Doctoral Program Review
Self Study Report

The Department of Aerospace Engineering
Texas A&M University, College Station TX

Oct. 2011
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I. Aerospace Vision Committee Report
Preface

Modern aerospace engineering encompasses so much more than simply aeronautics and astronautics. Aerospace engineering is constantly evolving and focusing on new research thrusts stretching the imagination of researchers and students alike. With so many new extensions in the fields associated with aerospace engineering, new research focuses arise, from multifunctional materials to wind energy. Aerospace engineering at Texas A&M University goes beyond basic curriculum and essential laboratories, bringing relevance to aerospace courses and equipping our students with cutting edge facilities and research opportunities. Our academic disciplines include aerodynamics and propulsion, dynamics and control, and materials and structures, giving all of our students the balanced start that they need to be successful leaders in the future.

Over the past decade the Department of Aerospace Engineering has invested in graduate education by building a series of research laboratories in the areas of hypersonics, laser diagnostics, robotics, multifunctional materials and flight mechanics through start up fund investments and federal grants. The graduate faculty has increased by almost 50%, and the quality and quantity of graduate students has also increased substantially, as indicated by many metrics including GRE scores, number of competitive national fellowships and placement of our students in leadership positions in academia, industry and government labs. Research expenditures have almost doubled during the last decade, and there is a diversity of research areas for graduate studies, including five research thrust areas: Aerospace propulsion and energy systems, Autonomous aerospace vehicle systems, Controlled intelligent materials and structures, Hypersonic vehicles systems, and Space exploration and sensing systems.

In this self-study, we provide an idea of just a few of the research and educational focus areas that our students and faculty are exploring. We appreciate your time and commitment to assessing our PhD program. We look forward to your visit in October. Thanks, and gig ‘em!

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1. Introduction

1.1 Charge to the 2011 Doctoral Review Committee

The external review of the Aerospace Engineering Doctoral Program is part of a periodic Academic Program Review at Texas A&M University sponsored by both the Office of Graduate Studies (OGS) and the Office of Undergraduate Studies. The role of the external review is to provide academic leaders with critical information about the quality and size of our Doctoral Program, establish needs for future resources, assess student market, strengths and weaknesses, and overall contribution to the mission of the University. The results from this review will be used to assess the status of the Aerospace Engineering Doctoral Program with respect to our peers across the nation and to suggest improvements. The purpose of the Self Study document (this report) is to provide the necessary background for the Review Committee to effectively gauge the Doctoral Program and the assessment processes.

Over the last eight years, and hence since the last review, the Aerospace Engineering department has undergone significant growth as part of a faculty reinvestment program. During this period, the faculty grew from 20 to 29. The impact on the PhD program is summarized in Figs. 1.1a-c, where the student numbers, research funding and course offerings all increased in proportion to the faculty growth; a more detailed assessment of the PhD program is given in Chapter 4 of this program self-study. The conclusions, and recommendations, from the last (2003) program review, as summarized in the Appendix, strongly influenced the direction of growth during this reinvestment program.

Through the 2011 review, we seek to further improve the quality of our Doctoral Program. Specifically, we ask that the team:

1. Assess the quality of the program (strengths, weaknesses, and overall contribution to the mission of the University) and provide suggestions for improvement.
2. Examine our methods and metrics of assessment and provide suggestions for improvement.
3. Assess the impact of the Faculty Reinvestment program that took place since the last review in 2003. The goal of this program was to improve the quality of education by having more faculty members available for mentoring.
4. Evaluate our future plans to enhance our doctoral program productivity and improve our external visibility, and provide suggestions for improvement.
5. Address the following questions as required in the Guidelines for Academic Review:
   i. What evidence exists to show that the Aerospace Engineering Department is measuring student learning outcomes, research strengths and service?
   ii. What evidence exists to show that the Department is using assessment results to improve the curriculum and instruction, strengthen research and service, promote diversity and globalization, and to evaluate the effectiveness of PhD training?
   iii. What evidence exists to show that the Department is using assessment of teaching, research and service to improve each activity and to make decisions about the use of technology, facilities and hiring?

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iv. What evidence exists to show that the Department and the College of Engineering is using objective assessment processes to decide how to allocate fiscal, physical and human resources?

![Graph](image)

1.2 Organization of the Self Study

The Self Study Report is organized as follows. In Chapter One, we present an overview of the motivation for the Doctoral Program Review. In Chapter 2, we provide an overview of the Aerospace Engineering Department. In Chapter 3, we describe the graduate program and processes. In Chapter 4, we describe the PhD program assessment results.
2. Aerospace Engineering Department

2.1 Founding of the Department

The first course in aerodynamics was introduced in the Department of Mechanical Engineering (ME 428) in 1928, and the first course in airplane design (ME 434) came into existence in the year 1931. These were the beginnings of what became the Aeronautical Engineering Department at Texas A&M University in 1940. During the 1942-43 school year, the department became the first in the Southwest, and fourteenth in the nation, to be accredited by the Engineering Council for Professional Development (ECPD). After a significant growth in the two subsequent decades, the name was changed in 1963 to the Department of Aerospace Engineering.

Initially, the students and faculty came from the Department of Mechanical Engineering, but by 1944 the first full class, consisting of two students, was graduated with B.S. in Aeronautical Engineering. The number of graduates steadily increased in the 1940s, as a consequence of the World War II GI Bill, and after some decline in the 1950s, the undergraduate student enrollment saw a steady, slow increase in the two subsequent decades. The “star wars” initiatives of President Reagan gave a boost to the enrollment of undergraduate and graduate students throughout the 1980s, and after a decline in the early 1990s, a steady state enrollment has reached the present level of approximately 600 undergraduate students. The upward rise in the graduate student enrollment during the 1980s has, however, been sustained to a large degree. The evolution of enrollment is shown in Figs. 2.1 and 2.2 for undergraduate and graduate students, respectively. The corresponding faculty growth, beginning with three in 1941, is shown decade-by-decade in Fig. 2.3.

During the first decade of development of the department, emphasis was placed on aerodynamics, structures, math and design. Until 1948 flight training was required for sophomores and juniors. Graduate level courses offered during this time were mainly in structural analysis, testing and design. During the next decade, advanced aerodynamics courses (fluid dynamics, compressible fluids and experimental aerodynamics) were offered and flight-training courses were phased out. The graduate-level course offering expanded in the 1960s to include the theory of elasticity, plates and shells and matrix methods of structural analysis. During this time, undergraduate courses were offered in space technology, aircraft propulsion, chemical rocket propulsion, and structural design of missiles and spacecraft. In the late 1970s, major changes were made to the curricula that brought the balance of the three major disciplines that exist today.

In the 1990s and more recently, several undergraduate courses have been added at the senior level that have strengthened the curriculum in order to prepare the students for industry as well as for graduate studies. Examples of these courses are aeroelasticity, active controls for aerospace vehicles, numerical simulation, heat transfer and viscous flows, finite elements, and composite materials. The last two are cross-listed with the multi-disciplinary Mechanics and Materials (MEMA) program. Seminars and special topics courses are also offered.

The graduate program in the department began in 1946 with six Masters degree students. The first M.S. degree was awarded in 1949, while the first PhD degree was granted 20 years later in 1969. Most of the early research in the department was in the structures and materials area due to the
expertise of the faculty in those years. In the late 1950s the fluid dynamics area got a boost with the construction of wind tunnels. The dynamics and controls area had the first PhD degree granted in 1978.

Fig. 2.1 Thirty-year history of undergraduate enrollment in Aerospace Engineering

Fig. 2.2. Thirty-Year history of graduate enrollment in Aerospace Engineering

Fig. 2.3 Seventy-year history of the Aerospace Engineering faculty
2.2 Current State of the Department

2.3 Administrative Structure and Academic Disciplines of the Department

The College of Engineering utilizes a Department Head administrative structure. The Department Head for Aerospace Engineering is Dr. Dimitris Lagoudas. The Aerospace Engineering Department Organization is shown in Fig. 2.4. As shown, the Aerospace Department also has an Associate Department Head for Graduate Programs and Research Infrastructure and an Assistant Department Head for Undergraduate Programs and Outreach. The Associate Department Head is Dr. Rodney Bowersox, and the Administrative Coordinator for Graduate Programs is Mrs. Karen Knabe. The Assistant Department Head for Undergraduate Programs is Dr. Kristi Shryock.

The academic operations are divided among the three discipline groups, Aerodynamics and Propulsion (A&P), Dynamics and Controls (D&C) and Materials and Structures (M&S), as listed in Fig. 2.4. The tenured/tenure track faculty members are listed first, and the research and emeritus faculty are listed along the bottom. The bold underlined font indicates the group leaders.

Fig. 2.4 Departmental Administration and Academic Disciplines

2.3.1 Faculty

The names of the tenured/tenure-track faculty are listed in Table 2.1, and corresponding two-page resumes are given in the Appendix. The A&P faculty are listed in the first group of rows (blue) in Table 2.1; the D&C faculty are listed in the second grouping (gray), and M&S faculty are listed in the last group (blue). The discipline group leaders are indicated in bold and underlined. As can be inferred from Table 2.1, the department is evenly distributed over the three basic core divisions.
As a result of an assessment described in Section 4.6.1, the department defined five major research thrust areas: Aerospace Propulsion and Energy Systems (APES), Autonomous Aerospace Vehicle Systems (AAVS), Controlled Intelligent Materials and Structures (CIMS), Hypersonic Vehicle Systems (HyVS), and Space Exploration and Sensing Systems (SESS). The thrust areas are listed in the last five columns of Table 2.1. The faculty and thrust leaders, as indicated by bold type, are listed in the rows. Faculty research is not limited to these areas. Instead, these were defined to capitalize on common interests to create critical mass to compete for center-level research programs.

In terms of administration, the core discipline group leaders form an Academic Advisory Committee to provide guidance to the department head on issues such as the health of the academic programs, hiring needs, laboratory and classroom needs, etc. The research thrust leaders form a Research Advisory Committee to provide guidance to the department head on health of the research thrust, hiring needs, laboratory needs, etc.

Table 2.1 Faculty by Core Discipline and Research Thrust Area

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<th>Rank</th>
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*Aerospace Propulsion and Energy Systems (APES), Autonomous Aerospace Vehicle Systems (AAVS), Controlled Intelligent Materials and Structures (CIMS), Hypersonic Vehicle Systems (HyVS), and Space Exploration and Sensing Systems (SESS)
2.3.2 Student Body

The undergraduate enrollment was shown graphically in Fig. 2.1, and as indicated the total enrollments generally range from 400-600. The graduate enrollment data in Fig. 2.2 demonstrates a continual growth of the graduate program. The more recent graduate student demographics are plotted in Fig. 2.5. Two noteworthy trends are that both the percentage of PhD students and domestic students are steadily rising. Also, the GRE scores (Fig. 2.6) have remained relatively steady, exceeding 1300 for most years. The one drop below 1300 was the result of the increased faculty hire, which resulted in a spike in the demand, and hence, the lower average. However, even in the low year, our average exceeded the reported allowable minimums for the program.

![Fig. 2.5 Graduate student enrollment](image)

![Fig. 2.6 GRE Scores (Total Average of 1308 with a 2.7% standard deviation)](image)

2.3.3 Advisory Board

The mission of the Advisory Board is to advise and assist the Department in pursuing the following objectives:

- Review and evaluate the Department's strategic goals and plan, and other specific initiatives
• Review and evaluate the undergraduate curriculum with regard to ensuring that the curriculum is properly focused
• Assist the department in establishing beneficial relationships with industry
• Assist the department in resource development in support of the needs of the department

Membership on the Board is by invitation of the Department Head. Members are selected based on their leadership ability, their contributions to the aerospace community, their ability to contribute to the objectives of the Board and their desire to serve. Members are appointed for three years with the term commencing with the first meeting attended. Members may be appointed for a second term. The Board meets twice each year, once during each academic semester. The Advisory Board has the following members:

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<th>LAST NAME</th>
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<td>C. Cale</td>
<td>Rockwell Collins</td>
</tr>
<tr>
<td>Westergaard</td>
<td>Carsten</td>
<td>Vestas Technology R&amp;D Americas, Inc.</td>
</tr>
<tr>
<td>Wood</td>
<td>Tom</td>
<td>Bell Helicopter</td>
</tr>
</tbody>
</table>

2.3.4 Budget Summary

The educational programs in the Aerospace Engineering Department are supported by State appropriated funds, student fees, sponsored research grants, investment income, Office of Graduate Studies, and industry gifts. Displayed in Fig. 2.7 is the departmental income received for the years
2008-2011. The Department receives an academic budget directly from the Dean of Engineering, which primarily funds faculty salaries and half of the staff salaries. The Department is also an operating division of the Texas Engineering Experiment Station (TEES). Most research is contracted through TEES, which returns a portion (54%) of the overhead directly to the department and the faculty member(s) in charge of a project. These funds are used to support additional staff salaries, graduate student teaching assistant salaries, and operational expenses. In addition, income is received from fellowships and scholarships, endowments and gifts, and student fees. These funds are used to support graduate salaries, graduate activities, and additional graduate student teaching assistant salaries.

