

<u>AA 498 SPECIAL TOPICS IN AERONAUTICS AND ASTRONAUTICS</u>

SPRING QUARTER 2012

CREDITS AND CONTACT HOURS: Variable**,** 1-5 credits**;** Contact hours vary by credits.

COORDINATOR: Various faculty

TEXTBOOK: As needed

SUPPLEMENTAL MATERIALS: As needed

CATALOG DATA: SPECIAL TOPICS IN AERONAUTICS AND ASTRONAUTICS, Elective

COURSE DESCRIPTION: Topics of current interest in the Department of Aeronautics and Astronautics

PREREQUISITES BY TOPIC: None.

RELATIONSHIP TO STUDENT OUTCOMES: **V**aries, depending on course topic.

TOPICS: Variable

AA 499 UNDERGRADUATE RESEARCH

AUTUMN, WINTER, SPRING, SUMMER QUARTERS

CREDITS AND COURSE CONTENT: 1-5 credits; Independent Study

COORDINATOR: Various faculty

TEXTBOOK: None

REFERENCES: As needed

CATALOG DATA: Undergraduate Research, Elective
Investigation of a special project by the student, under the supervision of a faculty member. A maximum of 6 credits may be applied toward senior technical electives.

PREREQUISITES BY TOPIC: Depends on project.

RELATIONSHIP TO STUDENT OUTCOMES:

a) An 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.
c) An ability to design a system, component, or process to meet desired needs.
d) An ability to function on multi-disciplinary teams.
e) An ability to identify, formulate, and solve engineering problems.
f) An understanding of professional and ethical responsibility.
g) An ability to communicate effectively.
h) The broad education necessary to understand the impact of engineering solutions in a global and societal context.
i) A recognition of the need for, and an ability to engage in life-long learning.
j) A knowledge of contemporary issues.
k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

TOPICS: Highly Individual; topics in past years included:

1) Studying the efficiencies of propellers using the 3x3 wind tunnel
2) Mars Gravity Biosatellite Propulsion Study
3) Water adsorption in Zeolite 3A for in-situ resource utilization applications.
4) Using vortex generators as a means for modifying the low-speed stall characteristics of 3D tapered wings.
5) Traverse development for flow dynamic control experiments.
6) Design and construction of a remote controlled fish Robot.
7) Water tank traverse mechanism
8) Fluid mechanics of viscous flow
9) Magnetic sensors for damage detection
10) Drag of Non-Retractable Landing Gear

Appendix B – Faculty Vitae

List of Faculty*

Tenured or Tenure-Track Faculty:

Breidenthal, Robert E.	Professor
Bruckner, Adam P.	Professor
Dabiri, Dana	Associate Professor
Ferrante, Antonino	Assistant Professor
Hermanson, James C.	Professor and Chair
Holsapple, Keith A.	Professor
Jarboe, Thomas R.	*Professor*
Kurosaka, Mitsuru	Professor
Lin, Kuen Y.	Professor
Livne, Eli	Professor
Mesbahi, Mehran	Professor
Morgansen, Kristi A.	Associate Professor
Shumlak, Uri	Professor
You, Setthivoine	Assistant Professor

Research Faculty:

Feraboli, Paolo	*Research Associate Professor*
Milroy, Richard	*Research Professor*
Slough, John	*Research Associate Professor*

Lecturers:

Raymond Golingo	Lecturer Part Time and Research Scientist/Engineer
Knowlen, Carl	Lecturer Part Time and Senior Research Scientist
Lum, Christopher	Lecturer Part Time and Research Scientist/Engineer

Affiliate Faculty:

Dana Andrews	Affiliate Professor (Ret. Andrews Space, Inc.)
Susan Murphy	Affiliate Associate Professor (Boeing)

Note : FTT and Research Faculty listed in Italic font have not taught undergraduate courses in the past three years. Research faculty normally do not have teaching assignments. The list of Vitae which follows contains only those faculty who have taught undergraduate courses during the past two years.

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* This list includes faculty in the department at the time this report was submitted. Three new faculty, including the new Dean of Engineering, will join the department in July and August 2013. Information about the new faculty will be available at the time of the ABET site visit, October 13-15, 2013.

Dana G. Andrews

Education
Ph.D., Aeronautical & Astronautical Engineering, Stanford, 1974
M.S., Aeronautical & Astronautical Engineering, Caltech, 1967
B.S., Aeronautical & Astronautical Engineering, UW, 1966

Academic experience
University of Washington, Affiliate Professor, 2012-present

Current membership in professional organizations
AIAA (Senior Member)
IAF

Honors and awards
Engineer of the Year, The Boeing Company, 1983

Publication/presentations of past five years

Andrews, D.G., "Use of Space Resources on Earth, Fact or Fiction?", IAC-11.D3.2.7, , 62nd International Astronautical Congress, Cape Town, 2011.

Andrews, D.G., and Cannon, J.L., "Mars Lite, an Affordable Way to Solve Mars's Mysteries", IAC-11.A5.4.10, 62nd International Astronautical Congress, Cape Town, 2011.

Andrews, D.G., Woodcock, G.R., and Bloudek, B., "Space Colonization, A Study of Supply and Demand", IAC- 11.E5.1.8, 62nd International Astronautical Congress, Cape Town, 2011.

Andrews, D.G., Woodcock, G.R., and Bloudek, B., "Space Colonization, A Study of Supply and Demand", Paper ID: 7609, 61st International Astronautical Congress, Prague, 2010.

Andrews, D.G., Kessler, T., and Sponable, J., "Space Transportation Solutions and Innovations", Paper ID 7606, 61st International Astronautical Congress, Prague, 2010.

Professional development activities

Professional conferences

Robert E. Breidenthal

Education
Ph.D., Aeronautics, Caltech, 1979
M.S., Aeronautics, Caltech, 1974
B.S., Aeronautical Engineering, Wichita State University, 1973

Academic Experience
University of Washington (AA), Professor, 1997– Present, full time
University of Washington (AA), Associate Professor, 1987-1997, full time
University of Washington (AA), Assistant Professor, 1983-1989, full time
University of Washington (AA), Research Assistant Professor, 1980-1983 full time
Caltech (Aeronautics), Postdoc, 1978–1980, full time

Current membership in professional organizations
Instrument and glider pilot
American Physical Society, member
American Institute of Aeronautics and Astronautics, member

Honors and awards
Donald W. Douglas Fellow, Caltech 1973-1978.
NSF Fellow, Caltech 1973-1976.
Professor of the Year, Department of Aeronautics and Astronautics 1994.
Tan Chin Tuan Visiting Professorship, National Technological University, Singapore 2005.
Commencement Speaker, AA Department 2006, 2007.
UW Outstanding Professor nomination 2008

Service activities
- Education Committee, Future of Flight
- Fund Review Committee, UW, Chair
- Faculty Council for Benefits and Retirement, UW

Publication/presentations of past five years

The effect of acceleration on turbulent entrainment, R.E. Breidenthal, *Physica Scripta T* 132 014001, 2008.

An aerodynamic study of the CFHT dome using CFD and water tunnel tests, M Baril, T. Benedict, K. Thanjavur, D. Salmon, K. Vogiatzis, R. Racine, R. Breidenthal, *SPIE Proceedings* 8449 Modeling, Systems Engineering, and Project Management for Astronomy V, G.Z. Angeli, P. Dierickx, Editors, 844903, 13 August 2012.

Environmental concerns in general aviation, R.E. Breidenthal, *Ethical Issues in Aviation,* ed. E.A. Hoppe, 2011.

Combustion Chamber for Internal Combustion Engine, R.E. Breidenthal, US Patent 7,353,797 issued 4/8/08.

Vortex generator, R.E. Breidenthal, US Patent Application 13/542,673 filed July 6, 2012.

Gas Turbine Engine with Supersonic Compressor, W.B. Roberts III, S.P. Lawlor, R.E. Breidenthal, US Patent Application 13/542,678 filed July 6, 2012.

22 patent applications (approx.) filed by ClearSign Combustion Corporation as of February 22, 2013 for electric fields to modify combustors and heat transfer to turbine blades (R.E. Breidenthal co-inventor).

Wildfire simulation using a chemically-reacting plume in a crossflow, R.E. Breidenthal, T. Alvarado, B. Potter, Division of Fluid Dynamics Annual Meeting, American Physical Society, Long Beach 2010.

Turbine blade cooling using Coulomb repulsion, R.E. Breidenthal, J. Colannino, J. Dees, D. Goodson, I. Krichtafovitch, T. Prevo, Division of Fluid Dynamics Annual Meeting, American Physical Society, San Diego 2012.

The peculiar behavior of stationary and accelerating vortices, R.E. Breidenthal, several locations and times, including Bangalore, India, UCSD, UC Irvine, 2009-2013.

Professional development activities

Cloud physics workshop, Bangalore, India, Feb. 2013.

Preparation for commercial and instructor glider rating.

Consulting for numerous companies, including Boeing, Learjet, Ramgen, ClearSign Combustion, part time.

Adam Bruckner

Education
Ph.D.: Princeton University, 1972
M.A.: Princeton University, 1968
B.Engr.: McGill University, 1966

Academic Experience
Professor: Sept. 1991-present
Department Chair: July 1998-June 2010
Research Professor: July 1988 - Sept. 1991
Research Associate Professor: July 1978 – July 1988
Research Assistant Professor: July 1975 – July 1978
Research Associate: June 1972 – July 1975

Current membership in professional organizations
American Institute of Aeronautics and Astronautics (AIAA) (Fellow)
American Society of Engineering Educators (ASEE)
Sigma Xi (Scientific Research Society)

Honors and awards
Fellow, American Institute of Aeronautics and Astronautics (AIAA), 1997
Certificate of Appreciation, Universities Space Research Association (USRA), 1994
Professor of the Year, AA Dept. (Co-recipient) 1994
AIAA Certificate of Recognition, 1992; Certificate of Appreciation, 1991
AIAA Associate Fellow, 1989
Burlington Resources, Inc. Faculty Achievement Award for Outstanding Research, 1989
USRA Distinguished Service Award, 1989
NASA Certificate of Appreciation, 1985, 1986, 1989, 1992
NASA Certificate of Recognition, 1983
AIAA PNW Section Award for Outstanding Contribution to Aerospace Engineering, 1973
British Association Medal, McGill University, 1966

Service activities
- Chair, Undergraduate Program Committee, 2011-present
- Chair, Space Systems Center Committee, 2005-present
- Chair, Instructional Laboratory Committee, 1998-present
- Space Allocation and Utilization Committee, 2009-present (Chair, 2009-2012)
- Astronautics Working Group, 2011-present
- Accreditation and Continuous Improvement Committee, 2012-present
- Council for Educational Policy, 2011-present
- Technical Advisory Board, Global Integrated Systems Engineering (GISE) Program, 2006-present
- Museum of Flight Space Collections Committee, 2011- present
- Museum of Flight Pathfinder Awards Selection Committee, 2008-present

Publications/presentations of past five years

Bauer, P., Bengherbia, T., Knowlen, C., **Bruckner, A.**, Yao, Y., and Giraud, M. “Equations of State and Scale Effect Implementation for 1-D Modelling of Performance in Ram Accelerator Thermally Choked Propulsion Mode,” submitted to *Int. J. Engineering Systems Modelling and Simulation*

Bauer, P., Bengherbia, T., Knowlen, C., **Bruckner, A.P.**, Yao, Y., and Giraud, M., “Influence of Compressibility Effects for 1D Modeling of the Thermally Choked Ram Accelerator,” 27th International Symposium on Ballistics, Freiburg, Germany, April 22-26, 2013.

Bauer, P., Bengherbia, T., **Bruckner, A.P.**, Knowlen, C., Yao, Y., Giraud, M., “Equation of State Selection for 1-D Modeling of the Thermally Choked Ram Accelerator,” Paper AIAA 2013-0884, 51st AIAA Aerospace Sciences Meeting, Grapevine TX, Jan. 7-10, 2013.

Igbinosun, O., Wood, S., **Bruckner, A.P.**, “Interfacial Water as a Mars ISRU Objective: Detection of Microscopic Water using Fiber Optic Sensors, Paper AIAA 2013-0437, 51st AIAA Aerospace Sciences Meeting, Grapevine TX, Jan. 7-10, 2013.

Bengherbia, T., Yao, Y., Bauer, P., Knowlen, C., **Bruckner, A.P.,** and Giraud, M., “One-Dimensional Modeling of Thermally Choked Ram Accelerator Based on CFD Simulations,” Paper AIAA 2012-982, 50th AIAA Aerospace Sciences Meeting, Nashville TN, Jan. 9-12, 2012.

Bruckner, A.P., and Knowlen, C., “Ram Accelerator,” in *Encyclopedia of Aerospace Engineering*, Blockey, R., and Shyy, W. (eds.), John Wiley & Sons Ltd, Chichester, UK, pp. 1063-1074, 2011. (Invited)

Lee, J., Eberhardt, D.S., and **Bruckner**, A.P., “From Biplanes to Spaceplanes: The History of the University of Washington Department of Aeronautics and Astronautics,” ASEE Annual Conference and Exposition, Austin, TX, June 14-17, 2009.

Knowlen, C., Higgins, A.J., Harris, P., and **Bruckner**, A.P., “Hypersonic Shock-Induced Combustion Propulsion,” Paper AIAA-2009-0715, 47th Aerospace Sciences Meeting and Exhibit, Orlando, FL, Jan. 5-8, 2009.

Professional development activities

UW College of Engineering ADVANCE Workshops, 2001-2010
Technical conferences and workshops

Dana Dabiri

Education
Ph.D., University of California, San Diego, CA, Aerospace Engineering, 1992
M.S., University of California, Berkeley, CA, Mechanical Engineering, 1987
B.S., University of California, San Diego, CA, Mechanical Engineering (Magna Cum Laude), 1985

Academic Experience
University of Washington (AA), Associate Professor, 9/09 – Present
University of Washington (AA), Assistant Professor, 1/02 – 9/09
California Institute of Technology, Research Scientist, 4/93-12/01
University of California San Diego, Post-doctoral Research Associate, 6/92-4/93
University of California San Diego, Graduate Research Student, 1/88-6/92
University of California Berkeley, Graduate Research Student, 8/85-12/87

Honors and awards
Nominated for Distinguished Teaching Award, 2006, University of Washington
UC Regents Fellowship, 1988 – 1989, University of California, San Diego
Gallery of Fluid Motion Best Poster Award, 1993, Albuquerque, New Mexico

Service activities
- UAEU/UW Educational Collaboration Committee, 2010-present
- Department Strategic Planning Committee, 2008-present
- Department Undergraduate Committee, 2002-2010, 2012-present
- Department UWAL Committee, 2004-present
- Faculty Search Committee, 2011-present
- Associate Editor for Journal of Visualization, 3/2009-Present

Publications/presentations of past five years

Legend: 1: student, 2: institutional collaborator, 3: external collaborator, 4: post-doc, 5: scientist.

C Zhu,[3] R Deng,[3] J Zeng,[3] G.E. Khalil,[1] **D Dabiri**,[1] Z Gu,[3] Y Xia[3] "Synthesis and Characterization of Pressure and Temperature Dual-responsive Polystyrene Microbeads," *Particle*, 2013

Lei Y-C[1], Tien W-H[1], Duncan J. [1], Paul M. [1], **Dabiri D.**, Rösgen T. [3], Hove J. [3] "A vision-based hybrid particle tracking velocimetry (PTV) technique using a modified cascade-correlation peak-finding method", *Experiments in Fluids*, 53 (5), 1251-1268, 2012

Amin M. [1], **Dabiri D.**, Navaz H. K.[3] "Comprehensive study on the effects of fluid dynamics of air curtain and geometry, on infiltration rate of open refrigerated cavities", *Applied Thermal Engineering*, **35**, 120-126, 2012

Amin M. [1], **Dabiri D.**, Navaz H. K.[3] "Effects of secondary variables on infiltration rate of open refrigerated vertical display cases with single-band air curtain", *Applied Thermal Engineering*, **31**, 3055-3065, 2011.