Fig. 2.7 Departmental Budget Summary
3. Aerospace Engineering Graduate Program

3.1 Administration of the Graduate Program

The administration of the graduate program in Aerospace Engineering is a joint effort of the Department of Aerospace Engineering and the Office of Graduate Studies. The function and role of each is described below.

3.1.1 Role of Office of Graduate Studies

The Office of Graduate Studies (OGS) under the direction of the Dean of Graduate Studies (Dr. Butler-Purry) is responsible for administering the graduate program for the University. The OGS responsibilities include:

- Preparing and issuing policies, rules and scheduling governing the graduate program, and graduate merit and regents fellowships,
- Maintaining the “official” student’s graduate academic record including the degree program, committee members, petitions, grades, etc.,
- Reviewing students’ records to determine whether they have complied with all the necessary degree requirements at each stage of their progress,
- Granting formal admission into the graduate program and approving the removal of students’ probationary status, and

Additionally, the Office of Graduate Studies is responsible for administering the Graduate Faculty. The Graduate Faculty consists of the President, the Executive Vice President and Provost, the Associate Provost, the Dean of the Office of Graduate Studies, the Deans of all colleges, selected Directors, and a properly qualified academic group appointed by the Office of Graduate Studies. Members of the Graduate Faculty participate in the graduate degree programs of the University by serving on student advisory committees and teaching graduate courses. Individuals, regardless of rank, who are not members of the Graduate Faculty of Texas A&M University may not teach graduate courses or serve on student advisory committees unless the Office of Graduate Studies grants special approval.

The Department Head initiates nomination for membership on the Graduate Faculty. The Graduate Faculty is composed of Members, Associate Members, Adjunct Members and Special Appointments. Members and Associate Members are selected from qualified individuals of the academic staff of Texas A&M University, from staff of other parts of the University, from the Texas A&M University System and from affiliated research organizations located in College Station. The Adjunct Member classification is used for recognized scholars who do not hold a permanent appointment to the faculty of the University, but who otherwise meet the basic requirements for the status of Member. Special Appointments are temporary appointments to the Graduate Faculty that allow for the teaching of a single graduate course or for membership on a specific student's advisory committee. The Special Appointment does not count towards the minimum number of graduate

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2 See [http://ogs.tamu.edu](http://ogs.tamu.edu) for most recent graduate catalogs and procedures.
faculty necessary to form the committee. Almost all full-time faculty members in the Department are members of the graduate faculty.

3.1.2 Role of the Department

The Department’s Graduate Program Director serves as a liaison between the Graduate Studies Office and the Department of Aerospace Engineering on graduate matters, and is a member of the College of Engineering Graduate Instruction Committee. The Department Graduate Program Director is also responsible for establishing and maintaining departmental graduate policies and procedures, departmental graduate student records, applications processing, scholarship nominations, offer letters to prospective research and teaching assistants, etc. and will normally act for the Department Head in certain graduate matters. Dr. Rodney Bowersox serves as the Department Graduate Program Director and Ms. Karen Knabe is the Department's Administrative Coordinator for graduate program activities. The Office of Graduate Studies (OGS) and the Registrar's office maintain all “official” student records.

The department and the faculty have the primary responsibility for maintaining quality control with regard to admissions, degree programs, thesis and dissertation proposals, qualifying and preliminary examinations for doctoral candidates, course inventory and content, matriculation of MS students to the PhD program, etc. All degree programs, thesis and dissertation proposals and new course offerings require department head approval. The doctoral qualifying exam, preliminary exam and final defense are discussed in further detail in a later section.

The Director of Graduate Programs, in consultation with the department head, handles the assignment of graduate teaching assistants (GATs). This is done with the consultation and approval of the student’s graduate program advisor. Some research assistants are assigned GAT duties when faculty research funding falls short and they are in need of support for a student who has been funded as a GAR.

Other responsibilities include the coordination and administration of the departmental qualifying examination for doctoral students (the AFQE). The Director and the Graduate Admissions Committee share this task.

3.2 Graduate Degrees

The Department of Aerospace Engineering offers the Master of Science (thesis and non-thesis option), Master of Engineering, and Doctor of Philosophy degrees in Aerospace Engineering. The College of Engineering offers the Doctor of Engineering degree, with emphasis in various areas, including Aerospace Engineering. Below is a brief description of each degree.

3.2.1 The Degree of Master of Science (Thesis Option)

The degree requires a minimum of 32 credit hours of course work beyond a Bachelor of Science degree, plus a thesis. The thesis must be defended in an oral presentation. A typical degree program will include 21-24 credits of course work, 2 required credits of graduate seminar (AERO 681 or MEMA 681), and the balance in research credits. The exact distribution of course work and research
credits is left to the discretion of the student and his/her Graduate Advisory Committee, but requires approval of the Department Head or Associate Department Head for Graduate Programs.

3.2.2 The Degree of Master of Science (Non-Thesis Option)

The degree requires a minimum of 36 credit hours of approved courses beyond the Bachelor of Science plus a technical report. Of these 36 hours, 18 credit hours must be in the major department and a minimum of six credit hours must be in supporting fields. The department requires that 2 of the 36 credits must be graduate seminar (AERO 681 or MEMA 681). A technical report is required for this option. Additional courses, as well as the content of the required technical report, are left to the discretion of the student’s Graduate Advisory Committee.

3.2.3 The Degree of Master of Engineering

The degree requires 30 credit hours of course work beyond a Bachelor of Science degree. The work in the major field includes one or two written reports. These reports do not necessarily involve results of research conducted by the student. The degree does not require the submittal of a formal report to the University. While this degree option is formally available to students in Aerospace Engineering, it is rarely utilized and generally not favored by the faculty.

3.2.4 The Degree of Doctor of Philosophy

The degree requires a minimum of 64 credit hours beyond the master’s degree. Additionally, the degree requires the student to defend and submit a dissertation to the University. A typical degree program will include 20-40 credits of course work, four required credits of graduate seminar (AERO 681 or MEMA 681), and the balance in research credits. The distribution of course work and research credits is left to the discretion of the student and his/her Graduate Advisory Committee, but requires approval of the Department Head or Assoc. Department Head for Graduate Programs.

At the completion of the first two semesters of course work (3 semesters if the student’s first semester is spring), the student must pass the Aerospace Fundamental Qualifying Examination (AFQE) given each summer. Failure to pass the AFQE will result in dismissal from the PhD program. In addition, after completion of all course work on the degree program, the student must pass the preliminary examination before officially beginning his/her research work. The AFQE and preliminary examination are described in detail in the section dealing with Degree Program Requirements.

3.2.5 The Degree of Doctor of Engineering

The degree requires a minimum of 64 hours beyond the master degree. The Doctor of Engineering degree is non-research oriented and is intended to prepare the student to work at the highest levels of the engineering profession. The College of Engineering administers this degree. The Department of Aerospace Engineering has not utilized this degree program to any significant extent (one in the last five years).
3.3 Admission Procedures and Requirements

The admission of graduate students is a joint effort of the university Office of Admissions and Records (OAR), the Department of Aerospace Engineering and, for international students, the International Student Services (ISS) Office. An application package consists of the application (electronic), official transcripts, GRE test score information, reference letters and other materials, which the student may choose to provide. For international students, various other documents are required including proper visa and financial support documents and TOEFL scores. A nonrefundable application fee of $50 for U.S. citizens and permanent residents, or $75 for international applicants, is required to process an application. In some cases, the department (or a faculty member) may choose to pay the application fee for the prospective student.

3.3.1 Role of the University Office of Admissions and Records (OAR)

All admission documents are collected by OAR, paper documents are scanned, and all documents are stored in an electronic document repository called OARDocs, which is accessible by a secure Internet browser connection. Paper documents are generally scanned within 24-48 hours of receipt by OAR. The student’s application is available to the department in real-time (both partial and complete applications). The admission decision process by the department is handled through an online, web-based admissions decision system called OARADS. The department may admit a student at any point during the admissions process.

In addition, upon request, OAR evaluates the transcripts by calculating the GPR on the last 60 hours of undergraduate coursework earned at a senior-level institution, or if the student has a master’s degree, then calculating the GPR on all graduate coursework, excluding non-degree courses or research hours. For international transcripts, grades are converted to an equivalent 4.0 basis. Alternatively, the department can use the cumulative scores on the transcripts.

For international students, the International Student Services (ISS) office assists students with applications, required INS documentation, verification of required insurance and financial information, etc.

3.3.2 Role of the Department

The Graduate Program Director, Dr. Rodney Bowersox, and the Administrative Coordinator for the Graduate Program, Ms. Karen Knabe, administer the admissions process for the department under the supervision of the department head, Dr. Dimitris Lagoudas. The Graduate Program Director is assisted by a faculty Graduate Admissions Committee consisting of 3 faculty (1 faculty member from each of the major discipline areas). The department head appoints these committee members. The committee meets periodically (typically 2-3 times per semester), assesses each application, and makes a recommendation for admission or denial. Applications that are acceptable to the Admissions Committee are then circulated to the faculty for further evaluation before a final admission decision is made to the Graduate Program Director. This last step in accepting a student requires that a faculty member be identified who will supervise the student, and also identifies the source of funding that will support the student. Unlike some departments, the department established a goal in 2002 that all students who are admitted should be admitted with the premise...
that they are worthy of full financial support as research assistants (or with fellowships), and that it would not admit students with the intent that they be funded as teaching assistants.

3.3.3 Entrance Requirements

The following conditions must be met before a student is admitted to the Aerospace Engineering Graduate Program

- The student is academically qualified for pursuing graduate work
- A faculty member is committed to supervising the student
- The department has adequate resources to support the student

The review process proceeds as follows. At the beginning of each year (January), the department determines the number of graduate students that it may reasonably expect to be able to handle given faculty and financial resources. A committee, called the Graduate Affairs Committee, evaluates applications using criteria that include prior academic performance, GRE and TOEFL scores, reputation of prior institutions attended, faculty recommendations, student “statement of purpose,” work experience, and other information as deemed appropriate. The minimum standards for consideration for admission are given below:

- **PhD**
  - GPA ≥ 3.4 (last 60 hrs of UG coursework or MS degree)
  - GRE ≥ 1250
- **Masters**
  - GPA ≥ 3.2 (last 60 hrs of UG coursework or MS degree)
  - GRE ≥ 1225

Students may enter into the Aerospace PhD program with or without a MS degree (direct PhD). For international applications, the Graduate Admissions Committee, with faculty and other input, has compiled a list of "top universities" for each country from which the department receives its applications. The student is generally admitted if he/she is a graduate of one of these "top universities." Applicants, who may be otherwise qualified, may be denied admission when departmental resources are inadequate, when the applicant’s profile is not competitive with other applicants, when the student does not have appropriate background training, etc.

3.3.4 English Language Proficiency Requirements for International Students

For international students, the department follows the university requirements for English language proficiency. Texas A&M requires students from other countries to demonstrate the ability to speak, write and understand the English language. The English Proficiency requirements are independent of admission requirements. Graduate students may meet this requirement in one of four ways:

- English Language Proficiency Verification through official TOEFL score of 550 (213 computer based) or higher taken within the last two years, GRE Verbal score 400 or higher taken within the last five years, or GMAT Verbal score 22 or higher taken within the last five
years. Texas A&M requires an official copy of the test scores to meet the English Proficiency requirements;

- English Language Proficiency Certification by taking the English Language Proficiency Examination (ELPE) prior to registration for the first semester at Texas A&M;
- English Language Proficiency Certification by receiving a Baccalaureate degree following four years of study at an accredited U.S. institution; or
- English Language Proficiency Certification through appropriate English training programs at other U.S. institutions.

The English Language Institute (ELI) offers a comprehensive and innovative program designed for international students who want to learn English or improve their English language ability prior to studying at an American college or university, particularly Texas A&M University. Students who do not prove English proficiency by other means must enroll in ELI course (1 per semester) until they are certified.

Students who will serve as Graduate Assistants–Teaching (GAT) must complete the English Proficiency Certification Process at Texas A&M, or show that they have completed an equivalent program at another U.S. institution. All other international students may demonstrate their abilities in English through English Proficiency Verification.

In order to proceed in the graduate program, students must be in good academic standing with Office of Graduate Studies, which means maintaining GPA of 3.0 or better.

3.4 Masters Degree Requirements

3.4.1 Master of Science (Thesis Option) Degree Requirements

The Master of Science degree requires a minimum of 32 semester credit hours of approved courses and research. University regulations allow up to eight hours of the 32 to be research. The research must lead to a thesis that "reflects a comprehensive understanding of the pertinent literature and expresses in clear and legible English, the problem(s) for study, the method, significance and results of the student's original research." The student must complete nine resident credit hours during one regular semester or one 10-week summer session to meet the residency requirement. There are other restrictions on the use of transfer credit, special topics courses, etc.

The student's program is under the direction of an advisory committee approved by the Department Head (and requires approval of the University Office of Graduate Studies). The student’s advisory committee will consist of no fewer than three members of the graduate faculty representative of the student’s field(s) of study and research. The chair or one of the co-chairs of the advisory committee must be from the student’s major department, and at least one or more of the members must be from a department other than the student’s major department. This committee defines and approves the student’s degree plan and thesis proposal, conducts a final oral thesis defense, and provides other direction as appropriate. The Automated Degree Plan System is located
on the web site http://ogsdpss.tamu.edu. Degree requirements for the MS/Thesis Option are presented in Table 3.1. The timeframe for earning the degree is one and a half to two years.

Table 3.1. Master of Science (Thesis Option)

<table>
<thead>
<tr>
<th>Course</th>
<th>Number of Courses</th>
<th>Total Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seminar (AERO 681)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Departmental &amp;</td>
<td>varies (7-8)</td>
<td>22 (minimum)</td>
</tr>
<tr>
<td>Supporting Courses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research (AERO 691)</td>
<td>varies</td>
<td>8 or less</td>
</tr>
<tr>
<td>Total Credit Hours</td>
<td></td>
<td>32 (min), 33 (max)</td>
</tr>
</tbody>
</table>

The department does not require core courses for the MS/Thesis Option degree program. Typical degree programs will include advanced mathematics courses, departmental courses supporting the student’s major thrust area, and supporting courses from other departments. A maximum of 8 credits of research (AERO 691) is permitted in the degree program. Each student is required to take the departmental seminar course for 2 semesters (AERO 681).

3.4.2 Master of Science (Non-Thesis Option) Degree Requirements

The Master of Science/Non-Thesis Option has similar requirements to the MS/Thesis Option, except that a thesis is not required and a minimum of 36 credit hours of approved courses is required on the degree program. Of these 36 hours, 18 credit hours must be in the major department and a minimum of six credit hours must be in supporting fields. Degree requirements for the MS/Non-Thesis Option are presented in Table 3.2. The timeframe for earning the degree is one and a half to two years.

Table 3.2 Master of Science (Non-Thesis Option)

<table>
<thead>
<tr>
<th>Course</th>
<th>Number of Courses</th>
<th>Total Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seminar (AERO 681)</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Departmental</td>
<td>Varies</td>
<td>18 (minimum)</td>
</tr>
<tr>
<td>Supporting Depts.</td>
<td>Varies</td>
<td>6 (minimum)</td>
</tr>
<tr>
<td>Other</td>
<td>Varies</td>
<td>10 (minimum)</td>
</tr>
<tr>
<td>Total Credit Hours</td>
<td></td>
<td>36 (minimum)</td>
</tr>
</tbody>
</table>

The department does not require core courses for the MS/Non-Thesis Option degree program. Typical degree programs will include advanced mathematics courses, departmental courses supporting the student’s major thrust area, and supporting courses from other departments. Each student is required to take the departmental seminar course for 2 semesters (AERO 681).
3.4.3 Master of Engineering Degree Requirements

The Master of Engineering degree requires a minimum of 30 semester credit hours of approved courses, with some restrictions on the use of transfer credit, special topics courses, etc. Approximately one-third of the required 30 credit hours of coursework will be taken in fields outside of the major field of study. The work in the major field must include a written report, but this need not reflect independent research. The student’s advisory committee for the Master of Engineering will be the member of the Graduate Affairs Committee in the student's interest field or the Director of Graduate Programs. If additional committee members are deemed necessary by the department, the advising committee chair, in consultation with the student, will select additional members for the advisory committee. The advising faculty member or committee will guide the student in selection of appropriate courses. The Department requires submission of a degree plan by the end of the second semester. The Automated Degree Plan System is located on the web site http://ogsdpss.tamu.edu. The student is required to pass a final examination administered by the advisory committee, and the practice of the Department is that this exam focuses on an oral presentation of the written report mentioned above. The Advisory Committee reviews the student’s degree program and provides other direction as appropriate. The timeframe with the Department for earning the degree is one full year.

3.5 Doctorate Degree Requirements

3.5.1 PhD Degree Requirements

Work leading to the PhD degree at Texas A&M University is designed to give the candidate a thorough and comprehensive knowledge of his or her professional field and training in methods of research. The final basis for granting the degree is the candidate's grasp of the subject matter of a broad field of study and a demonstrated ability to do independent research. In addition, the candidate must have acquired the ability to express thoughts clearly both orally and in writing. The degree is not granted solely for the completion of coursework, residence and technical requirements, although these requirements must be met.

The faculty member and student select the advisory committee to direct the student’s doctoral program. “The student’s advisory committee will consist of no fewer than four members of the graduate faculty representative of the student’s several fields of study and research, where the chair or co-chair must be from the student’s department (or intercollegiate faculty, if applicable), and at least one or more of the members must be from a department other than the student’s major department.” The advisory committee evaluates the student’s previous education and degree objectives. Then, with the student, develops a proposed degree plan and outlines a research problem which, when completed, will constitute the basic requirements for the degree. The Department requires the degree plan by the end of the student's third semester. “The committee members’ signatures on the degree plan indicate their willingness to accept the responsibility for guiding and directing the entire academic program of the student and for initiating all academic actions concerning the student.” The online degree plan must be filed with the Office of Graduate Studies prior to the deadline imposed by the student's college and no later than 90 days prior to the preliminary examination. The degree plan system is located at http://ogsdpss.tamu.edu.
The PhD degree requires a minimum of 64 credit hours beyond the MS. For a student who has completed a baccalaureate degree but not a master's degree, a minimum of 96 credit hours is required on the degree plan.

To be admitted to candidacy for a doctoral degree in aerospace engineering, a student must have (a) satisfied the residency requirements, (b) passed the Departmental PhD qualifying exams, (c) passed the preliminary examination, (d) completed all formal coursework, and (e) filed with the Office of Graduate Studies the approved dissertation proposal. The final examination is not authorized for any doctoral student who has not been admitted to candidacy. The details of the qualifying, preliminary and final examinations are provided in a later section.

The research proposal must be approved at a meeting of the student's advisory committee, at which time the feasibility of the proposed research and the adequacy of available facilities are reviewed. The approved proposal is submitted to the Office of Graduate Studies at least 14 weeks prior to the close of the semester or summer session in which the student expects to receive the degree or prior to the scheduling of the final examination, whichever comes first, for final approval.

The ability to perform independent research must be demonstrated by the dissertation, which must be the original work of the candidate. Whereas acceptance of the dissertation is based primarily on its scholarly merit, it must also exhibit creditable literary workmanship.

The timeframe within the Department for earning the degree is nominally four to five years. The State recently instituted the 99 hour cap rule, which requires that students who complete more than 99 hours of graduate credit beyond the masters degree will be required to pay tuition and fees at the out-of-state rate (regardless of whether they are funded or unfunded, state residents or not, etc.). This policy is in-place to encourage students to graduate within the four-year period.

The department does not require core courses for the PhD degree program. However, because of the qualifying examination requirement, many students will typically take AERO 601 – Principles of Fluid Motion, AERO 603 – Continuum Mechanics, and AERO 622 – Spacecraft Dynamics and Control. Typical degree programs will include advanced mathematics courses, departmental courses supporting the student’s major thrust area, and supporting courses from other departments. Each student is required to take the departmental seminar course for 4 semesters (AERO 681). Degree requirements are presented in Table 3.3.

<table>
<thead>
<tr>
<th>Course</th>
<th>Number of Courses</th>
<th>Total Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seminar (AERO 681)</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Departmental</td>
<td>Variable</td>
<td>Variable</td>
</tr>
<tr>
<td>Supporting Depts.</td>
<td>Variable</td>
<td>Variable</td>
</tr>
<tr>
<td>Research (AERO 691)</td>
<td>Variable</td>
<td>Variable</td>
</tr>
<tr>
<td>Total Credit Hours</td>
<td></td>
<td>64 (minimum)a</td>
</tr>
</tbody>
</table>

aBeyond the masters degree. For students without a master's degree, 96 credit hours is required on the degree plan.
3.5.2 PhD Qualifying and Preliminary Examinations

All PhD doctoral students must complete three examinations; one required by the department (the Aerospace Fundamentals Qualifying Exam) and two required by the Office of Graduate Studies (the Preliminary Exam and the Dissertation Defense). Each of these is described in detail below.

The first examination is the Aerospace Fundamentals Qualifying Examination (AFQE). The purpose of the AFQE exam is to ensure that students pursuing a doctoral degree in aerospace engineering have an understanding of required background in the three fundamental areas of aerospace engineering. All students who initiated PhD status, re-entered PhD status, moved from MS to PhD status, or transferred into the department with PhD status are required to take the AFQE in late May or early June following their first academic year of study. Students who entered in the spring or summer of a given year are required to take the AFQE the following year as if they had entered in the fall of the that year. The AFQE is a department requirement and cannot be postponed.

The examination covers fundamental topics from the three broad disciplines of A&P, D&C and M&S, as well as the mathematics associated with such disciplines. The score from the AFQE, the student’s academic performance record, and recommendations from the student’s advisor(s) will be used as a total evaluation of performance. A positive evaluation will be the basis for continuation in the PhD program. The Graduate Affairs Committee (Director of Graduate programs, one faculty member from each discipline area) determines whether the student has passed or failed with input from the student’s advisor. Students who fail the exam are given a second opportunity, which can be in the form of an oral exam in the area(s) of weakness or a complete retake the following August. Those students who fail the AFQE may be given the opportunity to switch to a masters program (provided they do not have a masters degree from Texas A&M), or they must leave the department.

The AFQE consists of three closed-book examinations of 2-3 hours duration on each of the three broad discipline areas. The three examinations are generally given on a Monday-Wednesday-Friday timeframe. The examinations are constructed by a faculty committee; typically, those who teach the baseline courses in these three areas [i.e., AERO 601 – Principles of Fluid Motion, AERO 603 – Continuum Mechanics (or MEMA 601 – Theory of Elasticity) and AERO 622 – Spacecraft Dynamics and Control]. While the AFQE is over the three general discipline areas noted above, the exam content is not restricted to topics covered by these suggested courses alone, nor is the AFQE a simple re-test or another final exam in these suggested courses. The pass rate for the AFQE is summarized in Table 3.4. These data show that the pass rate (~90%) is very good, and that the careful entrance selection is achieving the desired result of minimal attrition.

| Table 3.4 AFQE Pass Rate (2002 – 2010) |
|-------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                               | 2002            | 2003            | 2004            | 2005            | 2006            | 2007            | 2008            | 2009            | 2010            |
| AFQE Pass Rate                | 92%             | 89%             | 89%             | 100%            | 86%             | 94%             | 95%             | 80%             | 89%             |
The second examination is the *Preliminary Exam*. The preliminary examination for a doctoral student shall be given no earlier than a date at which the student is within approximately six credit hours of completion of the formal coursework on the degree plan (i.e., all coursework on the degree plan except 681, 684, 690, 691 and 692 courses). The student is strongly encouraged to complete the Preliminary Examination no later than the end of the semester following the completion of the formal coursework on the degree plan. The Office of Graduate Studies must receive the results of the preliminary examination at least 14 weeks prior to the final examination date. The examination shall be oral and written unless otherwise recommended by the student's advisory committee and approved by the Office of Graduate Studies. The written part of the examination will cover all fields of study included in the student's degree plan. Each member of the advisory committee is responsible for administering a written examination in his or her particular field, unless he or she chooses to waive participation in this part of the examination. Two or more members of the advisory committee may give a joint written examination. One or more members may require a student to take a departmental or intercollegiate faculty examination to supplement or replace a written examination. Each written examination must be completed and reported as satisfactory to the chair of the advisory committee before the oral portion of the examination may be held. In case any written examination is reported unsatisfactory, the entire advisory committee must agree (1) to proceed with the oral portion of the preliminary examination, or (2) to adopt another course of action regarding the unsatisfactory written examination. Either procedure is subject to the approval of the Office of Graduate Studies.