Amin M. [1], **Dabiri D.**, Navaz H. K.[3] "A Comprehensive Experimental Study on the Effects of Geometry of Open Refrigerated Display Cases and Fluid Dynamics of Air Curtains on Infiltration Rate" *Applied Thermal Engineering*, **31**, 3055-3065, 2011
Kimura F. [1], McCann J. [2], Khalil G.E. [2], **Dabiri D.**, Xia Y. [2] ,Callis J.B.[2] "*Simultaneous velocity and pressure measurements using luminescent Microspheres*", *Review of Scientific Instruments* **81**, 064101, 2010

Duncan J. [1], **Dabiri D.**, Hove J.[3], Gharib M.[3] "Universal outlier detection for particle image velocimetry (PIV) & particle tracking velocimetry (PTV) data", *Meas. Sci. Technol.* **21** 057002, 2010

Duncan J.[1] Bryce T.,[1] Thomsen H.,[1] **Dabiri D.**, Hove J.R.[3] **"**An Extended Study of a Generalized DPIV Processing Technique**"**, *Measurement Science and Technology*, **20**, (7), 075401, 2009.

Amin M. [1], **Dabiri D.**, Navaz H.K.[3] "Tracer gas technique: A new approach for steady state infiltration rate measurement of open refrigerated display cases", *Journal of Food Engineering*, **92** (2), 172-181, 2009.

Dabiri D. "Digital Liquid Crystal Particle Thermometry/Velocimetry (DLCPT/V) – A Review**"**, Invited Review Article, *Exp. Fluids*, **46** (2), 191-241, 2009.

Amin M.[1], Navaz H.K. [3], Kehtarnavaz N.[3], **Dabiri D.** "Systematic Approach for Solving Large-Scale Problems by Neural Network: Open Refrigerated Display Cases and Droplet Evaporation Problems", *Food and Bioprocess Technology,* 2009.

Kimura F.,[1] Rodriguez M.,[1] McCann J.,[4] Carlson B.,[2] Callis J.,[2] **Dabiri D.**, & Khalil G.,[2] "Development and Characterization of Fast Responding Pressure-Sensitive Microspheres," *Review of Scientific Instruments*, **79** (7), 074102, 2008

Grothe R.,[1] Rixon G.,[1] & **Dabiri D.**, "An Improved Three-Dimensional Characterization of Defocusing Digital Particle Image Velocimetry (DDPIV) Based on a New Imaging Volume Definition," *Measurement Science & Technology,* **19** *(*6), 065402, 2008.

Tien W.H.,[1] Kartes P.,[1] Yamasaki T.,[1] & **Dabiri D.** "A color-coded backlighted defocusing digital particle image velocimetry system," *Exp. Fluids*, **44**, 1015-1026, 2008.

Professional development activities

Technical conferences

Antonino Ferrante

Education

Ph.D., Mechanical and Aerospace Engineering, University of California, Irvine, 2004

M.S., Aeronautics and Aerospace (with honors), von Kármán Institute for Fluid Dynamics, Belgium, 1997

Laurea, Ingegneria Aeronautica (summa cum laude), Università di Napoli 'Federico II', Italy, 1996

Academic experience

University of Washington (AA), Assistant Professor, 7/2009-Present
University of Washington (AA), Affiliate Assistant Professor, 8/2008-6/2009
California Institute of Technology (GALCIT), Postdoctoral Scholar, 3/2007-6/2009
University of California, Irvine (MAE), Postdoctoral Scholar , 3/2004-2/2007
University of California, Irvine (MAE), Graduate Research Assistant, 9/1998-2/2004
Università di Napoli 'Federico II', Italy (AE), Research Assistant, 8/1997-8/1998
von Kármán Institute, Belgium (AA), Graduate Research Assistant , 9/1996-6/1997

Current membership in professional organizations

AIAA, APS

Honors and awards

2012 ICTAM Travel Fellowship Grant Award, U.S. National Academies of Science (NAS)
2012 Royalty Research Fund Award, University of Washington (UW)
2011 NSF CAREER Award, Office of CyberInfrastructure, Fluid Dynamics, Particulate and Multiphase Processes
2004 Capability Application Project on IBM Power4+, High-Performance Computing Modernization Program, Department of Defense (DoD)
2003 Gallery of Fluid Motion, Video Entry Award, American Physical Society, Division of Fluid Dynamics (APS-DFD)
2003 Dissertation Fellowship Award, Henry Samueli School of Engineering, University of California, Irvine
1998 Study Abroad Fellowship Award, Università di Napoli 'Federico II', Italy
1997 Belgian Government Prize & Diploma with Honors,von Kármán Institute for Fluid Dynamics, Belgium

Service activities

- Reviewer for 15 top journals in fluid mechanics and computational physics
- Chaired seven conference sessions at APS, AIAA and ICTAM conferences
- Graduate Committee in the Dept. of Aeronautics & Astronautics, UW
- Computer Committee in the Dept. of Aeronautics & Astronautics, UW
- Strategic Planning Committee in the Dept. of Aeronautics & Astronautics, UW
- Organizer of the AA Fluid Mechanics Seminars (since 2013)
- Webmaster of the UW Fluid Mechanics site: http://fluidmechanics.uw.edu/

- Committee chair on qualifying exams of three graduate students, Committee member on three qualifying exams, two M.S. thesis defense, and general doctoral exams: one in Physics (GSR), two in AA
- Panel reviewer for NSF and DoE

Publications/presentations of past five years

Lucci F., Ferrante A. & Elghobashi S., "Is Stokes number an appropriate indicator for turbulence modulation by particles of Taylor-length-scale size?" *Physics of Fluids, Vol. 23, 025101, pp. 1-7 (2011)*

Ferrante A., Matheou G. & Dimotakis P.E., "LES of an inclined sonic jet into a supersonic turbulent crossflow at Mach 3.6," *Journal of Turbulence, Vol. 12, n. 2, pp. 1-32 (2011)*

Lucci F., Ferrante A. & Elghobashi S. "Modulation of isotropic turbulence by particles of Taylor-lengthscale size," *Journal of Fluid Mechanics, Vol. 650, pp. 5-55 (2010),* Featured article in "Focus on Fluids" of *Journal of Fluid Mechanics* (May 2010)

L'vov V.S., Pomyalov A., Ferrante A. & Elghobashi S., "An analytical model for temporally-developing turbulent boundary layers," *Journal of Experimental and Theoretical Physics Letters, Vol. 86, pp. 102-107 (2007)*

Ferrante A. & Elghobashi S., "On the accuracy of the two-fluid formulation in DNS of bubble-laden turbulent boundary layers," *Physics of Fluids, Vol. 19, 045105, pp. 1-8 (2007)*

Ferrante A. & Elghobashi S., "On the effects of microbubbles on the Taylor-Green vortex flow," *Journal of Fluid Mechanics, Vol. 572, pp. 145-177 (2007)*

Dodd M. & Ferrante A., "Direct numerical simulation of particle dispersion in a spatially developing turbulent boundary layer," *International Conference on Multiphase Flow Jeju, Korea, May 26-31, 2013*

Dodd M. & Ferrante A., "A coupled pressure-correction/volume of fluid method for DNS of droplet-laden isotropic turbulence," *International Conference on Multiphase Flow Jeju, Korea, May 26-31, 2013*

Baraldi A. & Ferrante A., "DNS of fully-resolved droplet-laden isotropic turbulence: a mass-conserving volume of fluid method," *23rd International Conference of Theoretical and Applied Mechanics (ICTAM) Beijing, China, August 19-24, 2012*

Baraldi A. & Ferrante A., "A mass-conserving volume of fluid method for fully-resolved DNS of droplet-laden isotropic turbulence," *International Conference on Numerical Methods in Multiphase Flows, Pennsilvania State University, June 12-14, 2012*

Baraldi A. & Ferrante A., "A VoF method for DNS of droplet-laden incompressible turbulence," *7th International Conference on Computational Fluid Dynamics Big Island, Hawaii, July 9-13, 2012*

Professional development activities

"Faculty Fellow Teaching Workshop," University of Washington, Seattle, WA, Sept. 12-16, 2011

"Tutorials on Advanced MPI/OpenMP/CUDA/OpenCL/VisIt", Supercomputing 2010, New Orleans, LA, Nov. 14-15, 2010

"National Engineering Teaching Institute", ASEE, Louisville KY, June 17-19, 2010

“Hypersonic entry and cruise vehicles”, Stanford University / NASA / VKI, Stanford, CA, June 30 - July 3, 2008.

Various technical conferences

Ray Golingo

Education
Ph.D., Aeronautics & Astronautics, University of Washington, 2003
M.S., Aeronautics & Astronautics, University of Washington, 1998
B.S., Aeronautics & Astronautics, University of Washington, 1990

Academic experience
University of Washington, Lecturer, 6/2011-Present
University of Washington, Research Scientist, 1/2004-Present
University of Washington, Teaching Assistant, 9/1990-3/91
University of Washington, Teaching Assistant, 9/1997-12/1997
University of Washington, Assistant Crew Chief (UWAL), 6/1989-9/1990

Current membership in professional organizations
American Physical Society

Publication/presentations of past five years

"Note: Zeeman Splitting Measurements in a High Temperature Plasma," R.P. Golingo, U. Shumlak, and D.J. Den Hartog, *Review of Scientific Instruments* 81(12), 126104 (2010).

"Modeling Magnetic Fields Measured by Surface Probes Embedded in a Cylindrical Flux Conserver," R.P. Golingo, *Review of Scientific Instruments* 78 (3), 033504 (2007).

"Advanced Space Propulsion Based on the Flow-Stabilized Z-Pinch Fusion Concept," U. Shumlak, R.C. Lilly, C.S. Adams, R.P. Golingo, S.L. Jackson, S.D Knecht, and B.A. Nelson, Paper AIAA-2006-4805 (2006).

Professional development activities

Technical conferences

James C. Hermanson

Education
Ph.D., Aeronautics, California Institute of Technology, 1985
M.S., Aeronautics, California Institute of Technology, 1980
B.S., Aeronautics & Astronautics, University of Washington, 1977

Academic experience
University of Washington (AA), Chair, 2010-present
University of Washington (AA), Professor, 2008-present
University of Washington (AA), Associate Professor, 2002-2008,
Worcester Polytechnic Institute, Mechanical Engineering, Professor, 2002
Worcester Polytechnic Institute, Mechanical Engineering, Associate Professor, 1997-2002
Worcester Polytechnic Institute, Mechanical Engineering, Assistant Professor, 1995-1997
University of Connecticut, Mechanical Engineering, Visiting Associate Professor, 1993
University of Washington (APL), Senior Engineer/Research Assistant Professor, 1986-1988

Current membership in professional organizations
American Institute of Aeronautics and Astronautics (Associate Fellow)
American Society of Mechanical Engineers (Fellow)
American Physical Society (Member)

Honors and awards
Best Paper Award, *18th Microgravity Science and Space Processing Symposium* (42nd AIAA Aerospace Sciences Meeting), January 2004.
Boeing Professor, UW, 2002-2005.
ASME Curriculum Innovation Award - Honorable Mention, 2001
Russell M. Searle Instructorship (*Teacher of the Year*), ME/WPI, 2001
George I. Alden Chair in Engineering, WPI, 1999.

Service activities
- A&A Strategic Planning Committee (Chair)
- College of Engineering Executive Committee

Publication/presentations of past five years

"Disruption of Volatile and Non-volatile Droplets under Locally Supersonic Conditions," Kim, Y.J. and Hermanson, J.C., *AIAA Journal* **50** (8), 1754-1765, 2012.

"Breakup and Vaporization of Droplets under Locally Supersonic Conditions," Kim, Y.J. and Hermanson, J.C., *Phys. Fluids* **24** (7), 076102, 2012.

"Experimental Investigation of Convective Structure Evolution and Heat Transfer in Quasi-Steady Evaporating Liquid Films", Kimball, J.T., Hermanson, J.C., and Allen, J.S., *Phys. Fluids* **24**, 052102, 2012.

“Turbulent Structure Dynamics of Buoyant and Non-buoyant Pulsed Jet Diffusion Flames,” Fregeau, M., Hermanson, J.C., Stocker, D.P., and Hegde, U.G., *Combustion Science and Technology*, **183**, 309 – 330, 2010.

“NO_x/CO Emissions of Strongly-Pulsed Jet Diffusion Flames,” Fregeau, M. and Hermanson, J.C., *Combustion Science and Technology*, **181**, 536-554, 2009.

“Ultrasonic measurement of condensate film thickness,” Kimball, J.T., Bailey, M.F., and Hermanson, J.C., *Journal of the Acoustical Society of America* **124** (4), EL196-202, 2008.

“Convective Structure and Heat Transfer of Evaporating Films under Transient Conditions,” Kimball, J.T., Hermanson, J.C. and Allen, J.S. Paper No. 96, *23rd International Symposium on Transport Phenomena*, Auckland, New Zealand, November 2012.

“Reaction Zone Structure of Swirled, Strongly-Pulsed Turbulent Jet Diffusion Flames,” Liao, Y. –H. and Hermanson, J. C. Paper No. 57, *23rd International Symposium on Transport Phenomena*, Auckland, New Zealand, November 2012.

“Stability of an Evaporating Liquid Film under Nonequilibrium Conditions with Variable Gravity,” Narendranath, A.D., Hermanson, J.C., Struthers, A.A., Kolkka, R.W., and Allen, J.S. *ASME Fluids Engineering Division Summer Meeting*, Puerto Rico, USA, July 2012.

“The Effects of Swirl on the Structure of Strongly-Pulsed Turbulent Diffusion Flames,” Liao, Y.-H. and Hermanson, J.C., Paper T-33, *7th US National Combustion Meeting*, Atlanta, GA, March 2011.

“The CO/NO_x Emissions of Strongly-Pulsed Turbulent Jet Diffusion Flames with Swirl,” Liao, Y.-H. and Hermanson, J.C., Paper T-34, *7th US National Combustion Meeting*, Atlanta, GA, March 2011.

Professional development activities
University of Washington Leadership Agility Workshop, 2012
Executive coaching, 2011-present
University of Washington Foster School of Business *Enhancing Leadership Effectiveness* course, 2009.
Technical conferences

Keith A. Holsapple

Education
Ph.D., Aeronautics and Astronautics, University of Washington, 1966
M.S., Engineering, University of Washington, 1964
B.S., Aeronautical Engineering, University of Washington, 1960

Academic experience
University of Washington (AA), Professor
University of Washington, Associate Dean, College of Engineering
University of Washington (AA), Associate Professor
University of Washington (AA), Assistant Professor
University of Washington (AA), Senior Lecturer

Current membership in professional organizations
American Institute of Aeronautics and Astronautics
American Geophysical Union
American Society of Mechanical Engineers
Society of Automotive Engineers
Registered Mechanical Engineer, State of Washington

Honors and awards
Asteroid "**20360Holsapple"** named in my honor.

Service activities

- Multiple journal referee, 5-10/year. Membership on national committees.

Publication/presentations of past 4 years

Holsapple, K. A., " Modeling granular material flows: The angle of repose, fluidization and the cliff collapse problem", Icarus, March, 2012.

Housen, K. R. and **Holsapple, K. A**., "Craters without ejecta", Icarus, 219, 1, p. 297-306, 2012.

Housen, K. R. and **Holsapple, K. A**., " Ejecta From Impact Craters", *Icarus*, Volume 211, Issue 1, p. 856-875, 2010.

Holsapple, K. A., "On YORP-Induced Deformations of Asteroids", *Icarus*, Volume 205, Issue 2, p. 430-442, 2009.

Holsapple, K. A., "Techniques for the deflection of threatening asteroids: Some theoretical considerations, problems and a few myths", *Proceedings, 1st IAA Planetary Defense Conference: Protecting Earth from Asteroids*, Granada, 27-30 2009.

Ormö, J., Lepinette, A., Sturkell, E., Lindström, M., Housen, K., **Holsapple, K.,** "Dynamics of the water resurge at marine-target impact craters analyzed with a combination of low-velocity impact experiments and numerical simulation". Geological Society of America Special Publication "Large Meteorite Impacts IV", Feb. 2009.

Holsapple, K. A., "On the Strength of small bodies of the Solar System", *Planetary and Space Science*, 2009.

Holsapple, K.A. and Patrick Michel, "Tidal disruptions II: A continuum theory for solid bodies with strength, with applications to the satellites of the Solar System", *Icarus*, Volume 193, Issue 1, p. 283-30, 2008.

Holsapple, K. A., " Spinning rods, elliptical disks and solid ellipsoidal bodies: Elastic and plastic stresses and limit spins", International Journal of Non-Linear Mechanics 43, 8, 2008.

E. Pierazzo, N. Artemieva, E. Asphaug, E.C. Baldwin, J. Cazamias, R. Coker, G.S. Collins, D.A. Crawford, T. Davison, D. Elbeshausen, **K.A. Holsapple**, K.R. Housen, D.G. Korycansky, K. Wünnemann. "Validation of numerical codes for impact and explosion cratering". Meteoritics and Planetary Science 43, 12, 2008.

Holsapple, K. A. and Kevin R. Housen, "A Crater and Its Ejecta: An Interpretation of Deep Impact", in *Deep Impact at Comet Tempel 1*, Elsevier, p. 586-597. 2007.

Housen, K. R.; Holsapple, K. A., "Deflecting Asteroids by Impacts: What is Beta?", 43rd Lunar and Planetary Science Conference, Contribution No. 1659, id.2539, 2013.

Holsapple, K. A. and K. R. Housen, "Studies of Impacts: Experimental and Numerical Simulations of Cratering, Disruptions, and Asteroid Deflections", Asteroids, Comets and Meteorites, Nigata, Japan, 2012.

Housen, K. R.; **Holsapple**, K. A., "Deflecting Asteroids by Impacts: What is Beta?, 43rd Lunar and Planetary Science Conference, LPI Contribution No. 1659, 2012.

Holsapple, K. A. and K. R. Housen, "Measuring the momentum transfer for asteroid deflections". European Planetary Science Conference Proceeding, Nantes, France, 2011.

Holsapple, K. A., "The flow of granular materials versus the angle of repose". European Planetary Science Conference Proceeding, Nantes, France, 2011.

Holsapple. K. A., " On the flow and fluidization of granular materials: Applications to large lunar craters, cliff collapses and asteroid shapes" 42nd *Lunar and Planetary Science*, Contribution No. 1047, 2011.

Housen, K. R. and **Holsapple, K. A.,** "Momentum Transfer in Hypervelocity Collisions", 42nd *Lunar and Planetary Science*, Contribution No., 2011.

Ormo, J., Housen, K. R., **Holsapple**, K. A., Lepinette, A., Melero Asensio, I., Torres Redondo, J. "Low velocity experimental impact cratering facility for the study of wet target impacts., 42nd *Lunar and Planetary Science*, Contribution No. 1047, 2011.

Housen, K. R. and **Holsapple, K. A.,** "Asteroids Without Ejecta", *Lunar and Planetary Science XLI*, LPI Contribution No. 1533, 2010

Pierazzo, E.; Collins, G. S.; **Holsapple, K. A.;** Housen, K. R.; Korycansky, D. G.; Plesko, C. S.; Price, M. C.; Wünnemann, "Impact Hydrocode Benchmark and Validation Project: Impacts Into Cohesionless Soil", K., LPI Contribution No. 1533, *Lunar and Planetary Science XLI*, 2010.

Holsapple, K. A., "The Deformation of Asteroids from YORP Spin-Up", LPI Contribution No. 2053, *Lunar and Planetary Science XL*, 2009.

Holsapple, K. A.; Housen, K. R., "Deep Impact: An Outburst Triggered by an Impact?", LPI Contribution No. 1936, *Lunar and Planetary Science XL*, 2009

Professional development activities
Multiple technical conference attendance

Carl Knowlen

Education
Ph.D., Aeronautical & Astronautical Engineering, UW, 1991
M.S., Aeronautical & Astronautical Engineering, UW, 1985
B.S., Aeronautical & Astronautical Engineering, UW, 1983

Academic experience
University of Washington, Part Time Lecturer (2010 – present)
University of Washington, Research Associate (1991 – 1996)

Honors and awards
Invitation Fellowship, Japan Society for the Promotion of Science, 1996
Certificate of Recognition, PNW Section, AIAA, 1986
Louis & Katherine Marsh Fellowship, 1983-1984
Rockwell Design Award, 1983
Minta-Martin Student Competition Certificate of Merit, 1983
Edward O'Brien Scholarship, 1982-1983

Service activities
- Engineering Discovery Days Coordinator for Dept. of Aeronautics & Astronautics.
- Safety committee member for Dept. of Aeronautics & Astronautics.

Publication/presentations of past five years

"One-Dimensional Modeling of Thermally Choked Ram Accelerator Based on CFD Simulations," Bengherbia, T., Yao, Y., Bauer, P., **Knowlen, C.,** Bruckner, A.P., and Giraud, M., Paper AIAA 2012-982, AIAA 50th Aerospace Sciences Meeting, Nashville TN, Jan. 9-12, 2012

"Improved 1-D unsteady modeling of the thermally choked RAMAC in the sub-detonative propulsion mode," Bengherbia, T., Yao Y., Bauer P., Giraud M., Knowlen C., *J. of Appl. Mech.*, Vol. 78, pp. 150-167, 2011.

"Ram Accelerator," Bruckner A.P. & **Knowlen C.**, in *Encyclopedia of Aerospace Engineering*, R. Blockley and W. Shyy (eds), John Wiley & Sons, Ltd., 2011.

"One-dimensional Performance Modeling of the RAMAC in Subdetonative Regime," Bengherbia, T., Yao Y., Bauer P., **Knowlen C.**, *Aerotecnica, J. of Aerospace Sci., Tech. and Syst.*, Vol. 89, pp. 3-13, 2010.

"Hypersonic Shock-Induced Combustion Propulsion," **Knowlen C.**, Higgins A.J., Harris P., & Bruckner A.P., 47th AIAA Aerospace Sciences Meeting, Orlando, FL, AIAA 2009-715, January 2009.

Professional development activities

Technical conferences

Mitsuru Kurosaka

Education
Ph.D., Mechanical Engineering, California Institute of Technology, 1968
M.S., Mechanical Engineering, University of Tokyo, 1961
B.S., Naval Architecture, University of Tokyo, 1959

Academic experience
University of Washington, Professor, 1987-present
L'ecole Nationale Supérieure de Mécanique et d'Aérotecnique, Visiting Professor, 2007
University of Tennessee Space Institute, Professor, 1979-1987
Massachusetts Institute of Technology, Visiting Professor, 1984-1985
University of Tennessee Space Institute, Associate Professor, 1977-1979

Current membership in professional organizations
AIAA (associate fellow)
ASME (fellow)
Japan Gas Turbine Society (member)

Honors and awards
Professor of Year, Department of Aeronautics and Astronautics 1993
AIAA General H.H.(Hap) Arnold Award 1983

Service activities
- Peer review committee (chair)
- Safety Committee (chair)
- Undergraduate Committee

Publication/presentations of past five years
"Azimuthal vorticity-gradient in the formative stages of vortex breakdown" with C.B. Cain, S. Srigrarom, J.D. Wimer, D. Dabiri, W.F. Johnson, J.C. Hatcher, B.R. Thompson, M.Kikuchi, K. Hirano,T.Yuge and T.Honda, (2006) vol 569, pp.1-28, *Journal of Fluid Mechanics*

Professional development activities
Technical conferences

Kuen Y. Lin

Education
Ph.D.: Massachusetts Institute of Technology, Aeronautics & Astronautics, 1977
M.S.: Massachusetts Institute of Technology, Aeronautics & Astronautics, 1973
B.S.: National Taiwan University, Mechanical Engineering, 1969

Academic experience
University of Washington, Professor, 1991- Present, Full time
Associate Professor, 1986- 1991; Associate Professor (WOT), 1984- 1986

Current membership in professional organizations
American Institute of Aeronautics and Astronautics (Associate Fellow)
Sigma Xi

Honors and awards
Excellence in Engineering Education Collaboration Award, American Society for Engineering Education (ASEE) 2011
CUX Top Excellence Award on Developing UW-Boeing Aircraft Composite Certificate Program 2007
Distinguished Contribution to Lifelong Learning Award Nominee, University of Washington 2006
Technical and Research Excellence Award, National Association of Asian American Professionals 2005
Professor of Year Award, Department of Aeronautics and Astronautics, University of Washington 2001
Professor of Year Award, Department of Aeronautics and Astronautics, University of Washington 1998
American Institute of Aeronautics and Astronautics, Associate Fellow 1995

Service activities
- A&A Graduate Committee member
- AIAA Adviser
- Faculty Senate
- Director of UW-Boeing Aircraft Composite Structural Analysis and Design Certificate Program
- Co-Director of AMTAS

Publication/presentations of past five years

Lin, K.Y., Richard, L., and Liu, W., "Delamination Arrest Fastener in Aircraft Composite Structures," Proc. of 19th Intern. Conference on Composite Materials (ICCM19), Montreal, Canada, July 28- Aug 2, 2013.

Cheung, C.H., Gray, P.G., and Lin, K.Y., "Design and Optimization of an Axial Mode II Crack Arrest Specimen," Proc. of 53rd AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, Honolulu, Hawaii, April 23-26, 2012.

Bruun, E.D., Cheung, C.H., Gray, P.M., and Lin, K.Y., "Design and Experimental Validation of a Mixed-Mode Crack Arrest Specimen," Proc. of 53rd AIAA/ASME /ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, Honolulu, Hawaii, April 23-26, 2012.

Cheung, C.H., and Lin, K.Y., "Numerical Analysis of Fastener Delamination/ Disbond Arrest Mechanism in Aircraft Composite Structures," Journal of Aircraft, Vol. 49, March 2012.

Cheung, C.H., Gray, P.G., and Lin, K.Y., "Fastener as Fail-Safe Disbond/ Delamination Arrest for Laminated Composite Structures," Proc. of 18th International Conference on Composite Materials (ICCM18), Jeju Island, Korea, Aug. 21-26, 2011.

Gray, P.G., Cheung, C.H., and Lin, K.Y., "Design Tool for Laminated Composite Structures Disbond Arrest Mechanism," Proc. of SAMPE 2010, Seattle, WA, May 17-20, 2010.

Cheung, C.H., Gray, P.G., and Lin, K.Y., "Analysis of Fasteners as Disbond Arrest Mechanism for Laminated Composite Structures," Proc. of 51st AIAA/ASME/ASCE/ AHS/ASC Structures, Structural Dynamics, and Materials Conference, Orlando, FL, April 12-15, 2010.

Cheung, C.H., and Lin, K.Y., "Reliability of Damage Tolerance Composite Structure Using Fasteners as Disbond Arrest Mechanism," Proc. of 50th AIAA/ASME/ASCE/ AHS/ASC Structures, Structural Dynamics, and Materials Conference, Palm Springs, CA, May 4-7, 2009.

Tajima, S., and Lin, K.Y., "Characterization of Aging Effects in Polymeric Composites Using X-ray Photoelectron Spectroscopy," Proc. of 3rd Intern. Symposium on Advanced Fluid/Solid Science and Technology in Experimental Mechanics, Dec. 7-10, 2008, Tainan, Taiwan (keynote paper).

Styuart, A., Lin, K.Y., and Livne, E., "Probabilistic Modeling of Structural/ Aeroelastic Life Cycle for Reliability Evaluation of Damage Tolerant Composite Structures," Proc. of Inter. Council of the Aeronautical Sciences (ICAS) 2008 Congress, Anchorage, Alaska, Sept. 14-19, 2008.

Styuart, A., Demasi, L., Livne, E., and Lin, K.Y., "Probabilistic Modeling of Aeroelastic Life Cycle for Risk Evaluation of Composite Structures," Proc. of 10th AIAA Non-Deterministic Approaches Conf., Schaumburg, Illinois, April 7-10, 2008.

Styuart, A., Cheung, C.H., and Lin, K.Y., "Reliability-based Evaluation of the Damage Growth in Composite Structures," Proceedings of the 10th AIAA Non-Deterministic Approaches Conference, Schaumburg, Illinois, April 7-10, 2008.

Styuart, A., and Lin, K.Y., "Selection of Certification Tests for Composite Structures Using Optimal Statistical Decision," Proc. of the 10th AIAA Non-Deterministic Approaches Conference, Schaumburg, Illinois, April 7-10, 2008.

Professional development activities

Developed UW/Boeing "Aircraft Composite Structural Analysis and Design" Certificate Program, 2004- present.

Co-founded AMTAS- A FAA Center of Excellence on Advanced Materials for Transport Aircraft Structures, 2004- present.

Technical conferences

Eli Livne

Education
Ph.D., Aerospace Engineering, University of California, Los Angeles, 1990
M.S., Aeronautical Engineering, Technion, Israel Institute of Technology, 1982
High School Teaching Credential, Technion, Israel Institute of Technology, 1974
B.S., Aeronautical Engineering, Technion, Israel Institute of Technology, 1974

Academic experience
University of Washington (AA), Professor, 2002-present
University of Washington (AA), Associate Professor, 1996-2002
University of Washington (AA), Assistant Professor, 1996-2002
University of California, Los Angeles, Postdoctoral Research Fellow, 1990

Current membership in professional organizations
AIAA(Associate Fellow)

Honors and awards

The ASME/Boeing Structures & Materials Award, April 1998, for the best paper (out of more than 400 papers) "which was judged to be an outstanding contribution to the engineering profession and was given at the 38th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference", April 1997.
NSF National Young Investigator Award, 1992 - 1997.
UCLA School of Engineering and Applied Science Outstanding Ph.D. 1989-90.
1987-1988 Josephine de Karman Fellowship.
1984 - 85, 85 - 86, 86 - 87, 87 - 88, 88 - 89, 89 - 90 UCLA Fellowships.
Valedictorian - Department of Aeronautical Engineering, Technion, Israel, 1974.

Service activities

- Chair, Faculty Search Committee (for two new professors), 2013
- AA Strategic Planning Committee
- AA Undergraduate Committee
- College of Engineering Boeing-Sutter Professorship Committee
- AIAA – Editor in Chief of the Journal of Aircraft

Publication/presentations of past five years

Demasi, L., and Livne, E., "Dynamic Aeroelasticity of Structurally Nonlinear Configurations Using Linear Modally Reduced Aerodynamic Generalized Forces", AIAA Journal, 2009, Vol. 47, No.1, pp. 70-90.

Demasi, L., and Livne, E., "Aeroelastic Coupling of Geometrically Nonlinear Structures and Linear Unsteady Aerodynamics: Two Formulations", Journal of Fluids and Structures, Vol. 25, Issue 5, July 2009, pp. 918-935.

Bhatia, M., and Livne, E., “Design-Oriented Thermostructural Analysis with External & Internal Radiation. Part 2: Transient Response”, AIAA Journal, 2009, vol. 47, May, No. 5, pp. 1228-1240.

Styuart, A., Livne, E., Demasi, L., and Mor, M., “Risk Assessment of Aeroelastic Failure Phenomena in Damage Tolerant Composite Structures”, AIAA Journal, Vol. 49, No. 3, March 2011, pp. 655-669.
Demasi, L., and Livne, E., "Contributions to Joined-Wing Aeroelasticity", Paper IFASD-2009-175, International Forum on Aeroelasticity and Structural Dynamics, Seattle, WA, June 21-25, 2009.

Chen, P.C., Zhang, Z., and Livne, E., "ZEUS-DO: Design Oriented CFD-Based Unsteady Aerodynamics for Flight Vehicle Shape Optimization", AIAA-2010-2720, 51st AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, Orlando, Florida, Apr. 12-15, 2010.