Prior to scheduling the preliminary examination with the other committee members, the committee chair will review with the student eligibility criteria, using the Preliminary Examination Checklist to ensure the student is ready for the examination. The following list of eligibility requirements applies.

- Student is registered at Texas A&M University for the semester or summer term during which any portion of the preliminary examination may fall. If the entire examination falls between semesters, then the student must be registered for the term immediately preceding the examination.
- An approved degree plan was on file with the Office of Graduate Studies at least 90 days prior to the first written examination.
- Student’s cumulative GPR is greater than 3.0.
- Student’s degree plan GPR is greater than 3.0.
- All English language proficiency requirements have been satisfied.
- All committee members have scheduled or waived the written portion and agreed to attend the oral portion of the examination or have found a substitute. Only one substitution is allowed and it cannot be for the committee chair.
- At the end of the semester in which the exam is given, there are no more than 6 hours of coursework remaining on the degree plan (except 681, 684, 690, 691 and 692). The head of the student’s department (or Chair of the Intercollegiate Faculty, if applicable) has the authority to approve a waiver of this criterion.
- The time span from the first written examination to the oral is no more than three weeks. (In cases of department-wide written examinations, this criterion is not applicable.) The head
of the student’s department (or chair of the intercollegiate faculty, if applicable) has the authority to approve a waiver of this criterion.

Once all requirements are met, departments or interdisciplinary degree programs may announce the schedule of the written and oral parts of the examination.

Credit for the preliminary examination is not transferable. If a departmental or intercollegiate faculty examination is used as part of the written portion of the preliminary examination, it must be the last examination offered prior to the date scheduled for the preliminary examination. In the schedule of the written portion, all members of the student’s advisory committee are to be included.

Through the preliminary examination, the student’s advisory committee should be satisfied that the student has demonstrated the following qualifications:

1. A mastery of the subject matter of all fields in the program;
2. An adequate knowledge of the literature in these fields and an ability to carry out bibliographical research.

In case a student is required to take, as a part of the written portion of a preliminary examination, an examination administered by a department or intercollegiate faculty, the department or intercollegiate faculty must:

1. Offer the examination at least once every six months. The departmental or interdisciplinary degree program examination should be announced at least 30 days prior to the scheduled examination date.
2. Assume the responsibility for marking the examination satisfactory or unsatisfactory, or otherwise graded, and in the case of unsatisfactory, stating specifically the reasons for such a mark.
3. Forward the marked examination to the chair of the student’s advisory committee within one week after the examination.

The chair of the student’s advisory committee is responsible for making all written examinations available to the members of the advisory committee at or before the oral portion of the examination. A positive vote by all members of the graduate committee with at most one dissention is required to pass a student on his or her exam. A department or interdisciplinary degree program can have a stricter requirement provided there is consistency within all degree programs within a department or interdisciplinary program.

The chair of the advisory committee will promptly report the results of the Preliminary Examination to the Office of Graduate Studies, using the Report of Doctoral Preliminary Examination form, and the Preliminary Examination checklist. Both forms must have the appropriate signatures. These forms should be submitted to the Office of Graduate Studies within 10 working days of the scheduled examination.

Exam results must be submitted with the original signatures of the committee members as approved by the Office of Graduate Studies. If an approved committee member substitution (1
only) has been made, their signature must also be submitted to the Office of Graduate Studies. The original signature of the department head is also required for results for the preliminary examination.

After passing the required preliminary oral and written examinations for the doctoral degree, the student must complete all remaining requirements for the degree within four calendar years. Otherwise, the student will be required to repeat the preliminary examination.

Upon approval of the student's advisory committee, with no more than one member dissenting, and the approval by the Office of Graduate Studies, a student who has failed the preliminary examination may be given one re-examination, when adequate time has been given to permit the student to address the inadequacies emerging from the first examination (normally six months). The student and the advisory committee jointly negotiate a mutually acceptable date for this purpose.

3.5.3 Dissertation Defense

The candidate for the doctoral degree must pass a final examination by deadline dates announced in the Office of Graduate Studies calendar each semester or summer session. No student is given a final examination unless her or his current official GPR is 3.000 or better and she or he has been admitted to candidacy. There must be no un-absolved grades of D, F or U for any course listed on the degree plan. To absolve a deficient grade, a student must have repeated the course and achieved a grade of C or better. A student must have completed all coursework on his or her degree plan with the exception of any remaining 691 (Research) for which he/she is registered. Faculty have the option of giving Incomplete (I) grades for all 691 research hours until the time where the student successfully passes the final exam; at which time the I grades in 691 are changed to S (Satisfactory).

The student's advisory committee conducts the final examination. The final examination is not administered until the student has been “admitted to candidacy” for a doctoral degree, which requires that a student must have: (1) satisfied the residency requirements, (2) passed the preliminary examination, (3) completed all formal course work, and (4) filed with the Office of Graduate Studies the approved dissertation proposal. In addition, the final examination for the PhD student is not administered until such time that the dissertation is available in substantially final form to the student's advisory committee, and all concerned have had adequate time to review the document. Although the final examination may cover the broad field of the PhD candidate's training, the major portion of the time is generally devoted to the dissertation and closely allied topics. Persons other than members of the graduate faculty may, with mutual consent of the candidate and the major professor, be invited to attend a final examination for an advanced degree. A positive vote by all members of the graduate committee with at most one dissension is required to pass a student on his or her exam. Once the dissertation is acceptable to all advisory committee members and the department head, the student must file a pdf copy of the dissertation in final form with the university Thesis Office. A library bound copy is provided to the department.

A request for permission to hold and announce the final examination must be submitted to the Office of Graduate Studies a minimum of 10 business days in advance of the scheduled date of the exam. OGS must be notified in writing of any cancellation or change to the scheduled examination date. Exam results must be submitted with original signatures of only the committee members.
approved by OGS. A positive vote by all members of the graduate committee, with at most one dissention, is required to pass a student on his/her exam. Examinations that are not completed and reported to OGS within 10 business days of the scheduled examination date will be recorded as failures. A doctoral student is allowed only one opportunity to take the final exam. Final examinations must be passed by the dates announced each semester or summer term by OGS in order for the student to graduate in that semester.

Examination schedules must be arranged so that all members of Advisory Committee can be present for the Final Examination. Substitutions should be requested only as an absolute necessity. Unless emergency circumstances exist, arrangements for a substitution should be made by the individual member of the Advisory Committee who is to be absent—not by the student involved, the Chair of the Advisory Committee, nor the Head of the student’s major department. If a member must be absent from any scheduled examination, he or she should arrange with a Member of the Graduate Faculty from his or her department to sit at the examination as a substitute and should notify the Committee Chair. No substitutions for the Chair of Advisory Committees will be approved. If a Chair cannot attend a scheduled examination, or if two (or more) members of an Advisory Committee must be absent, the examination must be rescheduled.

Doctoral students have one year from successfully completing the final examination to clear the Thesis Office and graduate. Otherwise, the student will be required to repeat the final examination. With the approval of the advisory committee and department head or chair of the interdisciplinary program, the student may request an extension of the one-year with the submission of a Time Limit Petition to OGS.

3.5.4 Doctor of Engineering Degree Requirements

The Doctor of Engineering program differs from the PhD in that the research experience is replaced by an internship of at least one calendar year in industry, and a Record of Study, which usually consists of a report on the internship experience, replaces the dissertation. The Doctor of Engineering Degree is primarily administered by the Dwight Look College of Engineering, rather than by the individual department in the College. The objective of this program is the education of men and women to function at the highest levels of the engineering profession, with emphasis on solving problems that arise in the use of technology to benefit mankind. The program seeks to couple understanding of the characteristics of social and business institutions with high competence in engineering problem solving.

The College, with the approval of the University Office of Graduate Studies, under the direction of an advisory committee appoints the student’s program. This committee consists of no fewer than four members of the graduate faculty representative of the student's several fields of study. At least one of these members must be from a department other than the student's administrative department. The student's internship supervisor, a practicing engineer, also is a member of the advisory committee.

The student's advisory committee has the responsibility for guiding and directing the entire academic and internship program of the student and for initiating all action concerning the student.
The committee responsibilities include the proposed degree program, the written and oral qualifying examination, the technical adequacy of the internship program, the qualification of the student to embark on the internship, the internship report, and the final examination. The graduate portion of the student's degree plan must include a minimum of 96 semester credit hours, of which at least 80 credit hours are for coursework. The Professional Internship earns four credit hours per semester for summer term.

The internship experience is intended to be at an organizational level such that the student is able to deal with broadly based problems affecting more than one facet of the organization, rather than a single narrow or specific technical problem. The timeframe within the Department to earn the degree is three to four years.

This program is very rarely utilized in the Aerospace Engineering department.

**3.5.5 Doctorate of Engineering Exams**

The Doctor of Engineering examinations are administered by the Academic Dean's office in the College of Engineering, and are not described herein.

**3.6 Graduate Student Enrollment**

Graduate student enrollment has steadily grown over the last 10 years (see Fig. 2.5). The Fall 2010 enrollment was 139, which corresponded to an average of 4.8 per research active faculty (in fall 2010, there were 29 active research faculty). The departmental goal is 5.0 students per faculty. In addition to increasing the numbers of graduate students, the department has made a concerted effort to increase the number of domestic students, as reflected in Fig. 2.5, where over the last 10 years, the fraction of domestic students has increased from 30% to 67%. During the same time period, the average incoming GRE has remained very flat at just over 1300 (see Fig. 2.6), where the standard deviation was 2.7%. Over last the 10 years, approximately 43% (standard deviation of 3.3%) of the graduate student body where made up of PhD students.\(^3\)

Graduate student recruitment takes place primarily on an individual basis between the faculty members and potential students. In addition, the Office of Graduate Studies sponsors an annual recruitment visit to Texas A&M University for outstanding applicants, which results in nominally 5-10 new highly qualified students. Hence, the majority of the students are recruited and selected by the faculty. However, the Aerospace Engineering Graduate Office maintains the entrance standards.

Summarized in Table 3.5 are the women and minority enrollment for the past five years, as a percentage of total enrollments for each year. The minority data includes African American, Hispanic American and Native American students; however, women as a class are not included in this minority grouping. In general, enrollment of women has averaged ~15% of the total enrollment, which is consistent with the 15% national averages for the 2005 – 2010 period reported in the ADCA 2010 Enrollment Survey.\(^4\) Minority enrollment of ~8% is significantly lower than the state

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\(^3\)The faction has held relatively constant at 40% with 5% deviation since about 1985.

population demographics. The ADCA average for 2005 – 2010 ranged from 12 – 22%. Increased minority enrollment remains a challenge for the department.

### Table 3.5 Enrollment Demographics

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Enrollment</td>
<td>110</td>
<td>110</td>
<td>119</td>
<td>136</td>
<td>139</td>
</tr>
<tr>
<td>%Women</td>
<td>16%</td>
<td>13%</td>
<td>16%</td>
<td>17%</td>
<td>15%</td>
</tr>
<tr>
<td>%Underrepresented Groups</td>
<td>8%</td>
<td>7%</td>
<td>8%</td>
<td>9%</td>
<td>7%</td>
</tr>
</tbody>
</table>

The graduate enrollment by discipline area is listed in Table 3.6. This table shows the department has a reasonably well-balanced educational program across the three core disciplines.