Livne, E., and Nelson, C., "From Blank Slate to Flight Ready New Small Research UAVs in Twenty Weeks - Undergraduate Airplane Design at the University of Washington", AIAA Paper 2012-0845, AIAA Aerospace Sciences Meeting, Nashville, TN, January 9^{th}-12^{th}, 2012.

Chen, P.C., Zhang, Z., and Livne, E., "Towards CFD Based Aeroservoelastic Flight Vehicle Shape Optimization - New Capabilities and New Results with ZEUS-DO", 53rd AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, 2012, AIAA 2012-1561.

Invited talks on Airplane Design and Aeroservoelastic Optimization – NASA Langley Research Center, NASA Ames Research Center, The Air Force Research Lab (AFRL), Delft University, The Air Force Institute of Technology, The University of Michigan, Technion – Israel Institute of Technology.

Professional development activities

Technical conferences and workshops

Christopher W. Lum

Education
Ph.D., Aeronautics and Astronautics, University of Washington, 2009
M.S., Aeronautics and Astronautics, University of Washington, 2005
B.S., Aeronautics and Astronautics, University of Washington, 2003

Academic experience
University of Washington (AA), Research Scientist, 2010-present
Seattle University, Adjunct Professor, 2009-2011
University of Washington (AA), Postdoctoral Scholar, 2009-2010
University of Washington, Research Assistant, 2004-2009

Current membership in professional organizations
American Institute of Aeronautics and Astronautics
Institute of Electrical and Electronic Engineers

Honors and awards
2012: University of Washington College of Engineering's List of Highly Rated Instructors
2012: Department of Aeronautics and Astronautics Instructor of the Year
2011: University of Washington College of Engineering's List of Highly Rated Instructors
2009: Best Student Technical Paper Award, AIAA Infotech@Aerospace Conference
2008: Outstanding Paper Award, AIAA Aerodynamic Measurement Technology and Ground Testing Conference
2007: NASA Space Grant Consortium Graduate Fellowship recipient
2005: Osberg Family Trust fellowship recipient
2004: Nominated for the University of Washington Outstanding Teaching Assistant Award
2003: Andris Vagners Memorial Fellowship recipient
2002: Employee of the Quarter – Kirsten Wind Tunnel, Seattle WA, Summer quarter
2002: University of Washington Aeronautics and Astronautics Alumni Scholarship recipient
2002: George E. Solomon Academic Award recipient
2002: Sigma Gamma Tau Aerospace Honor Society member

Service activities
- A&A Design Build Fly Faculty Advisor, 2013-present

Publication/presentations of past five years
- **C. W. Lum**, J. Vagners, M. Vavrina, and J. Vian, "Formation Flight of Swarms of Autonomous Vehicles in Obstructed Environments Using Vector Field Navigation" Proceedings of the International Conference on Unmanned Aircraft Systems, June 2012.
- **C. W. Lum**, K. R. Gauksheim, T. Kosel, and T. McGeer, "Assessing and Estimating Risk of Operating Unmanned Aerial Systems in Populated Areas" Proceedings of the AIAA Aviation Technology, Integration, and Operations Conference, September 2011.

- **C. W. Lum**, and B. Waggoner, "A Risk Based Paradigm and Model for Unmanned Aerial Systems in the National Airspace" Proceedings of the AIAA Infotech@Aerospace Conference, March 2011.
- **C. W. Lum**, J. Vagners, J. S. Jang, and J. Vian, "Partitioned Searching and Deconfliction: Analysis and Flight Tests" Proceedings of the AACC American Control Conference, June 2010.
- **C.W. Lum**. Coordinated Searching and Target Identification Using Teams of Autonomous Agents. PhD dissertation, University of Washington, Seattle, WA, March 2009.
- **C.W. Lum**, R.T. Rysdyk, and J. Vagners, "A Search Algorithm for Teams of Heterogeneous Agents with Complete Coverage Guarantees" AIAA Journal of Aerospace Computing, Information, and Communication, Vol. 7, pg. 1-31, January 2010.
- **C.W. Lum**, M. L. Rowland, R.T. Rysdyk, and J. Vagners, "Rapid Verification and Validation of Strategic Autonomous Algorithms Using Human-in-the-Loop Architectures" Submitted to the AIAA Journal of Aircraft
- **C.W. Lum** and J. Vagners, "A Modular Algorithm for Exhaustive Map Searching Using Occupancy Based Maps" Proceedings of the AIAA Infotech@Aerospace Conference, April 2009 (Best Student Technical Paper Award)
- **C.W. Lum** and R.T. Rysdyk, "Feature Extraction of Low Dimensional Sensor Returns for Autonomous Target Identification" Proceedings of the AIAA Guidance, Navigation, and Control Conference, August 2008
- **C.W. Lum**, M. L. Rowland, and R.T. Rysdyk, "Human-in-the-Loop Distributed Simulation and Validation of Strategic Autonomous Algorithms" Proceedings of the AIAA Aerodynamic Measurement Technology and Ground Testing Conference, June 2008 (Outstanding Paper Award)
- **C.W. Lum** and R.T. Rysdyk, "Time Constrained Randomized Path Planning Using Spatial Networks" Proceedings of the AACC American Control Conference, June 2008
- "Searching and Identification of Submerged Marine Targets Using Simply Equipped Autonomous Vehicles," Robotics Science and Systems Poster Session, June 29, 2009.
- "Development of High Level Autonomous Algorithms and Implementation Using Pilot Interaction," EAA Chapter 26 Meeting, May 14, 2009.
- "Coordinated Searching and Target Identification Using Teams of Autonomous Agents," PhD Final Examination, March 3, 2009.
- Student Keynote Speaker, University of Washington Guggenheim Renovation Celebration, October 27, 2008.
- "Advances in Unmanned Systems: Research Activity from the University of Washington Department of Aeronautics and Astronautics," Pacific Northwest AIAA Technical Symposium, October 25, 2008.
- "Cooperative Searching and Geomagnetic Surveying Using Teams of Autonomous Agents," NASA Future Forum Poster Session, January 25, 2008.

Professional development activities

Technical conferences

Mehran Mesbahi

Education
Ph.D., Electrical Engineering, University of Southern California

Academic experience
University of Washington (AA), University of Washington, 2010-present
University of Washington (AA), Associate Professor, 2005-2010
University of Washington (AA), Assistant Professor, 2002-2005
University of Minnesota (Aerospace Engineering and Mechanics), Assistant Professor, 2000-2002
California Institute of Technology, Lecturer, Department of Control and Dynamical Systems 1998-1999
University of Southern California, Lecturer, Department of Electrical Engineering-Systems 1997-1998

Current membership in professional organizations
IEEE
AIAA

Honors and awards
Featured Speaker, UW College of Engineering Fall Series (Re-engineering Aerospace) 2011 (also on UWTV)
NASA Tech Brief Award (2), 2010
Professor of the Year, Aeronautics and Astronautics, UW, 2010
College of Engineering Innovator Award, UW, 2008
Professor of the Year, Aeronautics and Astronautics, UW, 2006
University of Washington Distinguished Teaching Award, 2005
Professor of the Year, Aeronautics and Astronautics, UW, 2004
NASA's Space Act Award, 2004
NSF CAREER Award, 2001
NASA New Technology Award, 2001
Shuttle Radar Topography Mission Star Award, 2000
Achievement Award for the Cassini Program, NASA, 1998
Cassini Attitude and Articulation Control Subsystem Award, JPL, Caltech, 1997

Service activities
- Vice Chair of Student Affairs, American Control Conference, 2014
- Associate Editor, *IEEE Transactions on Networked Systems* (20013-present)
- Associate Editor, *IEEE Transactions on Control Systems Technology* (2007-present)
- Reviewer of the following journals: IEEE Transactions on Automatic Control, Automatica, AIAA Journal of Guidance, Navigation, and Control, Journal of Astronautical Sciences, IEEE Transactions on Robotics and Automation.
- 2005-2011 Senior Fellow, Faculty Fellows Program, University of Washington, September 2005 (this is a week long, full-time activity, with about 15 hours for pre and post program meeting and preparation time).

- Controls Search Committee, Fall 2011-present

Publication/presentations of past five years

M. Mesbahi and M. Egerstedt, *Graph-theoretic Methods in Multiagent Networks*, Princeton University Press, 2010.

A. Chapman and M. Mesbahi, Semi-autonomous consensus: network measures and adaptive trees, *IEEE Transactions on Automatic Control*, 58 (1): 19-31, 2013

D. Zelazo, R. Dai, and M. Mesbahi. An energy management system for off-grid power systems, *Energy Systems* 3 (2): 153-179, 2012.

D. Zelazo and M. Mesbahi, Graph-theoretic analysis and synthesis of relative sensing networks, *IEEE Transactions on Automatic control*, 56 (5): 971-982, 2011.

D. Zelazo and M. Mesbahi, Edge agreement: graph-theoretic performance bounds and passivity analysis, *IEEE Transactions on Automatic Control*, 6 (3): 554-555, 2011.

Professional development activities

Technical conferences and workshops
Proposal review panels

Kristi A. Morgansen-Hill

Education
Ph.D., Engineering Sciences, Harvard University, 1999
S.M., Applied Mathematics, Harvard University, 1996
M.S., Mechanical Engineering, Boston University, 1994
B.S., Mechanical Engineering (summa cum laude), Boston University, 1993

Academic experience
University of Washington (AA), Associate Professor, 2009-present
University of Washington (AA), Associate Professor, 2002-2009
California Institute of Technology, Senior Research Fellow, Control and Dynamical Systems and Mech. Eng. 2001-2002
California Institute of Technology, Postdoctoral Scholar, Control and Dynamical Systems and Mech. Eng. 1999-2001
California Institute of Technology, Lecturer, Control and Dynamical Systems, 2000

Current membership in professional organizations
American Institute of Aeronautics and Astronautics
American Society of Engineering Educators
Institute of Electrical and Electronic Engineers (senior member 2006)

Honors and awards
UW College of Engineering Community of Innovators Award Nominee, 2012.
UWCollege of Engineering Community of Innovators Award Nominee, 2011.
O. Hugo Schuck Award for best paper in the theory category for the 2009 American Control Conference.
Senior Member, 2006, Institute of Electrical and Electronic Engineers.
National Science Foundation CAREER Award, 2003-2009, National Science Foundation.
Clare Boothe Luce Assistant Professor of Engineering, 2002-2007, The Luce Foundation.
Harvard University Jury Prize, June 1999, Harvard University.
National Science Foundation Graduate Research Fellowship, 1993-1996, NSF.
Boston University Trustee Scholar, 1989-1993, Boston University

Service activities

- A&A Graduate Committee, Chair and Graduate Faculty Advisor 2011-present
- A&A Faculty Search Committee 2007-present
- A&A Strategic Planning Committee 2007-present
- Robotics, Control and Mechatronics Committee 2002-present
- Center for Sensorimotor Neural Engineering, UW Deputy Director 2012-present
- IEEE Control System Society Board of Governors 2012-2014
- IEEE Control System Society Conference Editorial Board 2001-present

Publication/presentations of past five years

B.T. Hinson, M.K. Binder and **K.A. Morgansen**, "Path planning to optimize observability in a uniform flow field," *American Control Conference*, to appear, June 2013.

A. Alaeddini and **K.A. Morgansen**, "Autonomous state estimation using optic flow sensing," *American Control Conference*, to appear, June 2013.

J. Dyhr, **K. A. Morgansen**, T. L. Daniel and N. Cowan, "Flexible strategies for flight control: An active role for the abdomen," Journal of Experimental Biology, in press.

N. D. Powel and **K. A. Morgansen**, "Multiserver queueing for supervisory control of autonomous vehicles," *American Control Conference*, June 2012.

B. Hinson and **K. A. Morgansen**, "Flowfield estimation in the wake of a pitching and heaving airfoil," *American Control Conference*, June 2012.

E. Lalish and **K.A. Morgansen**, "Distributed reactive collision avoidance," *Autonomous Robots*, special issue, **32**(3), 2012.

C. Woodruff, L. Vu, **K.A. Morgansen** and D. Tomlin, "Deterministic modeling and evaluation of decision-making dynamics in sequential two-alternative forced choice tasks," *Proceedings of the IEEE*, *special issue on Interaction Dynamics: The Interface of Humans and Smart Machines*, **100**(3):734-750, March 2012.

N. Powel and **K.A. Morgansen**, "Communication-based performance bounds in nonlinear coordinated control," *International Journal of Robust and Nonlinear Control*, special issue, **21**(12):1410-1420, August 2011.

L. Techy, **K. A. Morgansen** and C. Woolsey, "Long-baseline acoustic localization of the Seaglider underwater glider," in *Proceedings of the American Control Conference*, June 2011.

L. Vu and **K.A. Morgansen**, "Stability of time-delay feedback switched linear systems," *IEEE Transactions on Automatic Control*, **55**(10):2385-2389, October 2010.

A. P. Melander, N. D. Powel, E. Lalish, **K. A. Morgansen**, J. S. Jang and J. Vian, "Implementation of deconfliction in multivehicle autonomous systems," in the 27th *International Congress of the Aeronautical Sciences*, Invited Paper, September 2010.

R. Pagliari, S. Kirti, **K.A. Morgansen**, T. Javidi and A. Scaglione, "A simple and scalable algorithm for alignment in broadcast networks," *IEEE Journal on Selected Areas in Communication*, **28**(7):1190-1199, September 2010.

B. I. Triplett, D.J. Klein and **K.A. Morgansen**, "Cooperative estimation for coordinated target tracking in a cluttered environment," *ACM/Springer Mobile Networks and Applications Journal (MONET),* (invited—special issue), **14**(3):336-349, June 2009.

L. Vu and **K. A. Morgansen**, "Stability of feedback switched systems with state and switching delay," in *Proceedings of the American Control Conference*, June 2009 **(recipient of the O. Hugo Schuck award for best paper in the theory category)**.