### Table 3.6 Recent Graduate Enrollments by Discipline

<table>
<thead>
<tr>
<th>Year</th>
<th>A&amp;P</th>
<th>D&amp;C</th>
<th>M&amp;S</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>36%</td>
<td>38%</td>
<td>26%</td>
</tr>
<tr>
<td>2010</td>
<td>39%</td>
<td>39%</td>
<td>22%</td>
</tr>
</tbody>
</table>

### 3.7 Financial Aid

The various forms of financial support for graduate students include Graduate Assistant Teaching (GAT), Graduate Assistants Non-Teaching (GANT), Graduate Assistant Research (GAR), Fellowships, and Other External Funding (e.g., government sponsorship). All graduate assistants are on half-time (20 hours/week) appointments. The stipend philosophy is that the department sets the rates for the GANTS/GATS and the faculty PI set the rates for their GARs. The stipends are determined from a survey of our peer institutions ($1900/mo) as well as a comparison to the average within the College of Engineering ($1600/mo). Based on this analysis, the stipend rates for GANT/GAT are:

- **PhD:** $1750 + Tuition (OGS/COE) + no Fees
- **MS:** $1600 + no Tuition/Fees

Individual faculty members award GARs with approval by the department head. The allowable range of monthly GAR and GANT stipend rates paid in Aerospace Engineering for the fall 2010 semester is $1400/mo. - $3500/mo. To go above or below this range requires permission from the department and TEES.

Graduate students are required to be full time students at Texas A&M University. In order to be considered a full-time student, a student must register for a minimum of nine credit hours during a regular (fall or spring) semester and a minimum of six credit hours during the summer semester. The current in-state tuition rate is approximately $5,500 per year. The current out-of-state tuition rate is approximately $11,000 per year. The University policy is that all PhD students receive tuition. Hence,
the department is currently moving towards putting more emphasis in the graduate program on PhD students. For MS students, faculty may choose to pay all, part or none of the tuition.

Stipend and tuition support are available via external research funding for graduate research assistants (GARs), departmental and college support for teaching assistants (GATs), and national and local fellowships.

In terms of the entire graduate program, approximately 90-95% of enrolled students are on some form of full stipend, fellowship or other support. Table 3.7 shows the distribution of funding sources for graduate students in aerospace engineering during Fall 2010. An example breakdown of the PhD student support is shown in Fig. 3.1 for fall 2010. As indicated in Fig. 3.1, a large fraction of the graduate student support results from external research grants.

**Table 3.7 Funding Sources for Graduate Students in Aerospace Engineering, Fall 2010**

<table>
<thead>
<tr>
<th>GAR</th>
<th>GAT/GANT</th>
<th>Internal Fellowship</th>
<th>External Fellowship</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>55%</td>
<td>14%</td>
<td>7%</td>
<td>12%</td>
<td>12%</td>
</tr>
</tbody>
</table>

*Only full, major fellowships are included (NSF, DoD SMART, NASA GSRP, NDSEG, Sandia, and NSF IGERT, TAMU Merit, COE National Excellence, TAMU Pathways to the Doctorate, the TAMU Diversity and the Aero Bradley); bIncludes Government sponsored students and self funded.

**Fig. 3.1 Source of support for PhD Students (Fall 2010)**

Students funded as GAR/GAT/GANT (50%) are provided with the same health insurance benefits as the employees. For GAT/GANTs, this health insurance benefit is paid by the State of Texas; however, for a GAR, the benefit is paid by the faculty member’s research contract or grant (currently the premium paid on behalf of the student is $200 per month).

Many of our top students are competitive for National Fellowships (NASA, NSF, NDSEG, Sandia Laboratories, SMART, etc.). In addition, the University and College of Engineering have dedicated fellowship monies available. The Department nominates its top recruits for fellowships at the College level (e.g., College of Engineering National Excellence and Regents Fellowships) and University level (Merit and Diversity Fellowships). In the recent past, the Department also received
tuition-pool monies from the Provost's Office to pay in-state tuition fees of incoming graduate students.

In order to attract the most highly qualified students to our graduate program and to keep the student morale high, it is extremely desirable to have a higher fraction of students on financial support as well as having their tuition and fees paid. This goal can be accomplished by generating additional research dollars and by careful enrollment management (i.e., through admissions).

The process of admitting students without funding generally has a negative effect on the department in several ways (student morale, faculty sometimes consider these students as unworthy, unfunded students may receive less faculty advisement since the faculty advisor has less at stake, etc.). Hence, as a general rule, the department does not admit students without financial support.

In terms of departmental and institutional support, the department supports nominally 20 GAT students per year, and the College of Engineering provides tuition for GAT-supported PhD students. This is a new change instituted in 2011, where previously all departmental teaching assistants (MS and PhD) received tuition support from the University. With this change, the department is moving toward only supporting PhD students as teaching assistants. A more complete description of the resources is given in Section 3.7.1. Lastly, the Aerospace Engineering students are highly competitive for national and local (TAMU) fellowships, and the department takes an active role in encouraging student applications. This has resulted in nominally ~15% of our PhD students on fellowship.

3.7.1 Resource Summary

The resource allocations for 2010 are listed in Table 3.8 to give an indication of the institutional support for the graduate program. The remaining financial support for the PhD program (graduate research assistants, faculty summer salaries, and laboratory development) is through external research grants. It is also important to note that 54% of the indirect charges are returned to the department as a reinvestment to help support the research program. Those funds are included in the institutional support listed below. In addition, 16% of the indirect is divided among the PIs on the research grant, again with the goal of enhancing the research program.

The available space (square footage) for the department is also summarized in Table 3.8. The physical space is as follows. The main office, faculty offices and most classrooms are in the Harvey (Bum) Bright Bldg (HRBB). Graduate offices and research laboratories are in the following additional buildings Reed-McDonald Bldg (RDMC), Richardson Bldg. (RICH), Wisenbaker Bldg. (WERC), Easterwood Research Complex (ERC), Munnerlyn Bldg. (MUNN), Riverside Campus (RC), and University Services Building (USB). The physical space distribution for the department is indicated on the maps in the Appendix. The amount of space seems sufficient. However, the distributed nature of the space has proven suboptimal, and the department is continually working to improve this situation.
Table 3.8 Institutional Support for Graduate Program (2010)

<table>
<thead>
<tr>
<th>Financial</th>
<th>Amount</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Assistants</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Stipend</td>
<td>$320K</td>
<td>Student Fees (1/3), Dept. IDC (2/3)</td>
</tr>
<tr>
<td>Tuition</td>
<td>$140K</td>
<td>OGS, COE</td>
</tr>
<tr>
<td>Faculty/Staff Salary(^a)</td>
<td>$4.24M</td>
<td>State Budget, Department IDC Return(^b)</td>
</tr>
<tr>
<td>Operations/Travel</td>
<td>$240K</td>
<td>Department IDC</td>
</tr>
<tr>
<td>Lab/Office Enhancements</td>
<td>$140K</td>
<td>Department IDC</td>
</tr>
<tr>
<td>Computer Lab Enhancements</td>
<td>$120K</td>
<td>Department IDC, COE</td>
</tr>
</tbody>
</table>

**Physical Space**

<table>
<thead>
<tr>
<th>Location</th>
<th>Amount</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty/Staff Offices</td>
<td>11,900</td>
<td>HRBB, WERC, ERC, MUNN</td>
</tr>
<tr>
<td>Graduate Student Offices</td>
<td>7,300</td>
<td>HRBB, RDMC, RICH, WERC, ERC, MUNN</td>
</tr>
<tr>
<td>Laboratories</td>
<td>38,800</td>
<td>HRBB, RDMC, RICH, WERC, ERC, MUNN, RC, USB</td>
</tr>
<tr>
<td>Computer Laboratory</td>
<td>3,500</td>
<td>HRBB</td>
</tr>
</tbody>
</table>

\(^a\) Faculty are on 9 month appointments, where summers are covered via research grants; \(^b\) Most staff members are supported through IDC return on research grants.

3.7.2 Budget Summary (continued from Section 2.3.4)

Shown in Figure 3.2 is a breakdown of the departmental resources used to support the graduate program for the years 2008-2011. The amounts included in each category represent the amount of funding used to support the graduate program and departmental operations, including faculty and staff salaries. The categories are similar to those shown in Fig. 2.7 but with higher fidelity in terms of the breakdown.

![Graduate Program Budget Summary](image-url)
Briefly, student fees are charged for the undergraduate and graduate courses to provide funds for TA support. The Office of Graduate Studies provides direct support for a number of activities (scholarships, PhD GAT/GANT tuition and Graduate Program Enhancement). Also, our students are competitive for industrial and local fellowships. TEES provides the operating budget. The investment income includes gifts and endowments. In addition, a large fraction of the research IDC return is reinvested into the graduate program through GAT and infrastructure support. The last category is the academic budget salaries provided by the State.

3.7.3 Research Centers and Laboratories

Several major research centers are affiliated with the Aerospace Engineering Department. A brief description of each is given below.

The Aerospace Engineering Department supports an array of nationally funded research centers. The following are Board of Regents approved research centers:

National Center for Hypersonic Laminar-Turbulent Transition Research. The National Center for Hypersonic Laminar-Turbulent Transition Research is an AFOSR/NASA supported national research center dedicated to the theoretical, computational, and experimental studies of laminar-turbulent boundary-layer transition in the hypersonic regime. The objectives are to (1) extend and enhance the theoretical framework to include relevant hypersonic physics; (2) perform fundamental stability experiments, and (3) establish/demonstrate strategies for transition control. For more information, see http://hypersonics.tamu.edu. Center Director: Dr. William Saric.

Texas Institute for Intelligent Bio-Nano Materials and Structures. The Texas Institute of Intelligent Bio-Nano Materials and Structures for Aerospace Vehicles (TiiMS) brings together some of the top researchers in Texas and the world - including a Nobel laureate and several members of the National Academies - in biotechnology, nanotechnology, biomaterials and aerospace engineering to develop the next generation of bio-nano materials and structures for aerospace vehicles. The new large-scale projects include the International Institute for Multifunctional Materials for Energy Conversion (IIMEC), which NSF-funded, and an AFOSR funded MURI on Functionally Graded Multifunctional Hybrid Composites for Extreme Environments. For more information, see http://tiims.tamu.edu. Center Director: Dr. Dimitris Lagoudas.

Oran W. Nicks Low Speed Wind Tunnel. The Oran W. Nicks Low Speed Wind Tunnel is a self-contained research facility located near Texas A&M. The main function of the facility is commercial wind tunnel testing, which supports the technical staff. The facility is also available for faculty-funded research. The facility is a closed circuit, single-return tunnel, with a 10 ft x 7 ft rectangular test section. The administrative building, tunnel and test section, an external balance, and drive motor all have independent foundations to reduce the transmission of vibrations among them. A wide variety of tests are conducted at the wind tunnel for industry, governmental agencies, educational institutions, and private individuals. Tests at the tunnel include, but are not limited to aircraft, space vehicles, ground vehicles, buildings and offshore structures. It is used for both basic and applied airflow research and development and also provides instructional aid for students of various departments. Center Director: Dr. Edward White.
The following are additional nationally recognized (and funded) centers housed within the department:

**Consortium for Autonomous Space Systems.** The Consortium for Autonomous Space Systems is an AFRL funded center focused on novel spacecraft designs that utilize autonomous control systems, smart sensors and cooperative control of satellite formations. In addition, enhanced education, with university, industry, government teaming, technology transfer and commercialization. Center Director: Dr. John Junkins.

**International Institute of Multifunctional Materials for Energy Conversion.** The International Institute of Multifunctional Materials for Energy Conversion (IIMEC) is a NSF supported, international collaboration effort, lead by Texas A&M, dedicated to researching materials for energy conversion. The countries involved range from North America, Asia, Africa, and across Europe. Center Director: Dr. Dimitris Lagoudas.

**SMART Vehicles Concepts Center.** The Smart Vehicle Concepts Center (SVC) is a NSF funded center with the following mission: (1) Conduct basic and applied research on the characterization of smart materials, and the development of adaptive sensors, actuators and devices (based on active materials and control methods) for application to vehicle sub-systems and components; (2) Build an unmatched base of research, engineering education, and technology transfer with emphasis on improved vehicle performance; and (3) Develop well-trained engineers and researchers (at the MS and PhD levels) with both experimental and theoretical viewpoints. Center supervisor: Dr. James Boyd.