Professional development activities

Technical conferences and workshops
Proposal review panels

Susan Murphy

Education
M.S.: City University, 2003
B.A.: Northeastern Illinois University, 1981

Academic Experience
Affiliate Associate Professor: Sept. 2008-present

Professional Certification
Project Management Professional (Project Management Institute): April, 2004 - present

Current membership in professional organizations
Project Management Institute (PMI): April, 2004 - present

Honors and awards
Boeing Cash Awards: 2011, 2010, 2009, 2008, 2004, 2003, 1998
Boeing Stock Awards: 2004, 2002, 2001, 1998
Boeing Stock Option Awards: 1998
Numerous Pride @ Boeing Awards
Numerous Instant Recognition Awards

Service activities
- Senior Project Manager, Boeing, 787 Airplane Level Integration Team, 2010-present
- Senior Project Manager, Boeing, 787 Wiring Integration, 2008-2010
- Senior Project Manager, Boeing, 787 Customer Introductions, 2007-2010
- Senior Project Manager, Boeing, CATIA V4-45 Information Technology Transition, 2006-2007
- Senior Project Manager, Boeing, 787 Remote Product Definition/Split Bridge, 2004-2006
- Senior Project Manager, Boeing, CAD/CAM Products and Services, 1997-2003
- Project Manager, Boeing, Distributed Computing Support Services, 1997-1997
- Project Manager, Boeing, Aerodynamics, 1995-1996
- Project Management and Systems Development Life Cycle Contractor to Boeing, DMR, 1993-1995
- Project Manager, Software Analyst and Developer, Sears Roebuck & Co, 1981-1993

Publications/presentations of past five years

Presentation: University of Washington, Aeronautics and Astronautics, Seattle, Washington, Winter Lecture Series, *Boeing 787: Globally Designed and Built* , January, 2013

Presentation: Industrial Technology Research Institute (ITRI), Hsinchu, Taiwan (ROC), ITRI Industry Lecture Series, *Project Management and Systems Engineering*, October, 2012

Professional development activities

None

Uri Shumlak

Education
Ph.D., Nuclear Engineering, University of California, Berkeley, 1992
M.S., Nuclear Engineering, Texas A & M University, 1987

Academic experience
University of Washington, Associate Chair for Research: Nov. 2010 – present
University of Washington, Professor: Sep. 2007 – present
University of Washington, Associate Professor: Sep. 2002 – Sep. 2007
University of Washington, Assistant Professor: Sep. 1999 – Sep. 2002
University of Washington, Research Assistant Professor: Dec. 1994 – Sep. 1999

Current membership in professional organizations
American Institute of Aeronautics and Astronautics
American Physical Society
Institute of Electrical and Electronics Engineers
Society for Industrial and Applied Mathematics
University Fusion Association

Honors and awards
University of Washington College of Engineering Faculty Innovator Award 2011
American Institute of Aeronautics and Astronautics Abe Zarem Award of Excellence 2003
University of Washington Aeronautics & Astronautics Professor of the Year 2002
American Institute of Aeronautics & Astronautics Senior Member 2001
University of Washington Aeronautics & Astronautics Professor of the Year 1999
National Research Council Postdoctoral Associateship 1992

Service activities
- University Fusion Association, Vice President, & President Elect
- University Fusion Association Executive Committee, Member
- DOE Office of Science Graduate Fellowship Selection Committee
- ASME Propulsion Technical Committee
- University of Washington Aeronautics & Astronautics Computer Committee, Chair
- University of Washington Aeronautics & Astronautics Space Allocation Committee, Chair
- University of Washington Aeronautics & Astronautics Strategic Planning Committee
- University of Washington Aeronautics & Astronautics Faculty Search Committee
- University of Washington Aeronautics & Astronautics Safety Committee
- University of Washington Aeronautics & Astronautics Space Systems Center Committee
- University of Washington Aeronautics & Astronautics Aero (Boeing) Committee
- University of Washington Aeronautics & Astronautics Astro (Aerojet) Committee

Publication/presentations of past five years

U. Shumlak, J. Chadney*, R.P. Golingo, D.J. Den Hartog, M.C. Hughes*, S.D. Knecht*, W. Lowrie*, V.S. Lukin, B.A. Nelson, R.J. Oberto*, J.L. Rohrbach*, M.P. Ross*, and G.V. Vogman*. The Sheared-Flow Stabilized Z-Pinch. Fusion Science and Technology 61 (1t), 119 (2012).

E. Kansa, U. Shumlak, and S. Tsynkov. Discrete Calderon's Projections on Parallelepipeds and their Application to Computing Exterior Magnetic Fields for FRC Plasmas. Journal of Computational Physics 234,172 (2012).

E.T. Meier* and U. Shumlak. A general nonlinear fluid model for reacting plasma-neutral mixtures. Physics of Plasmas 19 (7), 072508 (2012).

E.T. Meier*, A.H. Glasser, V.S. Lukin, and U. Shumlak. Modeling open boundaries in dissipative MHD simulation. Journal of Computational Physics 231 (7), 2963 (2012).

G.V. Vogman* and U. Shumlak. Deconvolution of Stark broadened spectra for multi-point density measurements in a flow Z-pinch. Review of Scientific Instruments 82 (10), 0034-6748 (2011).

B. Srinivasan* and U. Shumlak. Analytical and computational study of the ideal full two-fluid plasma model and asymptotic approximations for Hall-MHD. Physics of Plasmas 18 (9), 092113 (2011).

U. Shumlak, R. Lilly*, N. Reddell*, E. Sousa*, and B. Srinivasan*. Advanced physics calculations using a multi-fluid plasma model. Computer Physics Communications 182 (9), 1767 (2011).

W. Lowrie*, V.S. Lukin, and U. Shumlak. A priori mesh quality metric error analysis applied to a high-order finite element method. Journal of Computational Physics 230 (14), 5564 (2011).

B. Srinivasan*, A. Hakim*, and U. Shumlak. Numerical methods for two-fluid dispersive fast MHD phenomena. Communications in Computational Physics 10, 183 (2011).

J. Loverich*, A. Hakim*, and U. Shumlak. A discontinuous Galerkin method for ideal two-fluid plasma equations. Communications in Computational Physics 9, 240 (2011).

temperature plasma. Review of Scientific Instruments 81, 126104 (2010).

E.T. Meier*, V.S. Lukin, and U. Shumlak. Spectral element spatial discretization error in solving highly anisotropic heat conduction equation. Computer Physics Communications 181, 837 (2010).

W. Song* and U. Shumlak. Ultrasonically-Aided Electrospray Source for Charged Particles Approaching Monodisperse Distributions. Journal of Propulsion and Power 26 (2), 353 (2010).

U. Shumlak, C.S. Adams*, J.M. Blakely*, B.-J. Chan*, R.P. Golingo*, S.D. Knecht*, B.A. Nelson, R.J. Oberto*, M.R. Sybouts*, and G.V. Vogman*. Equilibrium, flow shear and stability measurements in the Z-pinch. Nuclear Fusion 49 (7), 075039 (2009).

K.A. Munson*, U. Shumlak, and B.A. Nelson. Extreme Ultraviolet Light Production from a ZaP Flow Z-Pinch Xenon Plasma. Journal of Micro/Nanolithography, MEMS, and MOEMS (JM3) 7 (1), 013003-1-9 (2008).

W. Song* and U. Shumlak. Charged Nanoparticle Source for High Thrust Level Colloid Thrusters. Journal of Propulsion and Power 24 (1), 139 (2008).

Professional development activities

Technical conferences and workshops

Setthivoine You

Education
Ph.D., Physics, Imperial College, London, 2002
M.S., Physics, Imperial College, London, 1997

Academic experience
University of Washington, Assistant Professor, 2009-present
University of Tokyo, Postdoctoral Scholar, 2007-2009
California Institute of Technology, 2002-2006
Culham Centre for Fusion Energy, PhD student, 1997-2002

Current membership in professional organizations
American Physical Society
European Physical Society
Electric Rocket Propulsion Society

Honors and awards
Foreign Postdoctoral Fellowship and Research Grant, Japan Society for the Promotion of Science, 2007-2009
Early Career Award, Dept. of Energy, 2013

Service activities
- Graduate Committee
- Sigma Gamma Tau
- Strategic Planning Committee

Publication/presentations of past five years

S. You, "The transport of relative canonical helicity", Phys. Plasmas, 19, 092107 (2012)

A. L. Balandin, Y. Ono, S. You, "3D vector tomography using vector spherical harmonics decomposition", Comp. & Mathematics with Applications, 63, 10 (2012) 1433-1441

S. You, H. Tanabe, Y. Ono, A. L. Balandin, "Vector and scalar tomography of compact toroid plasmas", J. Fusion Energy, 29, 6 (2010) 592-295

Professional Development

CELT course evaluation services
Technical conferences

Appendix C – Facilities and Equipment

APPENDIX C – Facilities and Equipment

In this Appendix all the experimental facilities and equipment used in the program's undergraduate instruction are listed. Also listed is the Aeronautics & Astronautics Machine Shop, which supports the program.

Aerodynamics Laboratory

In 1916, William E. Boeing saw the need for a wind tunnel to test advanced models of his Model C floatplane, which he intended to sell to the U.S. military. Boeing offered to pay for a wind tunnel at UW in exchange for a promise by the University to establish courses in aeronautics. This wind tunnel, in its original form, was operational from 1918 through 1938, when the modern Kirsten Wind Tunnel came on line. The modified original wind tunnel in the Aerodynamics Lab Building was replaced in the early 1990s with a modern 3'x3' wind tunnel. This facility provides a high-quality, low-turbulence flow at speeds up to 140 mph, and is used for instruction, as well as research . This facility is also available for independent student projects.

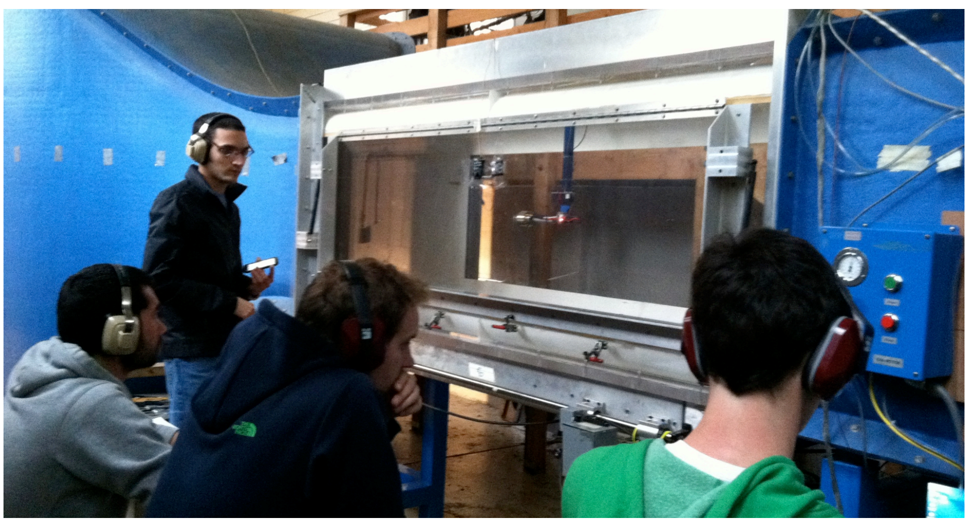


Figure C.1 Students working at the 3'x3' Wind Tunnel

Kirsten Wind Tunnel

The Boeing Company, the Washington State Legislature, and the Works Progress Administration allocated funds for the construction of a 8'x12' wind tunnel and building, which was completed in 1936 and came on line in 1938 following extensive shake-down testing. In the early 1950s the wind tunnel was named the Kirsten Wind Tunnel, in honor of Frederick W. Kirsten, the faculty member whose tireless efforts led to the construction of the tunnel. After nearly being shut down for lack of business in 1994, the Kirsten Wind Tunnel bounced back, and ever since then has had a months-long waiting list of diverse companies wanting to carry out aerodynamic testing in this very high quality facility. The Kirsten Wind Tunnel continues to be a premier facility for low-speed testing. The tunnel employs a student crew numbering 8–14, which provides them with excellent hands-on training, as well as paid employment, both during the academic year and the summer. The facility is also a key component of our airplane design sequence (AA 410/411), in which students test their designs to determine stability characteristics as well as validate performance parameters. In addition, it is used for one or more of the experiments in AA 321, Aerospace Laboratory I. A few times each year the tunnel is involved in independent student research projects that culminate in graduate theses or undergraduate reports. The facility is also used by faculty in sponsored research programs. Finally, The Kirsten Wind Tunnel has also been used by students participating in the annual AIAA Design, Build, Fly (DBF) competition.

Fig. C.2 Kirsten Wind Tunnel test section with AA 410/411 model and students.

Water Tunnel and Supersonic Wind Tunnel

A large water tunnel having a test section with cross-section of 2 ft x 2 ft and a length of 6 ft, and capable of a flow speed of 1 m/sec, is located in the department's Fluid Dynamics Laboratory, in Room 114 in Guggenheim Hall. This test facility was constructed in-house in the 1980s, and has been used for flow-visualization experiments in instruction and research, as well as for commercial testing. For its instructional purposes, the water tunnel has been used for scheduled experiments in the junior-level Aerospace Laboratory sequence, as well as for independent student projects. Diagnostic tools include a dye injection system (for both colored and fluorescent dyes) and an argon-laser light-sheet illumination system for the fluorescent dyes.

A small, blow-down, supersonic wind tunnel, capable of attaining a Mach number of 2.2 for durations up to 30-40 sec, and having a test section cross-section of 2"x2", is also located in the Fluid Dynamics Laboratory, and is used for both instructional and research purposes. This tunnel is equipped with a schlieren/shadowgraph optical visualization system, as well as with pressure and temperature transducers. This tunnel is fed by compressed air generated and stored in large, high-pressure tanks in the basement of the Kirsten Wind Tunnel building.

Other Equipment

Other equipment used for instructional purposes is listed in the tables below

Table C.1 List of equipment in Aerospace Laboratory supporting junior-level lab classes (AA 320, 321. 322); located in Guggenheim 205

Quantity	Description
	Aerospace Laboratory with 10 seats (GUG 205)
14	Pentium III-based PC for mid-range data acquisition
10	Oscilloscopes
10	Power supplies
10	Digital multimeters
5	DC Motor systems
5	Thermal printers
4	Beam vibration test rig and associated supplies
4	Spring-mass-damper vibration test rig and associated supplies

Table C.2 Other equipment available to junior-level lab classes (AA 320, 321, 322)

Quantity	Description
1	Instron Model 8801 structural testing machine
1	Instron Model 5585H structural testing machine
1	Solid rocket static test stand (for low-power, commercial hobby rocket motors)
1	Sophia 850 microturbine test facility

Table C.3 Equipment list in control systems laboratory facility (located in Guggenheim 205)

Quantity	Description
	Control Systems Laboratory (GUG 205)
	Experimental Apparatus:
1	Track inverted pendulum
2	Rotary arm inverted pendulum
2	Reaction mass actuation system
1	Flexible shaft/variable load dynamometer
5	DC motor system identification station
5	Magnetic ball levitation system
	Laboratory Equipment: • Lista 6'x3' Electronics Bench (10) • Oscilloscopes (10) • Multimeters (10) • Function Generators (9) • DC/AC 3-port power supply (10) • KEPCO 4 Quadrant Power Supply (Large, 4) • KEPCO 4 Quadrant Power Supply (Small, 2) • Hewlett Packard Digital Signal Analyzer (2) • Host/Development PC/Monitor (6) • Data Acquisition Analog/Encoder Cards • Misc. hardware/leads/tools • MathWorks products (Matlab, Simulink, xPCTarget, Realtime Workshop) • Target PC/Monitor (control computer, 6) • Embedded system target (e.g., Tattletale 8)

Machine Shop

The Department of Aeronautics & Astronautics has a modern, well-equipped machine shop that supports our instructional and research needs. The shop features three state-of-the-art CNC machines, a variety of manually-operated lathes and milling machines, a band saw, reciprocating saw, sheet metal brake, press, welding station, and all the supporting accessories and tools, as well as a full complement of hand tools. The shop is managed by a Research Scientist/Engineer – Instrument Maker, who teaches classes on machine shop basics and safety to our students.

Appendix D – Institutional Summary

Appendix D – Institutional Summary

1. The Institution

a. Name and address of the institution:
University of Washington, Seattle, WA 98195

b. Chief executive officer of the institution:
Michael K. Young, President

c. Self-study report submitted by:
James C. Hermanson, Chair, William E. Boeing Department of Aeronautics & Astronautics

Adam P. Bruckner, Chair Undergraduate Program Committee, William E. Boeing Department of Aeronautics & Astronautics

Marlo D. Anderson, Manager of Undergraduate Program, William E. Boeing Department of Aeronautics & Astronautics

d. Institution (University of Washington) is accredited by:
Northwest Commission on Colleges and Universities (NWCCU)

Initial University of Washington accreditation evaluation:
April 1918

Most recent University of Washington accreditation evaluation:
Accreditation was reaffirmed based on the Spring 2011 Year One Evaluation.