The Aerospace Engineering Department also houses an array of modern research laboratories. The laboratories are housed in the basement of the HR Bright Building, the Easterwood Complex, the Wisenbaker Building, the Munnerlyn Building and Riverside Airport. A brief description of each is given below.

**Aero/Fluid Dynamics Laboratory.** The aero/fluids laboratory houses an array of low-speed wind tunnels ranging in size from 4 ft x 5ft to 1 ft x 1 ft. The facilities are used for both education and basics research. Many pressure and velocity measuring devices are available, including manometers, pressure transducers, and laser Doppler anemometers. Smoke and helium bubble generators are used for flow visualization. In addition, various data acquisition and signal conditioning instruments are included in this lab. Faculty Director: Dr. Othon Rediniotis.

**AggieSat Lab Satellite Program.** The goal of the AggieSat Lab Satellite Program is to develop and demonstrate modern technologies by using a small-satellite platform, while educating students and enriching the undergraduate experience. The Lab takes an integrated approach to small-spacecraft research, design-build-fly, and education for multidisciplinary teams of freshmen through graduate students, along with industry and government affiliates. The Lab is currently engaged in a four-mission campaign with NASA Johnson Space Center to demonstrate autonomous rendezvous and docking technologies. For more information see http://aggiesatweb.tamu.edu. Program Director: Dr. Helen Reed.
**Damping Laboratory.** The Damping Lab has equipment that can measure the damping properties of metal matrix composites (MMC) in a simulated space environment. The space environment is simulated with a vacuum chamber in the lab. MMC damping properties are measured by observing the vibration response of the specimen in the chamber using laser-optical techniques. Faculty Director: Dr. Vikram Kinra.

**Dynamics and Control Laboratory.** This laboratory is used to conduct experiments on a variety of dynamical systems. A Contraves air bearing permits one-arc-second precision pointing of various experiments. The lab has been used to develop star sensors, relative navigation sensors, robots for ground emulation of spacecraft rendezvous and docking, and to conduct vibration suppression experiments for space structures. Faculty Director: Dr. John Junkins.

**Flight Mechanics Laboratory.** The Flight Mechanics Lab flight test facility is used for experimental research, flight demonstrations, and FAA certification of small- to medium-sized unmanned aircraft systems (UAS). This 5,000 square-foot facility is located in Hanger 7046, next to the control tower at the Old Bryan Air base (83TX). Also known as the A&M Riverside (1,900-acre campus). A 7,000-ft runway is retained in "active" status for UAS flight-testing. Unmanned Aircraft at this lab include a modified R/C Rascal 110 airplane, a Bergen R/C helicopter, and two custom-built small Tactical Unmanned Air Vehicles (TUAV). Two manned aircraft are also maintained for chase duties: a Piper Super Cub and a Schweizer 2-32 Sailplane. The facility also includes ground-based UAS flight test equipment, an instrumented small engine test stand, and a complete workshop. Faculty Director: Dr. John Valasek.

**Flight Research Laboratory.** The TEES Flight Research Laboratory is located in a hanger at the General Aviation facilities at Easterwood Airport in College Station. The lab owns two aircraft: a Cessna O-2 (military version of the Cessna 337 Skymaster) for heavy instrumentation, observation, and data transmission, and a Stemme S-10 VT powered sailplane for its ultra-low disturbance environment, and high-altitude capabilities. For more information, see http://flight.tamu.edu. Faculty Director: William Saric.

**General Materials Laboratory.** The General Materials Lab is used for the evaluation and simple processing of materials. Laboratory equipment includes two screw-driven load frames (one manual, one computer-controlled); a creep frame; sample preparation and evaluation equipment, including polishing and etching equipment and an optical microscope; sample processing furnaces; and Charpy, IZOD and Rockwell hardness test capability. The lab is used for an undergraduate materials lab, and priority is given to this class. Faculty Director: Dr. Tom Pollock.

**High-Speed Combustion Laser Laboratory.** The main research thrust of the laboratory is the study of supersonic flames. We have created a series of miniaturized high-speed flames that exhibit strong extinction due to the high strain imposed by the supersonic flow to the chemical reactions within the flame. A novel rotational / vibrational laser Raman technique has been implemented in the lab for the study of the supersonic flows. The technique combines powerful, pulsed lasers with state of the art detectors to accomplish a spectroscopic measurement in high-speed flows. The line imaging laser diagnostics provide an array of important multi-scalar measurements, such as pressure,
temperature, and major species concentration within a supersonic environment. Derived quantities, such as conserved scalars and scalar dissipation, quantify the level of mixing and the characteristic mixing timescale within the supersonic flames. Faculty Director: Dr. Adonios Karpetis.

**LASR Laboratory.** The Land, Air and Space Robotics (LASR) Lab is a robotics facility. The lab conducts research in robotic sensing and control with an aim to enhance the fields of proximity operations, human-robot interaction, stereo vision, swarm robotics, and autonomous aerial vehicles. Faculty Director: Dr. John Junkins.

**Materials and Testing Laboratory.** The Materials and Testing Lab is primarily used for processing and evaluating high-temperature metal matrix composite (MMC) materials, but the lab can be used to evaluate and process a wide range of materials. Three hydraulically-based MTS load frames are available for uniaxial mechanical testing. Each load frame can be equipped with one of five furnaces used in high temperature material evaluation. A hot isostatic press (HIP) and various furnaces are available to process metal matrix composites. This lab also includes various temperature-measuring devices. Faculty Director: Dr. Dimitris Lagoudas.

**NASA Langley Mach 6.0 Quiet Tunnel Laboratory.** The NASA Langley M6QT provides the low-disturbance environment required for meaningful hypersonic stability experiments. The facility was originally part of the Langley Hypersonic Facility Complex. The tunnel was reactivated in the Texas A&M University National Aerothermochemistry Laboratory (TAMU-NAL) in 2005. For more information, see http://hypersonics.tamu.edu. Faculty Director: Dr. William Saric.

**National Aerothermochemistry Laboratory.** The National Aerothermochemistry Laboratory (NAL) is an interdisciplinary facility committed to the development and utilization of state-of-the-art research facilities and instrumentation to perform fundamental and applied studies in high-speed gasdynamics with non-equilibrium effects. The laboratory houses unique high-speed wind tunnels and a suite of advanced diagnostics including molecular tagging velocimetry, planar laser induced fluorescence, as well as many others. The Bowersox, North and Saric research groups are working together to establish a world-class research capability to address important scientific and technical problems. For more information, see http://nal.tamu.edu. Faculty Director: Dr. Rodney Bowersox.

**Propulsion Laboratory.** This lab contains a fully instrumented and working turbine engine originally designed for cruise missiles. Inlet and nozzle configurations can be changed to vary engine inlet and back pressure. Faculty Director: Dr. Paul Cizmas.

**Structural Dynamics Testing Laboratory.** The Structural Dynamics Testing Lab exists for the dynamic testing of components and assemblies. The room contains a test frame capable of handling objects up to 25 feet long and weighing up to 2,000 pounds. Equipment and instrumentation in this lab centers on dynamic testing and evaluation of structures, including various shakers, accelerometers and strain gauges. This lab and its equipment are also used for an undergraduate instrumentation lab; priority is given to this class. Faculty Director: Dr. Tom Pollock.

**Vehicle Systems and Control Laboratory.** The Vehicle Systems & Control Laboratory (VSCL) conducts federal and industrial sponsored research in Computational Intelligence; Vehicle Management Systems; Human-Machine Interfaces; Virtual Instrumentation; and Flight Safety and
Training Systems and Software. A dedicated cluster of nine quad-core multi-processor computers enables high fidelity, real-time simulation and control. Three-dimensional terrain is projected onto a 150-degree field of view screen. For piloted simulation, the physical equipment of the EFS consists of the actual side-by-side cockpit and fuselage of an USAF Cessna T-37 with a traditional center stick and an actual YF-16 sidestick. For display research purposes, a glass cockpit consisting of both left and right touchscreen LCD flat panel displays with tactile feel are installed as head down displays. All of the equipment and software is located in the HR Bright Bldg. See http://jungfrau.tamu.edu/valasek/. Faculty Director: John Valasek

Water Tunnel Laboratory. The Water Tunnel Lab contains two water tunnels used as flow visualization tools by the Aerodynamics Lab and as a teaching aid for an undergraduate lab course. A hydrogen bubble (by water ionization), a laser light sheet and dye injection are used for flow visualization techniques in these water tunnels. This lab also contains video recording and viewing equipment to capture flow visualization data. Faculty Director: Dr. Othon Rediniotis.

Wave Propagation Laboratory. The Wave Propagation Lab is used for the nondestructive evaluation of adhesive joints, composites, thin coatings, multi-layered media and granular media. These materials can be evaluated to determine the anisotropic stiffness matrix, detect delamination and matrix cracking, and observe the evolution of damage in a material. Methods of non-destructive evaluation conducted in this lab include ultrasonics, using Piezo-electric devices to measure wave propagation through materials immersed in a water bath. Laser optics and thermographic equipment are used to track heat transfer rates through a material. Faculty Director: Dr. Vikram Kinra.

The department also works closely with the following centers:

Aerospace Vehicle Systems Institute. The AVSI addresses issues that impact the aerospace community through international cooperative research and collaboration conducted by industry, government and academia. AVSI creates an environment for aerospace industry members to collaborate on research and technology projects, influence standards and policies affecting the industry, and provide an aerospace industry voice to respond to technology market influences. For more information, see http://www.avsi.aero. Contact: Redman, David A.

Spacecraft Engineering Research Center. The Space Engineering Research Center (SERC) is the fusion of two research centers at Texas A&M University: The Center for Space Power (CSP) and the Spacecraft Technology Center (STC). The staff combines the skillset of engineers and researchers of both organizations. Over the years, SERC have worked on a variety of contracts with NASA, the DoD, Small and Large Space Companies. SERC also performs work with companies that are not in the Space field in projects that require innovative solutions. SERC also includes two student-based programs: The Space Engineering Institute (SEI) and The Systems Engineering Initiative (SYSEI). The Space Engineering Institute is an exclusive partnership with NASA that is focused on providing an opportunity for students to work in the space industry. The Systems Engineering Initiative is an extension of the Space Engineering Institute providing students with an opportunity to work with Non-NASA-based agencies. Throughout the school year, these programs
provide students with hands-on projects and practical training in various fields of engineering. For more information, see http://serc.tamu.edu/new/about.html. Contact: Hill, Charles H.

3.7.4 Computer Facilities

The Aerospace Engineering Department houses two clusters, and maintains an undergraduate and graduate computer laboratory. In addition, the faculty and students have access to the university Super Computing Center. An overview of the available resources is given below.

The graduate student laboratory (HRBB 627) is equipped with 21 Windows-based machines, 5 Apple machines and 10 Linux machines, all with printing capabilities. A large file server stores users roaming profile and work, which allow students to see their files from any machine in laboratory. Facility Supervisor: Mr. James Munnerlyn.

For high performance computing, the graduate students have access to the following four clusters (two within the department and two University-wide resources):

- **Wing.** Wing is an Apple Xserve-based 16-node cluster with 100 cores (2.66 GHz) with 2.25 GB of memory per core. The nodes are connected through a fast 10GB Myrinet interconnect. All students in our department have access to it. High-Performance Computing classes make use of this cluster. Faculty Supervisor: Dr. Diego Donzis.

- **Cube.** Cube is a 16-node, 32-processor Opteron (2.0 GHz) processor based cluster, which has 32 GB of main memory and 5 TB of disk storage. This computer is associated with the TAMU National Aerothermochemistry Laboratory, and is utilized primarily by the A&P group. Faculty Supervisor: Dr. Rodney Bowersox.

- **Eos.** Eos is an IBM iDataplex Cluster with 36 Tflops peak performance. It is the largest platform at the Supercomputing Center. It has 3168 cores at 2.8GHz and 9 TB of memory. A Voltaire Grid Director 4700 QDR IB switch provides the core-switching infrastructure.

- **Hydra.** Hydra is an IBM p5-575 Cluster with a peak performance of 6.3 TFlops with 832 cores (IBM's Power5+ processor) and 1.5 TB of main memory. Interconnect is based on 2-plane HPS (IBM's High Performance Switch).