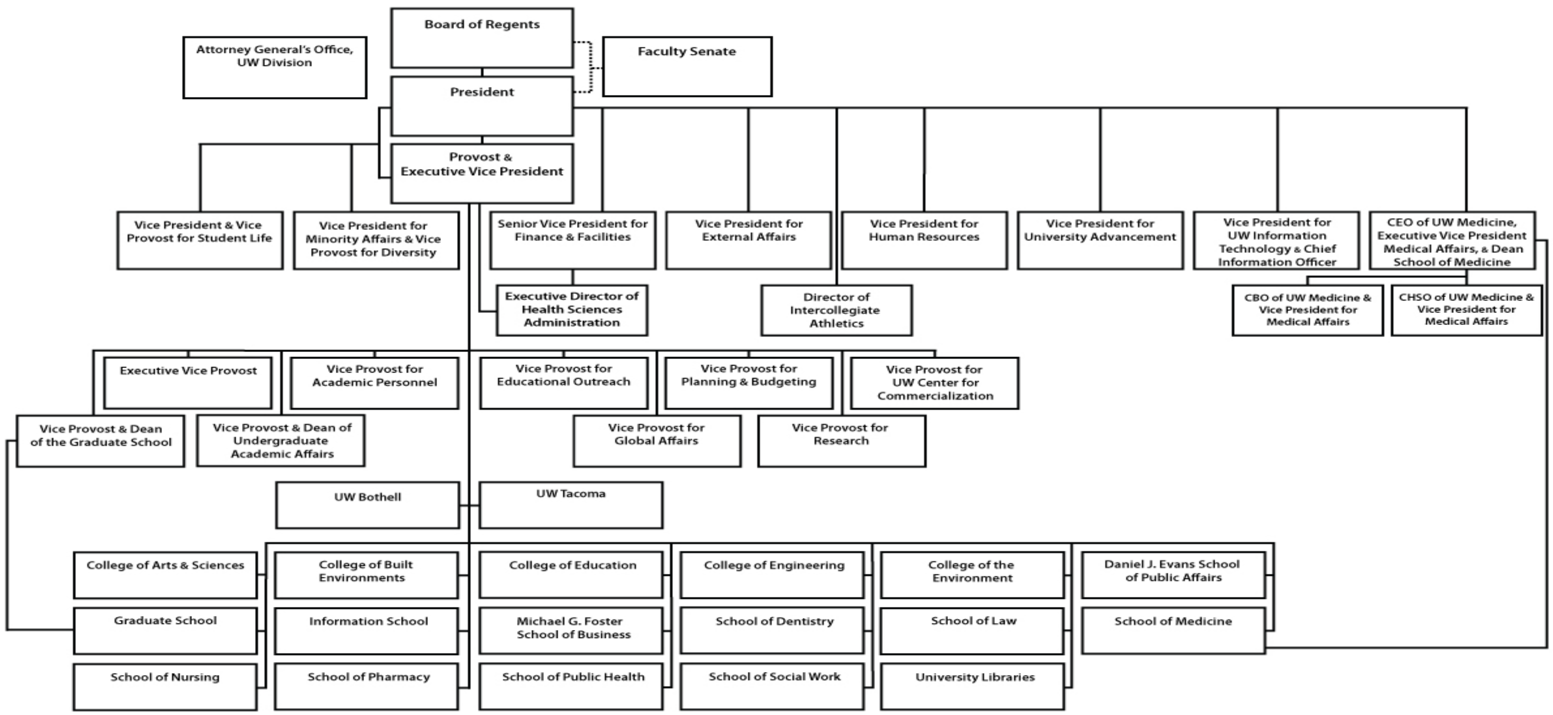
2. Type of Control

State-assisted Public Research University

3. a. Educational Unit

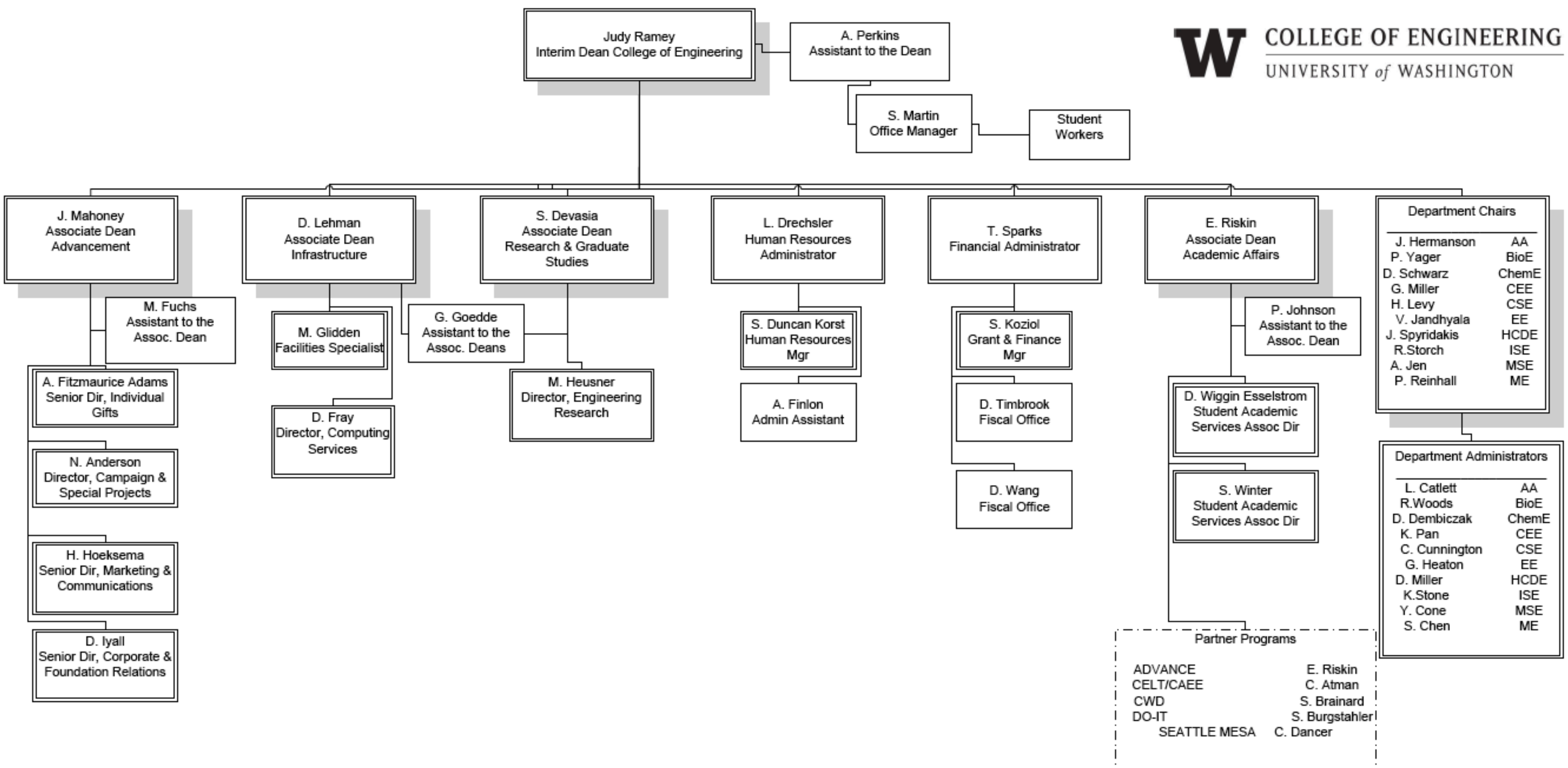
The University Organization Chart shows the position of the College of Engineering within the University of Washington. The College of Engineering is a separately organized unit with its own budgetary and program control within the University of Washington. Judy Ramey became the Interim Dean of the College effective January 1, 2013, when the previous Dean of the College, Matthew O'Donnell, stepped down. Judy Ramey reports to the Provost and Executive Vice President, Ana Mari Cauce.

University Organization Chart (Approved by the President by authority of the *Board of Regents Governance*, Standing Orders, Chapter 1) This chart reflects the reporting relationships of the University of Washington's administrative offices, schools, colleges, and campuses. Select any box on this chart to link to APS 1.2, University Wide Leadership List, where more information is available.



The College of Engineering Organizational Chart and the College's listing in the University Wide Leadership List show the engineering academic departments / programs and their reporting relationship within the College of Engineering. The names of the College of Engineering Department Chairs are listed as well as names and titles of the administrative heads of the principal units of the College of Engineering.

COLLEGE OF ENGINEERING ORGANIZATIONAL CHART



University-Wide Leadership List

Engineering, College of	Acting Dean—Judith A. Ramey Assistant to the Dean—Andrea Perkins
Academic Affairs	Associate Dean—Eve A. Riskin
Computing Services	Director—David T. Fray
Development and External Relations	Assistant Dean—Judy K. Mahoney
Infrastructure	Associate Dean—Dawn Lehman
Research and Graduate Studies	Associate Dean—David Notkin
Departments	
Aeronautics and Astronautics	Chair—James Hermanson
Bioengineering (with School of Medicine)	Chair—Paul Yager
Chemical Engineering	Chair—Dan Schwartz
Civil and Environmental Engineering	Chair—Greg Miller
Computer Science and Engineering	Chair—Henry (Hank) Levy
Electrical Engineering	Chair—Vikram Jandhyala
Human-Centered Design and Engineering	Chair—Jan Spyridakis
Industrial and Systems Engineering	Chair—Richard Storch
Materials Science and Engineering	Chair—Alex Jen
Mechanical Engineering	Chair—Per Reinhall
Engineering Programs	
Disabilities Opportunities Internetworking Technology (DO-IT)	Director—Sheryl Burgstahler
Mathematics, Engineering, Science Achievement (MESA)	Director—James Dorsey
Workforce Development, Center for (CWD)	Director—Suzanne G. Brainard

3. b. University of Washington Engineering Initiative

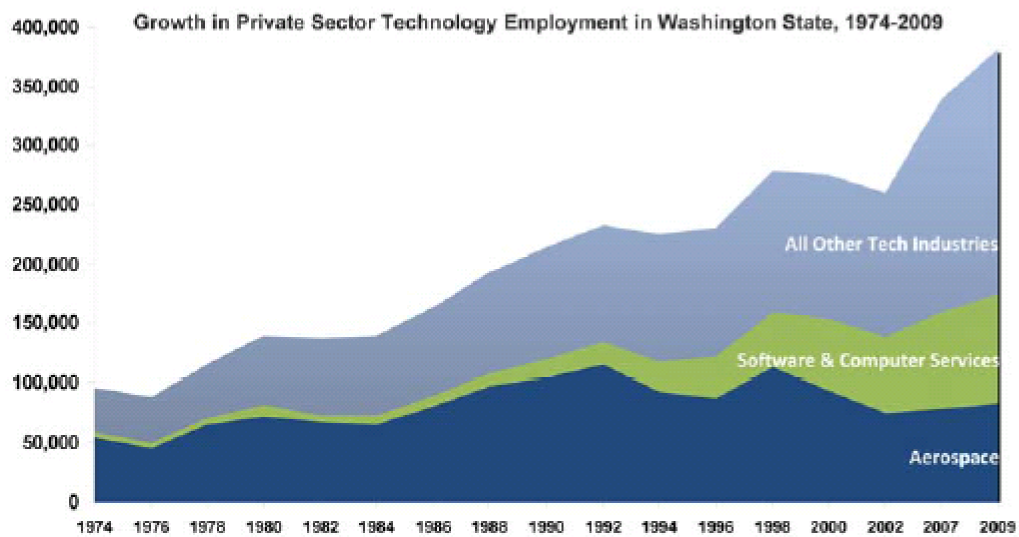
Objective

Send nearly 2,000 additional Engineers into the Washington workforce over the next 10 years by leveraging partnerships, requiring relatively modest additional State investment.

Washington State: "Innovation is in our nature"

Innovation defines Washington State. In the most recent Kauffman Foundation *New Economy Index,* Washington ranks second overall among the 50 states, behind only Massachusetts. As shown in Figure 1, technology industry employment in Washington has quadrupled since 1974.

Figure 1: Washington's technology industry employment has quadrupled since 1974.



Source: Technology Alliance: *The Economic Impact of Technology-based Industries in Washington State*, 2010

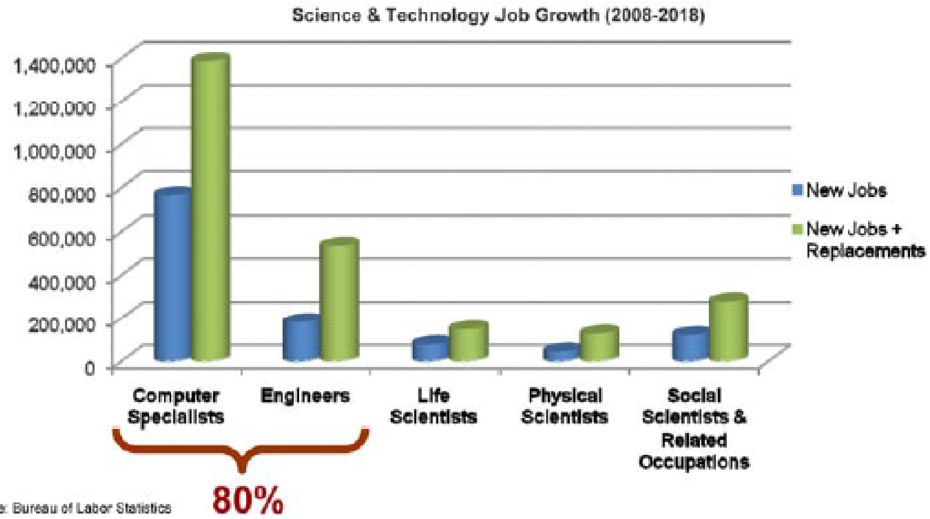
STEM graduates drive innovation

Individuals with degrees in STEM fields (Science, Technology, Engineering, and Mathematics) drive this innovation. They create and staff the companies. And these jobs create other jobs: economists estimate that the 381,000 jobs in Washington's technology industries support nearly 827,000 other jobs throughout our state economy, accounting for a total of more than 1.2 million jobs – equivalent to 42% of Washington employment.

Not all STEM is created equal

When it comes to future job growth, "not all STEM is created equal." As shown in Figure 2, the U.S. Bureau of Labor Statistics projects that in the current decade, 80% of all new jobs in all STEM fields will be in Computer Science and other fields of Engineering. Washington State workforce projections mirror this.

Figure 2: STEM (Science, Technology, Engineering, and Mathematics) careers are where the growth is – but *not all STEM is created equal.*

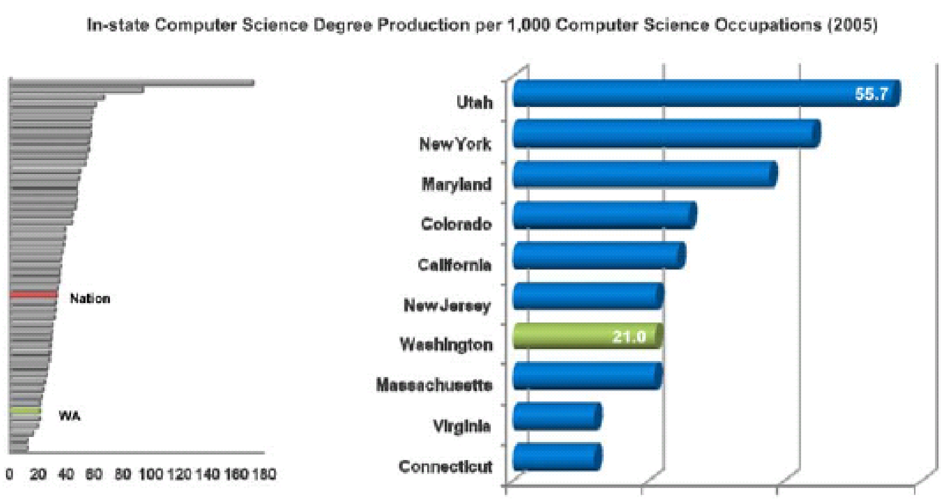


Source: Bureau of Labor Statistics

Washington STEM degree production does not match Washington workforce needs

Unfortunately, Computer Science and other fields of Engineering are precisely where Washington's higher education system has the greatest shortfall. Washington ranks 45th among the 50 states (and 7th among ten top technology states) in Computer Science degree production relative to the number of jobs in the field (Figure 3). Washington similarly ranks 45th (and 9th among ten top technology states) in Engineering degree production relative to the number of jobs in the field (Figure 4). Washington also ranks among the bottom states in *per capita* degree production in these fields, at both undergraduate and graduate levels.