3.8 Graduate Course Offerings

A summary of the all the graduate course offerings by the Aerospace Engineering Department is summarized in the Graduate Catalog; the Aerospace Engineering Section is repeated in the Appendix). The courses taught since the last review is summarized in Table 3.9. Syllabi for courses taught in the last five years are given in the Appendix. The Aerospace Engineering courses bear an AERO prefix. In addition, some of our materials and structures faculty members teach courses offered by the Mechanics and Materials (MEMA) and Materials Science and Engineering (MSEN) programs. Courses under these programs are taught jointly by the Mechanical, Civil and Aerospace Engineering Departments. The AERO, MEMA and MSEN courses, together, are considered the departmental course offerings for the department. Finally, each semester our faculty may offer special topics courses. These courses are designated 689. These courses often lead to new regularly scheduled courses with independent numbers. The 689 courses are also listed in Table 3.9. Cross-
listed courses are only listed once in Table 3.9. In addition, our faculty members continually create new courses to meet the changing needs of the aerospace field. A list of new courses that have been proposed and approved by the Department and College of Engineering are listed in Table 3.10. These courses will be taught in the near future (within the next two years).

Table 3.9 Aerospace Graduate Course Offerings (2003 – 2010)\textsuperscript{a,b}

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*Two X’s indicated taught twice during a year; Cross-listed course among AERO, MEMA and MSEN.*

Table 3.10 New Approved Courses to be offered within the Next Year
4. Assessment of the Doctoral Program in Aerospace Engineering

4.1 Role of the Aerospace Engineering Department in the University Mission

The Southern Association of Colleges and Schools Commission (SACS) and the Texas Higher Education Coordinating Board (THECB) assess the quality of Texas A&M University as a whole. The University Vision 2020 Strategic Plan was adopted in 1999 to meet the SACS and THECB guidelines and to provide a roadmap to enhance the value of Texas A&M to the Texas A&M University System, the State of Texas, and the nation. The Division of Research and Graduate Studies at Texas A&M University established the following Strategic Objectives to support the University Vision 2020 plan:

1. Advance High Impact Faculty Research, Scholarship, and Creative Work
2. Promote Outstanding Programs Attracting and Graduating the Very Best Students
3. Ensure World-Class Research Infrastructure and the Highest Quality Research Support and Services
4. Foster Comprehensive Excellence Across Texas A&M University
5. Elevate Interdisciplinary Programs that Open New Intellectual Arenas

The mission of the Aerospace Engineering Program is to:

1. To provide a quality undergraduate and graduate aerospace engineering education
2. To advance the engineering and science knowledge base through research
3. To assist industry in technical applications and innovations
4. To serve the aerospace profession through leadership in these areas

It is our belief that by meeting these objectives, the Aerospace Engineering Doctoral Program supports the University mission and Vision 2020 Objectives by providing a highly educated workforce, new knowledge, and future leadership for the Aerospace Engineering field, which plays an important role in the financial health of the state of Texas and the Nation.

4.2 Aerospace Engineering Doctoral Program Assessment Process

The external review is one of three steps utilized by the department, University and State to assess the Aerospace Engineering Doctoral Program. A brief overview of the steps is given below. Detailed assessment results are discussed in Chapter 2.

1. **Internal Assessment.** The department established a series of internal goals, outcomes and measures to help ensure continual improvement and that we achieve our overarching mission mentioned above. The department tracks the assessment results annually using the an online software package. 

2. **Texas Higher Education Coordinating Board (THECB) 18 Characteristics.** The Graduate Education Advisory Committee GEAC identified a set of 18 characteristics of doctoral programs. The THECB has subsequently adopted a policy requiring all public

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5 http://vision2020.tamu.edu/
6 Strategic Objectives FY11, April 30, 2010 (http://vpr.tamu.edu/)
7 http://www.weaveonline.com/
Texas universities to publish these 18 characteristics. *This assessment step compares our program to similar programs within the state of Texas.*

3. **External Doctoral Program Review.** An external review board is convened periodically (~8 years) to assess the Doctoral Program. In preparation, the department prepares a Self Study Report (this report). In the Self Study, we describe statistical measures over the last 5 years, resources, previous assessment results and changes since the last review. *This step provides an independent assessment of our program on a national level.*

4.3 Peer Group

The following are considered our peer universities as they embody a representative sample of major public university aerospace engineering programs (listed in alphabetical order). Caltech, Stanford and MIT (all private) are included for comparison purposes as they are routinely the top three ranked programs.

- California Institute of Technology (CIT)
- Georgia Institute of Technology (GT)
- Massachusetts Institute of Technology (MIT)
- Pennsylvania State University-University Park (PS)
- Purdue University-West Lafayette (PU)
- Stanford University (SU)
- University of Colorado-Boulder (UC)
- University of Illinois-Urbana-Champaign (UI)
- University of Texas-Austin (UT)
- University of Maryland-College Park (UMd)
- University of Michigan-Ann Arbor (UM)
- Virginia Polytechnic Institute & State University (VT)

4.4 Internal Assessment

Aerospace Engineering, like all other departments within the College of Engineering, utilizes the WEAVEOnline software package to formalize and track internal goals, outcomes and measures to help ensure continual improvement. The primary role of the internal review is to assess program outcomes. The following outcomes were defined to achieve the departmental mission (Section 4.1):

1. **The program and faculty will be excellent:** The faculty will represent the core areas of Aerospace Engineering (Fig. 2.4). They will have advanced knowledge to prepare students with the knowledge needed for the rapidly changing aerospace and related industries.

2. **Research will be of high quality:** The research will be of the high quality required for PhD dissertation studies.

3. **Applicants will be diverse and of high quality:** The PhD student applicants will be diverse and of high quality as measured by the diversity of the student body, previous degrees from other schools, GRE scores, GPR standards and national student awards.

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4. **Graduates of the program will be of high quality:** The graduates will be of high quality as evidenced by placement (academia, national laboratories, industry) and publications.

5. **Graduates will master the depth of knowledge required of a PhD:** Graduates will master the theories, concepts, principles and/or practices associated with their discipline enabling them to live and work productively in a global, diverse and rapidly changing field.

6. **Graduates will communicate complex information effectively:** Graduates will be able to effectively communicate complex information in both written and oral form.

The following metrics were defined to assess our success in achieving the above outcomes.

1. **Program Ranking:** The department goal is to achieve a #1 ranking among public universities.

2. **Research:** The departmental goals are that each faculty member establishes a well-funded research program of national prominence ($300K/yr), and produces, with their students, at least 3 archival journal publications/year, and maintains 2 MS and 3 PhD students/year.

3. **Graduate Student Enrollment:** The departmental goal is to maintain the PhD enrollment at 3 per faculty, while maintaining high GPR (>3.4) and GRE (>1250) standards.

4. **University Distinguished Professors:** The departmental goal is to maintain the number of Distinguished Professors at 10%. The University Distinguished Professor designation denotes a faculty member who is recognized as being in the top five percent of their field.

5. **NAE Members:** The departmental goal is to maintain a faculty body with an appropriate number of NAE members (~10%). The National Academy of Engineering (NAE) mission is to promote the technological welfare of the nation by marshaling the knowledge and insights of eminent members of the engineering profession.

6. **Nationally Funded Laboratories and Centers:** The departmental goal is to continually support relevant nationally funded laboratories and centers.

7. **GRE Scores:** The departmental goal for the GRE of incoming PhD students is greater than 1250. We consider the GRE an indicator of the quality of a graduate student’s preparation.

8. **GPR Standards:** The target GPR for graduating PhD students is greater than 3.5. The incoming GPR standard for PhD students is 3.4. We consider the GPR as an indicator of the quality of a graduate student’s preparation.

9. **Diverse Student Body:** The departmental goal is to continue to admit diverse and qualified students, with the target of 10% of under-represented groups and 20% women.

10. **National Student Awards:** The departmental goal is to continue promoting qualified students for national fellowship awards. Our target is for 20% of our graduate students to be supported on fellowship. The success rate is an indicator of the quality of our students.

11. **Student Placement:** The departmental goal is to place 100% of our PhD students. We also target 20% of our PhD students be placed in academia.

12. **Teaching Evaluations:** The department goal is that teaching be excellent as assessed by the graduate students. In terms of numerical evaluation scores, our target values are 4 out 5 overall. Hence, the department actively tracks student teaching evaluations for every course every semester to ensure that the teaching is meeting student evaluations.

13. **Curriculum Evaluations:** The department goal is to maintain a curriculum that is responsive to industrial and research needs.
14. **Teaching Facilities:** The department maintains classrooms with computer projection systems. In addition, the department maintains the Graduate Computing Laboratory (see Section 2.2) for education and research activities.

The mapping of metrics to outcomes is given in Table 4.1. Assessment results are discussed in Section 4.6.

### Table 4.1 Mapping of Metrics to Outcomes

<table>
<thead>
<tr>
<th>Metric → Outcome ↓</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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<th>7</th>
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<td>X</td>
<td>X</td>
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</tr>
</tbody>
</table>

### 4.5 Internal Assessment Results

A five-year summary of our metric data is Table 4.2. A brief description of each metric is described below in Sections 4.4 and 4.5.

### Table 4.2 Five-Year Summary of Metric Data

<table>
<thead>
<tr>
<th>Metric ↓</th>
<th>Year →</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rankings Among Public Schools</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td>8</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Research Active Faculty&lt;sup&gt;a&lt;/sup&gt;</td>
<td>28</td>
<td>29</td>
<td>28</td>
<td>29</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Total Funding&lt;sup&gt;b&lt;/sup&gt;</td>
<td>$8.3M</td>
<td>$8.2M</td>
<td>$8.6M</td>
<td>$10M</td>
<td>$11M</td>
<td></td>
</tr>
<tr>
<td>Average Funding/Faculty</td>
<td>$298K</td>
<td>$282K</td>
<td>$307K</td>
<td>$346K</td>
<td>$372K</td>
<td></td>
</tr>
<tr>
<td>Peer Reviewed Publications, /Faculty</td>
<td>73, 2.6</td>
<td>76, 2.6</td>
<td>113, 4.0</td>
<td>103, 3.6</td>
<td>109, 3.8</td>
<td></td>
</tr>
<tr>
<td>Grad. Students (total, per faculty)</td>
<td>110, 3.9</td>
<td>110, 3.8</td>
<td>119, 4.3</td>
<td>136, 4.7</td>
<td>139, 4.8</td>
<td></td>
</tr>
<tr>
<td>No. PhD Degrees Awarded</td>
<td>8</td>
<td>10</td>
<td>6</td>
<td>10</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>PhD Student Applications, New Enroll.</td>
<td>60, 12</td>
<td>46, 9</td>
<td>69, 12</td>
<td>68, 13</td>
<td>41, 24</td>
<td></td>
</tr>
<tr>
<td>PhD Student Enroll. (Total, %dom.)</td>
<td>41, 20%</td>
<td>47, 32%</td>
<td>52, 44%</td>
<td>55, 56%</td>
<td>63, 54%</td>
<td></td>
</tr>
<tr>
<td>Distinguished Professors</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>NAE Members</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Centers and Laboratories</td>
<td>19</td>
<td>19</td>
<td>19</td>
<td>20</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>AE GRE Scores (Total, Quantitative)</td>
<td>1331, 788</td>
<td>1304, 763</td>
<td>1257, 758</td>
<td>1338, 773</td>
<td>1329, 775</td>
<td></td>
</tr>
<tr>
<td>College GRE Scores (High, Average)</td>
<td>1331, 1248</td>
<td>1317, 1258</td>
<td>1296, 1247</td>
<td>1338, 1242</td>
<td>1329, 1277</td>
<td></td>
</tr>
<tr>
<td>GPR (Incoming)</td>
<td>3.68</td>
<td>3.33</td>
<td>3.72</td>
<td>3.73</td>
<td>3.68</td>
<td></td>
</tr>
<tr>
<td>PhD Stud. Diversity (%Wom., % URG)</td>
<td>10%, 2%</td>
<td>15%, 6%</td>
<td>17%, 8%</td>
<td>20%, 9%</td>
<td>10%, 6%</td>
<td></td>
</tr>
</tbody>
</table>
National and Local Fellowship Awards  

<table>
<thead>
<tr>
<th>Year</th>
<th>7</th>
<th>7</th>
<th>10</th>
<th>15</th>
<th>17</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhD Placement (Ac, Gov, Pr, PD)</td>
<td>2,0,4,1</td>
<td>2,1,3,1</td>
<td>0,0,3,2</td>
<td>1,1,4,4</td>
<td>2,0,3,5</td>
</tr>
<tr>
<td>AFQE Pass Rate</td>
<td>86%</td>
<td>94%</td>
<td>95%</td>
<td>80%</td>
<td>89%</td>
</tr>
<tr>
<td>Teaching Evaluations (aver, std, %)</td>
<td>*****</td>
<td>4.4, 0.7, 66</td>
<td>4.5, 0.7, 62</td>
<td>3.9, 0.8, 38</td>
<td>3.9, 0.9, 49</td>
</tr>
</tbody>
</table>

^a^Tenure/Tenure Track Faculty Only; ^b^Includes only external funding via tenure/tenure track faculty; Fig. 2.1 includes all external funding, which adds in research faculty and the low-speed wind tunnel commercial operations. The tabulated data is more indicative of the resources associated with the PhD program. ^c^Ac – Academia, Gov – Government Lab, Pr – Private Industry, PD – Post-doc. ^d^Fall semester, average, standard deviation and percentage of students responding.