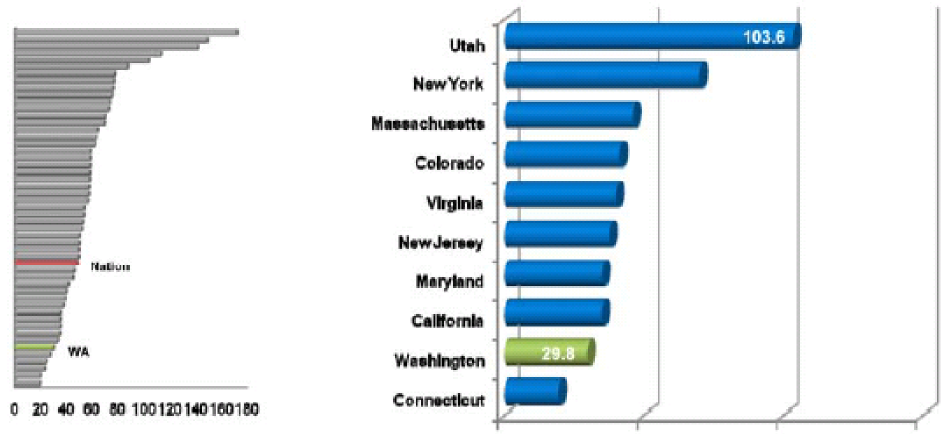
Figure 3: Washington ranks very low in Computer Science degree production relative to Computer Science occupations.



Source: NCHEMS/U.S. Census Bureau

Figure 4: Similarly for other fields of Engineering.

In-state Engineering Degree Production Per 1,000 Engineering Occupations (2005)

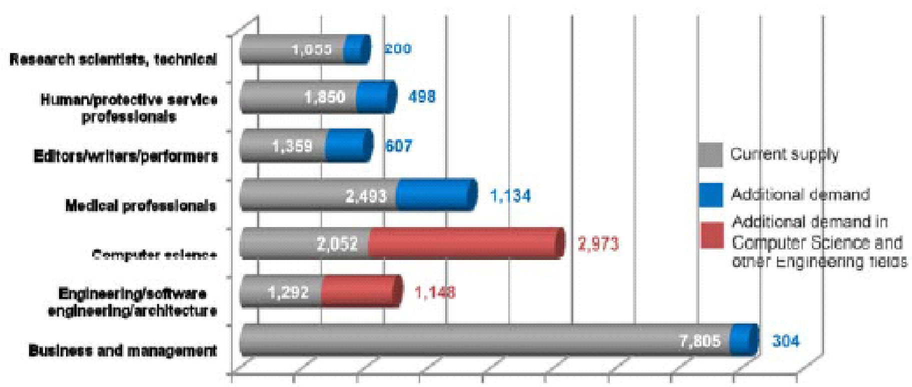


Source: NCHEMS/U.S. Census Bureau

A recent analysis by the Washington State Higher Education Coordinating Board indicates that Computer Science and other fields of Engineering rank first and second, among all fields requiring a bachelors education or greater, in the gap between workforce demand and degree production (Figure 5). A recent analysis of WorkSource job postings and Occupational Employment Statistics data by the *Seattle Times* shows that Computer Science and related fields dominate *all* job availability in Washington (Figure 6). <u>This gap between supply and demand in Computer Science and other fields of Engineering threatens the future of Washington's economy, and it deprives our children of the opportunity to be first-tier participants in the innovation economy.</u>

Figure 5: In Washington, the gap between demand and supply is greater in Computer Science and other fields of Engineering than in all other fields.

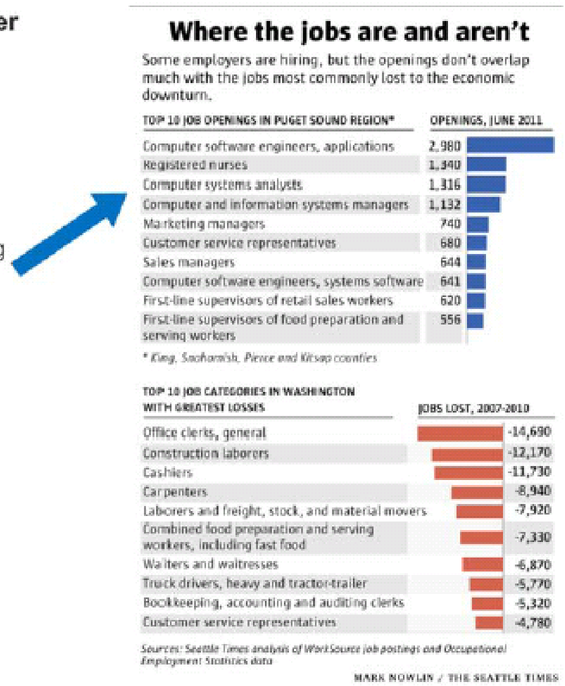
Comparison of current Supply with Future Demand for Baccalaureate & Graduate Degrees



Source: Higher Education Coordinating Board: *Regional Needs Analysis Report*, 2011. Analysis of Employment Security Department and IPEDS data.

Figure 6: Currently, Computer Science dominates all job availability in Washington.

57% of the job openings among the top 10 occupations are in computing.

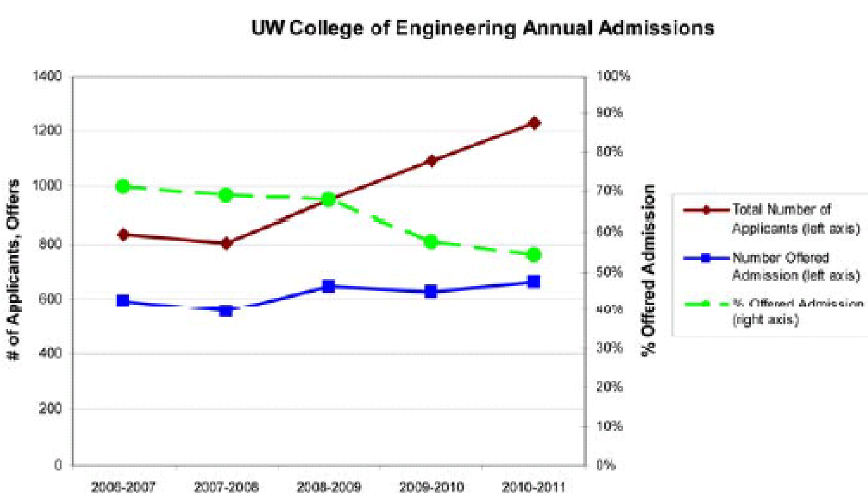


Source: Used with permission from the *Seattle Times*.

At UW, we have the student demand – we lack the program capacity

Although nationally there is a pipeline issue, at the University of Washington the limitation is program capacity, not student interest. As shown in Figure 7, in the most recent year, the UW College of Engineering was able to accommodate only 54% of undergraduate applicants. More than 500 undergraduates seeking to major in a UW Engineering program – *students who were already enrolled at UW or at a Washington State Community and Technical College and who had successfully fulfilled the pre-requisites for entry to Engineering* – had to be turned away last year. In the Department

Figure 7: *It's a capacity problem!* Last year the UW College of Engineering had to turn away more than 500 prospective undergraduate majors.



of Computer Science & Engineering, the most over-subscribed program in the College of Engineering, 70% of applicants had to be turned away – only 30% could be accommodated. More than 40% of the students that the College of Engineering was unable to accommodate, and more than 60% of the students that the Department of Computer Science & Engineering was unable to accommodate, had college grade point averages of 3.25 or above – successful college students are being turned away due to lack of capacity.

The University of Washington Engineering Initiative

Responding to the needs of Washington State's economy, technology businesses, and students, the University of Washington has crafted an opportunity for 425 additional students to join the College of Engineering.

This initiative will require a financial partnership between the University, UW students, and the State, including $3.75 million per year in new State funding. In the past, the State funding request for an Engineering enrollment increase of this size would have been roughly $8.5 million – 2.25 times as great. Under the University of Washington Engineering Initiative, however:

- Overall University of Washington enrollment will not increase as a result of the Initiative. Rather, responding to student demand, UW will shift enrollments towards Engineering from other fields. Thus, only the "marginal cost" of an Engineering education must be funded – the "base cost" of each student's education is already covered.
- A substantial proportion of the tuition generated by Engineering students will be retained by the College of Engineering, decreasing the subsidy required. (Engineering students take roughly half their courses in other fields – the remaining tuition helps to defray these costs.)
- The State will fund only the remaining "gap" – the marginal increment required to produce an Engineering degree, minus the portion covered by tuition.

Impact and scope of the initiative, however, also relies on the state's ability to mitigate additional budget reductions to higher education.

The University of Washington Engineering Initiative is an extremely cost-effective investment in the future of our state, our technology businesses, and our children. As a result of this initiative, supported by a relatively modest, targeted investment on the part of the State, the University of Washington will be able to send nearly 190 additional engineering graduates annually into the workforce – almost 2,000 over the next decade.

4. **Academic Support Units**

Each Engineering department requires certain courses in mathematics, natural sciences, communication, and engineering fundamentals. Table D-3 contains the course outline, description, or syllabus for each of the required mathematics, statistics, biology, chemistry, physics, applied mathematics, and writing courses required by some or all of the engineering departments.

Unit	**Head**
Applied Mathematics	Jose Nathan Kutz, Professor and Chair
Biology	H.D. 'Toby' Bradshaw, Professor and Chair
Chemistry	Paul B. Hopkins, Professor and Chair
Mathematics	Selim Tuncel, Professor and Chair
Physics	Blayne R. Heckel, Professor and Chair
Statistics	Elizabeth Thompson, Professor and Chair

5. **Non-academic Support Units**

Descriptions of the non-academic support units are in Table D-4.

Unit	**Head**
UW Enrollment Services	Philip Ballinger, Assistant Vice President for Enrollment, Admissions
UW Career Center	Susan Terry, Director
UW Information Technology (UW-IT)	Kelli Trosvig, Vice President and CIO
University of Washington Libraries	Lizabeth (Betsy) A. Wilson, Dean
College of Engineering Office of Student Academic Services	Eve Riskin, Associate Dean for Academic Affairs
UW ADVANCE Center for Institutional Change (CIC)	Eve Riskin, Professor and Director
Center for Engineering Learning & Teaching (CELT)	Cynthia J. Atman, Professor and Director
Center for Workforce Development	Suzanne Gage Brainard, Executive Director
College Computing Services	David T. Fray, Director

Disabilities, Opportunities, Internetworking, and Technology (DO-IT)	Sheryl Burgstahler, Director
Education at a Distance for Growth and Excellence (UW/EDGE) and Engineering Professional Programs (EPP)	David P. Szatmary, Vice Provost UW Educational Outreach
Engineering Library	Mel DeSart, Head
GenOM – Genomics Outreach for Minorities Project	Lisa Peterson, Director
Seattle MESA (Mathematics, Engineering, Science Achievement	Clarence Dancer, Director

6. Credit Unit

The College of Engineering adheres to the traditional ratio of one contact hour and two outside hours per week for each credit of coursework, which is the University guideline. Contact hours can include many different formats, including laboratories and quiz sections. As a rule of thumb, two hours of scheduled lab or quiz per week counts toward 1 credit, but exceptions may be warranted. Considering the flexibility allowed by the University and the diversity of teaching styles and learning environments, the College of Engineering's Council on Educational Policy will consider approving courses that do not meet these guidelines. For such courses, faculty should present written material justifying the departure from the traditional ratio and, additionally, should be prepared to justify the course credit/contact hour ratio to the Council on Educational Policy in person.

7. Tables

The following tables start on page 225 of this Appendix.

Table D-1. Program Enrollment and Degree Data

AERONAUTICAL AND ASTRONAUTICAL ENGINEERING

	Academic Year		Enrollment							Degrees Awarded		
			Year					Total Undergrad	Total Grad			
			1st	2nd	3rd	4th	5th			Bachelors	Masters	Doctorates
Current Year	2012-2013	FT	4	9	57	75	0	145	85	Available approximately mid-July		
		PT	0	0	1	1	0	2	112			
1	2011-2012	FT	4	12	53	66	0	135	76	57	35	6
		PT	0	0	2	7	0	9	115			
2	2010-2011	FT	0	11	44	56	0	111	76	40	24	5
		PT	0	0	1	5	0	6	87			
3	2009-2010	FT	0	12	35	61	0	108	66	52	36	4
		PT	0	0	2	3	0	5	123			
4	2008-2009	FT	0	7	49	56	0	112	63	41	26	5
		PT	0	0	1	1	0	2	85			

Table D-2. Personnel

AERONAUTICAL and ASTRONAUTICAL ENGINEERING

Year[1]: **Autumn 2012 (Active Employees)**

	HEAD COUNT		FTE
	FT	PT	
Administrative[2]	3	1	3.75
Faculty (tenure-track)[3]	15	0	13.00
Other Faculty (excluding student Assistants)	10	29	14.90
Student Teaching Assistants[4]	14	2	13.61
Technicians/Specialists	21	7	20.72
Office/Clerical Employees	3	23	4.00
Others[4] Student Research Assistants	31	1	29.50

College of Engineering notes:

- TA and RA at 50% or greater equals 1 FTE
- Data source is the CoE Data Resources website.

ABET notes:

Report data for the program being evaluated.

1 Data on this table should be for the fall term immediately preceding the visit. Updated tables for the fall term when the ABET team is visiting are to be prepared and presented to the team when they arrive.

2 Persons holding joint administrative/faculty positions or other combined assignments should be allocated to each category according to the fraction of the appointment assigned to that category.

3 For faculty members, 1 FTE equals what your institution defines as a full-time load.

4 For student teaching assistants, 1 FTE equals 20 hours per week of work (or service). For undergraduate and graduate students, 1 FTE equals 15 semester credit-hours (or 24 quarter credit-hours) per term of institutional course work, meaning all courses — science, humanities and social sciences, etc.

4 Specify any other category considered appropriate, or leave blank.

APPENDIX E – List of Visiting Committee Members

Visiting Committee

Department of Aeronautics and Astronautics
University of Washington
2012-2013

Dana Andrews
Chief Technology Officer (Ret.)
Andrews Space
Tukwila, WA 98168

Belinda A. Batten
Professor and Department Head
Oregon State University
Department of Mechanical Engineering
Corvallis, OR 97331-6001

Brian J. Cantwell
Edward C. Wells Professor of Engineering
Department of Aeronautics and Astronautics
Stanford University
Stanford, CA 94305-4035

Kourosh Hadi
Chief, Product Development-
747/777/787/767/737 Derivatives
The Boeing Company
Seattle, WA 98124-2207

Roger Myers
Deputy Lead for Space Launch Systems
Aerojet, Redmond Operations
Redmond, WA 9807

John Sullivan
Professor
School of Aeronautics and Astronautics
Purdue University
West Lafayette, IN 47907

Suzanna Darcy-Hennemann
Chief Pilot - Director, Flight Training
The Boeing Company
Seattle, WA 98124

Bonnie Dunbar* **(NAE)**
Director, Higher Education and STEM
Strategic Workforce Planning
The Boeing Company
Seattle, WA 98124

Dennis K. McLaughlin,
Professor of Aerospace Engineering
Penn State University
University Park, PA 16802

Kevin R. Fowler
VP & Chief Architect, BCA Processes & Tools
Boeing Commercial Aircraft
Seattle, WA 98124

Chris Lewicki
President & Chief Engineer
Planetary Resources, Inc.
Seattle, WA 98104-2818

Anthony M. Waas
Felix Pawlowski Collegiate Professor
University of Michigan
Department of Aerospace Engineering
Ann Arbor, MI

Rob Meyerson
President and Program Manager
Blue Origin
Kent, WA 98032-2442

Guruswami Ravichandran
Professor of Aerospace and Professor of Mechanical
California Institute of Technology
Pasadena, CA

Uday Hegde
Staff Scientist
NASA Headquarters
Washington, DC 20546

* Currently at University of Houston, Clear Lake, TX

APPENDIX F – Samples of Surveys

This is only a preview of the survey. Responses will not be saved. Close

Junior Autumn Quarter Entrance Survey

In order to maintain the level of excellence and academic standards that the department has set as a goal for itself, we are asking for your help in evaluating our program. ABET (Accreditation Board for Engineering and Technology) reviews engineering programs every six years to make sure that those standards have been met. Now that you have nearly completed one academic quarter in the AA program, we need your help in reviewing whether we are meeting those standards.

Question 1.

How would you rate the level of ***importance*** of the following ABET-defined outcomes at the time you entered the department?

Please rate on a scale of (5 - Highest) and (1-Lowest)

Required.

	5	4	3	2	1
(a) An ability to apply knowledge of mathematics, science, and engineering	○	○	○	○	○
	5	4	3	2	1
(b) An ability to design and conduct experiments, as well as to analyze and interpret data	○	○	○	○	○
	5	4	3	2	1
(c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.	○	○	○	○	○
	5	4	3	2	1
(d) An ability to function on multi-disciplinary teams	○	○	○	○	○
	5	4	3	2	1

(e) An ability to identify

(e) An ability to identify, formulate, and solve engineering problems					
	5	4	3	2	1
(f) An understanding of professional and ethical responsibility					
	5	4	3	2	1
(g) An ability to communicate effectively					
	5	4	3	2	1
(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context					
	5	4	3	2	1
(i) A recognition of the need for, and an ability to engage in life-long learning					
	5	4	3	2	1
(j) A knowledge of contemporary issues					
	5	4	3	2	1
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.					

Question 2.

How would you rate your level of ***preparation*** in the following ABET-defined outcomes at the time you entered the department?

Please rate on a scale of (5 - Highest) and (1-Lowest)

Required.

	5	4	3	2	1
(a) An ability to apply knowledge of mathematics, science, and engineering					
	5	4	3	2	1
(b) An ability to design and conduct experiments, as well as to analyze and interpret data					
	5	4	3	2	1

	5	4	3	2	1
(c) An ability to design a system, component, or process to meet desired needs within a realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.					
	5	4	3	2	1
(d) An ability to function on multi-disciplinary teams					
	5	4	3	2	1
(e) An ability to identify, formulate, and solve engineering problems					
	5	4	3	2	1
(f) An understanding of professional and ethical responsibility					
	5	4	3	2	1
(g) An ability to communicate effectively					
	5	4	3	2	1
(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context					
	5	4	3	2	1
(i) A recognition of the need for, and an ability to engage in life-long learning					
	5	4	3	2	1
(j) A knowledge of contemporary issues					
	5	4	3	2	1
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.					

Question 3.

Prior to starting the junior year did you take any of the following courses from AA faculty ?

Required.
- ☐ AA 210
- ☐ AA 260
- ☐ AA 299

Question 4.

Were you a transfer student?

If you transferred only AP or IB credits, mark Other.

Required.
- ☐ Yes
- ☐ No
- ☐ 2 Year School
- ☐ 4 Year School
- ☐ Other - AP or IB credit only

Question 5.

Have you participated in an internship or Co-Op, or are you going to participate in one next summer?

Required.
- ☐ Internship
- ☐ Co-Op
- ☐ Both
- ☐ No
- ☐ I want to.

Question 6.

With what company did you or are you planning to do your Co-op or Internship?

Question 7.

What is your approximate GPA?

Enter a number (without commas).

Question 8.

Do you have any comments, general or specific?

Question 9.

Please enter your Name (it will be kept confidential).

Review >>

Questions or Comments?
Contact Adam Bruckner at bruckner@aa.washington.edu

This is only a preview of the survey. Responses will not be saved. Close

Senior Program Exit Survey

In order to maintain the level of excellence and academic standards that the department has set as a goal for itself, we are asking for your help in evaluating our program. ABET (Accreditation Board for Engineering and Technology) reviews engineering programs every six years to make sure that those standards have been met. We need your help in reviewing whether we are meeting those standards.

Question 1.

The ABET-defined **Student Outcomes** describe what students are expected to know and be able to do by the time they graduate. Please rate yourself on each of the following **Student Outcomes,** now that you are about to graduate.

	5 - Excellent	4 - Above Average	3 - Average	2 - Below Average	1 - Poor
a) An 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	○	○	○	○	○
c) An ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability	○	○	○	○	○
d) An ability to function on multi-disciplinary teams	○	○	○	○	○
e) An ability to identify, formulate and solve engineering problems	○	○	○	○	○
f) An understanding of professional and ethical	○	○	○	○	○

responsibilities					
g) An ability to communicate effectively	○	○	○	○	○
h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context	○	○	○	○	○
i) A recognition of the need for, and an ability to engage in life-long learning	○	○	○	○	○
j) Knowledge of contemporary issues	○	○	○	○	○
k) An ability to use the techniques, skills and modern engineering tools necessary for engineering practice	○	○	○	○	○

Question 2.

Please tell us how well the junior year coursework prepared you for the senior year coursework.

○ 5 - Very well
○ 4
○ 3
○ 2
○ 1
○ 0 - Not At All

Question 3.

If you didn't feel that the junior year coursework adequately prepared you for your senior year AA courses, what particular area(s) do you feel need additional attention/improvement?

You may indicate a specific(s) course if you wish.

- [ ] Aerodynamics AA 301, AA 302
- [ ] Orbital Mechanics & Atmospheric Flight Mechanics AA 310, AA 311
- [ ] Vibrations AA 312
- [ ] Aerospace Structures AA 331, AA 332
- [ ] Propulsion AA 360
- [ ] Specific Course: ____________

Question 4.

What programming courses have you taken?

Please list the course(s) and language.

Question 5.

Which of the following courses did you take in the senior year, in addition to AA 447?

Please mark all that apply.

- ☐ AA 400 Gas Dynamics
- ☐ AA 402 Fluid Mechanics
- ☐ AA 405 Introduction to Aerospace Plasmas
- ☐ AA 410-411 Aircraft Design I & II
- ☐ AA 419 Aerospace Heat Transfer
- ☐ AA 420-421 Spacecraft and Space System Design I & II
- ☐ AA 430 Finite Element Analysis in Aerospace
- ☐ AA 432 Composite Materials for Aerospace Structures
- ☐ AA 440 Flight Mechanics
- ☐ AA 441 Flight Test Engineering
- ☐ AA 448 Control Systems Sensors and Actuators
- ☐ AA 449 Design of Automatic Conrol Systems
- ☐ AA 461 Advanced Air Breathing Propulsion
- ☐ AA 462 Rocket Propulsion
- ☐ AA 470 Systems Engineering
- ☐ AA 499 Undergraduate Research

Question 6.

Please identify gaps, unnecessary overlap, or problems that you perceive in the senior year curriculum.

Question 7.

If there is any particular class(es) that comes to mind for the question above, please identify it/them.

Specific comments will help us to improve our program.

Question 8.

Have you participated, in a co-op, summer research, or internship experience while in the department?

Please mark all that apply.

- [ ] Co-Op
- [ ] Internship
- [ ] Summer Research
- [ ] No

Question 9.

With what company or companies did you do your co-op and/or internship?

Question 10.

If you did a summer research project where did you do it?

Please name the institution and the name of your supervisor.

Question 11.

Now that you are about to graduate, what areas do you feel should have received more emphasis in the B.S.A.A.E. undergradaute engineering degree program?

	3 - More Emphasis	2 - Same Emphasis	1 - Less Emphasis	0 - Never Use / Don't Know
a. Mathematics (a)	○	○	○	○
b. Physics and Chemistry (a)	○	○	○	○
c. Computer Usage (b) (k)	○	○	○	○
d. Engineering Analysis (b) (k)	○	○	○	○
e. Laboratory experience (b)	○	○	○	○
f. Design/synthesis (c)	○	○	○	○
g. Hands-on practical engineering (b) (c) (k)	○	○	○	○

h. Engineering fundamentals (a) (e)	○	○	○	○
i. Work on interdisciplinary teams (d)	○	○	○	○
j. Professional and ethical responsibility (c) (f)	○	○	○	○
k. Communication skills (g)	○	○	○	○
l. Contemporary and societal issues in engineering (h) (j)	○	○	○	○
m. The need for life long learning (i)	○	○	○	○
n. Writing (g)	○	○	○	○

Question 12.

Program Educational Objectives (PEOs) are broad statements that describe the career and professional accomplishments that the program has been preparing graduates to achieve. Our program's PEOs are as follows:

The education of engineers at the undergraduate level is one of the key missions of the William E. Boeing Department of Aeronautics and Astronautics. The undergraduate program prepares graduates to be successful and highly valued engineers in local, national, and international industry, as well as in government organizations and institutions of higher learning. The objectives of the undergraduate program are for our graduates to serve the region, the nation, the profession, and society at large, as follows:

1) Our graduates will be engineers who solve critical technical problems related to aerospace engineering, and who devise innovative ways to develop and apply new technologies;
2) Our graduates will contribute knowledge to and participate in the identification and solution of problems facing society;
3) Our graduates will engage in a lifetime of continuous learning and contribution to all areas of aerospace engineering.

To achieve these objectives, faculty, staff, and teaching assistants pursue excellence in the department's educational programs, supported by state-of-the-art computing, laboratory, and instructional facilities, and utilize the fruits of developments in educational technology and engineering education research.

Do you feel that you have been prepared to meet these objectives?

○ Yes
○ No
○ Maybe
○ I don't know.
○ Some of them.
○ Please explain. __________

Question 13.

Do you have a job offer(s)?

- Yes
- No
- Not Sure Yet

Question 14.

What is the company's name?

Question 15.

Do you have any other job offers?

- Yes
- No

Question 16.

Are you going to graduate school ?

- Yes
- No

Question 17.

Please tell us the name of the graduate school and department.

Question 18.

Do you have a military obligation after graduation?

- Yes
- No

Question 19.

Please list the professional accomplishments you believe the AA department should be preparing its undergraduates to achieve during the first few years following graduation.

Question 20.

List the professors who you remember as contributing the most to your professional development.

Question 21.

Please provide an overall assessment of the program in terms of the achievement and capability levels that you feel you have developed. How they compare with your expectations on entering the department?

We would prefer that you provide your name, although this is optional. These forms will be confidential, in that only the Department Chair and the undergraduate advisors will be allowed access to the parts that name particular faculty. We want you to be forthright.

Thank you for participating; we value your input!.

Question 22.
Your Name

Review >>

Questions or Comments?
Contact Adam Bruckner at bruckner@aa.washington.edu

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Survey for Industry and Government, and Visiting Committee

The Department of Aeronautics and Astronautics at the University of Washington has adopted the **Program Educational Objectives** listed below. These objectives are broad statements which describe the career and professional accomplishments that the program is preparing its graduates to achieve. We need your feedback on whether or not we are meeting these objectives and whether or not they are appropriate. Your participation will enable us to provide ABET (Accreditation Board for Engineering and Technology) with feedback that it feels is critical to the evaluation of our program.

We realize that you are very busy, and we very much appreciate your time in completing this survey.

The education of engineers at the undergraduate level is one of the key missions of the William E. Boeing Department of Aeronautics and Astronautics. The undergraduate program prepares graduates to be successful and highly valued engineers in local, national, and international industry, as well as in government organizations and institutions of higher learning. The objectives of the undergraduate program are for our graduates to serve the region, the nation, the profession, and society at large, as follows:

> *1) Our graduates will be engineers who solve critical technical problems related to aerospace engineering, and who devise innovative ways to develop and apply new technologies;*
>
> *2) Our graduates will contribute knowledge to and participate in the identification and solution of problems facing society;*

3) Our graduates will engage in a lifetime of continuous learning and contribution to all areas of aerospace engineering.

To achieve these objectives, faculty, staff, and teaching assistants pursue excellence in the department's educational programs, supported by state-of-the-art computing, laboratory, and instructional facilities, and utilize the fruits of developments in educational technology and engineering education research.

Question 1.

The first part of objective (1) is to solve critical technical problems related to aerospace engineering. From your knowledge of our alumni, do you feel that our graduates are achieving this objective?

- 5 - Strongly Agree
- 4 - Moderately Agree
- 3 - Slightly Agree
- 2 - Slightly Disagree
- 1 - Strongly Disagree
- 0 - No opinion

Question 2.

Can you provide any specific example in response to question number 1?

Question 3.
Do you feel that this objective should be modified in any way?

- Yes
- No
- No Opinion

Question 4.

If you answered yes to the previous question, what modifications do you suggest?

Question 5.

The second part of objective (1) is to devise innovative ways to develop, and apply new technologies. From your knowledge of our alumni, do you feel that our graduates are achieving this objective?

- 5 – Strongly Agree
- 4 – Moderately Agree
- 3 – Slightly Agree
- 2 – Slightly Disagree
- 1 – Strongly Disagree
- 0 – No opinion

Question 6.

Can you provide any specific example in response to the second half of question number 5?

Question 7.
Do you feel that this objective should be modified in any way?

- Yes
- No
- No Opinion

Question 8.

If you answered yes to the previous question, what modifications do you suggest?

Question 9.

Objective (2) is to contribute knowledge to, and participate in the identification, and solution of problems facing society. From your knowledge of our alumni, do you feel that our graduates are achieving this objective?

- 5 – Strongly Agree
- 4 – Moderately Agree
- 3 – Slightly Agree
- 2 – Slightly Disagree
- 1 – Strongly Disagree
- 0 – No opinion

Question 10.

Can you provide any specific example in response to question number 9?

Question 11.
Do you feel that this objective should be modified in any way?

- Yes
- No
- No Opinion

Question 12.

If you answered yes to the previous question, what modifications do you suggest?

Question 13.

Objective (3) is to engage in a lifetime of continuous learning, and contribution to all areas of aerospace engineering. From your knowledge of our alumni, do you feel that our graduates are achieving this objective?

- 5 – Strongly Agree
- 4 – Moderately Agree
- 3 – Slightly Agree
- 2 – Slightly Disagree
- 1 – Strongly Disagree
- 0 – No opinion

Question 14.

Can you provide any specific example in response to question number 13?

Question 15.
Do you feel that this objective should be modified in any way?

- Yes
- No
- No Opinion

Question 16.

If you answered yes to the previous question, what modifications do you suggest?

Question 17.

From your knowledge of our alumni, what are the most valuable attributes of a University of Washington BSAAE graduate?

Question 18.

From your knowledge of our alumni, what are the most common shortcomings of a Univeristy of Washington BSAAE graduate? ?

Question 19.

Relative to peer institutions, please rate the University of Washington BSAAE graduates in terms of:

	5 - Excellent	4 - Above Average	3 - Average	2 - Below Average	1 - Poor	0 - No opinion
Understanding of mathematics, science, and engineering fundamentals.	◯	◯	◯	◯	◯	◯
Ability to design and conduct experiments, as well as to analyze and interpret data.	◯	◯	◯	◯	◯	◯
An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety,	◯	◯	◯	◯	◯	◯

manufacturability and sustainability.						
An ability to function on multi-disciplinary teams.	○	○	○	○	○	○
An ability to identify, formulate, and solve engineering problems.	○	○	○	○	○	○
An understanding of professional and ethical responsibility.	○	○	○	○	○	○
An ability to communicate effectively.	○	○	○	○	○	○
The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.	○	○	○	○	○	○
A recognition of the need for, and an ability to engage in life-long learning.	○	○	○	○	○	○
A knowledge of contemporary issues.	○	○	○	○	○	○
An ability to use techniques, skills and modern engineering tools necessary for engineering.	○	○	○	○	○	○

Question 20.

Do you feel that we have covered all of the areas that are important to an employer in our Program Educational Objectives ?

- ○ Yes
- ○ No
- ○ Unsure
- ○ No Opinion

Question 21.

If you answered no or unsure to question 20, please explain:

[ ]

Question 22.

Your Name:

Question 23.

Your Company's Name:

Submit responses

Questions or Comments?
Contact Marlo Anderson at marlo@aa.washington.edu

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Signature Attesting to Compliance

By signing below, I attest to the following:

That Aeronautical and Astronautical Engineering 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.*

Judy Ramey, Interim Dean

Judy Ramey — 6/13/13

Signature — **Date**