4.5.1 Metric 1 – Program Ranking

The US News and World Report Rankings for the last five years are summarized in the first row of Table 4.2. As indicated, the department is nominally ranked in the range of 5 – 8 in the nation among public universities. Similarly, in 2009, the National Research Council (NRC) released a survey (R- and S-Ranking) of engineering programs based on 2006-07 data. ^9^ A subset of the metrics is summarized in Table 4.3, along with the scores for the peer group listed in Section 4.3.

<table>
<thead>
<tr>
<th>Metric</th>
<th>TAMU</th>
<th>CIT</th>
<th>GT</th>
<th>MIT</th>
<th>PS</th>
<th>PU</th>
<th>SU</th>
<th>UC</th>
<th>UI</th>
<th>UT</th>
<th>UMd</th>
<th>UM</th>
<th>VT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aver. Qual. Rank (^a^ S,R)</td>
<td>7,20</td>
<td>1,1</td>
<td>10,15</td>
<td>12,3</td>
<td>12,20</td>
<td>12,8</td>
<td>2,2</td>
<td>6,3</td>
<td>13,13</td>
<td>21,7</td>
<td>7,18</td>
<td>3,5</td>
<td>15,10</td>
</tr>
<tr>
<td>Quantitative GRE</td>
<td>788</td>
<td>776</td>
<td>777</td>
<td>782</td>
<td>767</td>
<td>739</td>
<td>790</td>
<td>768</td>
<td>793</td>
<td>734</td>
<td>784</td>
<td>784</td>
<td>761</td>
</tr>
<tr>
<td>Time to Degree (yrs)</td>
<td>5.0</td>
<td>5.0</td>
<td>5.7</td>
<td>5.9</td>
<td>3.7</td>
<td>6.0</td>
<td>5.3</td>
<td>4.0</td>
<td>5.5</td>
<td>5.0</td>
<td>5.0</td>
<td>5.5</td>
<td>4.0</td>
</tr>
<tr>
<td>Publications/faculty</td>
<td>1.6^b^</td>
<td>3.7</td>
<td>1.2</td>
<td>0.8</td>
<td>1.5</td>
<td>1.6</td>
<td>1.5</td>
<td>0.9</td>
<td>1.5</td>
<td>0.8</td>
<td>1.8</td>
<td>2.6</td>
<td>1.0</td>
</tr>
<tr>
<td>% Faculty with Grants</td>
<td>75</td>
<td>95</td>
<td>90</td>
<td>77</td>
<td>86</td>
<td>70</td>
<td>94</td>
<td>100</td>
<td>70</td>
<td>82</td>
<td>89</td>
<td>89</td>
<td>86</td>
</tr>
<tr>
<td>Fae Div (%Wm, URG)</td>
<td>10,4</td>
<td>8,0</td>
<td>6,8</td>
<td>13,10</td>
<td>6,0</td>
<td>10,4</td>
<td>5,0</td>
<td>12,6</td>
<td>12,0</td>
<td>7,10</td>
<td>8,12</td>
<td>10,14</td>
<td>11,0</td>
</tr>
<tr>
<td>Stud Div (%Wm, URG^c^)</td>
<td>13,12</td>
<td>19,4</td>
<td>14,8</td>
<td>21,9</td>
<td>15,6</td>
<td>14,4</td>
<td>16,6</td>
<td>21,4</td>
<td>10,10</td>
<td>18,1</td>
<td>17,6</td>
<td>9,13</td>
<td>11,4</td>
</tr>
</tbody>
</table>

^a^Mean value; ^b^NRC has incorrect number of faculty members (they have 63 listed, should be 29 2.8 pub/fac); ^c^Limited to Black and Hispanic.

Examination of the data in Table 4.3 indicates that the quantitative differences between the peer universities are marginal. Therefore, we have concluded that rankings differences are highly correlated with program reputation. Upon further examination, it was noted that departments that project research thrusts/aerospace applications tended to outperform departments that emphasized core disciplines in the R-rankings. For example, for the TAMU Aerospace Department, the S-ranking, which is based on quantitative data, was nominally 7, where the R-ranking, which is based on impression, was nominally 20. Hence, an Aerospace Vision Committee was formed to analyze the departmental reputation and build a plan to enhance visibility and increase (and help stabilize) research productivity. The committee consisted of Dr. Bowersox (Chair), Distinguished Professors Junkins and Saric, and a junior professor for each of the three core groups (Drs. Benzerga, Chakravorty and Karpetis). This activity led to reformulating the administration of the department and the establishment of five highly visible cross-discipline research thrusts: Aerospace Propulsion and Energy Systems (APES), Autonomous Aerospace Vehicle Systems (AAVS), Controlled

^9^http://graduate-school.phds.org/rankings/aerospace-engineering
Intelligent Materials and Structures (CIMS), Hypersonic Vehicle Systems (HyVS), and Space Exploration and Sensing Systems (SESS). Although we are not claiming a cause and effect, we believe that the new departmental organization, described in Section 2.3, will enhance the visibility of our research programs and facilitate increased interdisciplinary research efforts leading to new opportunities for competing for large Center/MURI level research awards. The vision committee final report is included in the Appendix.

4.5.2 Metric 2 – Research

A yearly snapshot of the departmental research metrics (funding, publications, graduate students and PhD degrees awarded) is listed in the second row of Table 4.2. As indicated, the faculty research metrics are all very respectable and on the rise. Our 5-year average exceeds our target metrics. It is our belief that the increase is the direct result of the new faculty recruited during the Faculty Reinvestment program. Specifically, we used the faculty reinvestment positions to fill the deficiencies noted in the 2003 review. However, our selection process was heavily weighted toward selecting a well-rounded blend of new and seasoned faculty with strong research interests. The net result is evident in the increased research metrics.

4.5.3 Metric 3 – PhD Student Enrollment

The total number of graduate students (as listed in Table 4.2) has shown continual growth. The departmental target is that each faculty member continually supports 5 graduate students. In 2010, we were close to achieving that mark at 4.8. Also, the number of PhD students is also increasing (see Fig. 1.1), where the faculty members are currently supporting 2.2 PhD students per year. Our goal for the future is to increase the number of PhD students per faculty to 3.0, while maintaining the quality and balance with the MS program (goal of 2.0 per faculty as well). The number of PhD students per faculty is important, as it is a metric used in the rankings of graduate colleges.

The success rate of our students on the AFQE is nominally 89%, which is testament to the selection criteria. As is indicated in the THECB report (Table 3.7), 94% of our PhD candidates (those that pass the AFQE) complete the program.

For a more comprehensive view of the total graduate enrollment, see Section 3.6. The trends noted for the PhD program hold for the graduate program as a whole.

4.5.4 Metrics 4 & 5 – Distinguished Professors and NAE Members

The department currently has two Distinguished Professors (DP), Drs. J. Junkins and W. Saric, and three NAE members, Drs. T. Alfriend, J. Junkins and W. Saric. Professor Saric was hired during the faculty re-investment, which doubled the DPs and resulted in a 50% increase in NAE members. We are also working to create a productive environment that will allow others in the department to achieve this level of success. The measures include (1) the new organization of the department described in Section 2.2, (2) re-investment of research IDC (16% goes to the PIs), and (3) awarding of internal professorships to add to the success of high achieving faculty.
4.5.5 Metric 6 – Nationally Funded Centers and Laboratories

Over the last five years, the faculty members, through external research grants, have established a suite of new and advanced research laboratories. These new centers and labs include the AggieSat Program, the Consortium for Autonomous Space Systems, the Flight Research Lab, National Center for Hypersonic Laminar - Turbulence Transition, International Institute of Multifunctional Materials for Energy Conversion, the LASR Lab, the High-Speed Combustion Laser Lab, the National Aerothermochemistry Lab, the SMART Vehicles Concepts Center. We believe these facilities provide unique opportunities for our students to study a broad range of relevant technical problems. For a description of all of the departmental centers and laboratories, see Section 3.7.

As described in Section 4.5.1, the department defined 5 research thrust areas to help strengthen the research program. Our goal is achieve center level funding for all thrust areas. Currently, we have achieved this for 3 out of the 5: Controlled Intelligent Materials and Structures (CIMS), Hypersonic Vehicle Systems (HyVS), and Space Exploration and Sensing Systems (SESS).

4.5.6 Metrics 7 & 8 – GRE and GPR

The Aerospace engineering GRE scores have remained remarkably flat at just over 1300 (see row 14 in Table 4.2), and the quantitative scores are similar to those of our peers as listed in Table 4.3. When compared to the College of Engineering, the Aerospace scores led the College three out of the last five years. Moreover, the incoming GPA is nominally 3.7, which we feel is a respectable value. Unfortunately, this statistic is not provided across the departments, and hence comparisons cannot be made.

4.5.7 Metric 9 – Percent Women and Underrepresented Groups

The percentage of women and underrepresented groups within the PhD program are summarized in row 9 of Table 4.2. Our target is a combined 25%. As indicated, our results are rather modest. However, they are on par with our peers (Table 4.3). The department will continually work to offer PhD student opportunities to all groups.

4.5.8 Metric 10 – National Fellowships

The number of national fellowships per year is summarized in Table 4.2. The national awards include NSF, DoD SMART, NASA GSRP, NDSEG, Sandia, and NSF IGERT. The local awards include the TAMU Merit, COE National Excellence, TAMU Pathways to the Doctorate, the TAMU Diversity and the Aero Bradley fellowship. We consider the increased success by our students for these awards as additional evidence that student quality is excellent.

4.5.9 Metric 11 – Student Placement

Over the last 5 years, 39 out of 44 (or 89%) PhD graduates were placed immediately upon graduation. 16% of our PhD graduates, on average over the last 5 years, were placed directly into an academic position. A tabulation of PhD and MS graduates is given in the Appendix.
4.5.10 Metric 12 – Teaching Evaluations

Teaching evaluation results (departmental averages) are listed in the last row of Table 4.2. As indicated, the four-year average for the department is 4.2, which exceeds our expectation. However, the trend appears to be negative. The root cause for this may be the related to the reduced numbers of student participants in the faculty review, as the students now perform these online at their leisure. Individual faculty evaluations are discussed annually with the Department during the faculty annual review. Hence, corrective measures, if necessary, are based on these reviews.

4.5.11 Metrics 13 – Curriculum

The curriculum is determined by the faculty discipline groups (see Section 2.2) based on research requirements and student population. Twice a year, the graduate curriculum, is presented to the advisory board (described in Section 2.2) with the goal of obtaining feedback on relevance and completeness. Changes to the curriculum are based on these inputs as well as external program reviews such as the 2003 review described in the Appendix.

4.5.12 Metrics 14 – Teaching Facilities

In addition to the research laboratories described in Section 4.5.5, the department also maintains modern classrooms and computer facilities for the graduate program. Departmental curriculum and computer laboratory committees are in-place to ensure that the facilities are modern and appropriately utilized. Upgrades to the teaching infrastructure are based on faculty and advisory board recommendations (see the Appendix).

4.6 Internal Outcome Assessment Conclusions

4.6.1 Outcome 1 – The Program and Faculty will be Excellent

The research oriented metric results (metrics 14-6) have shown that overall the Doctoral Program is doing very well, where, over the last 5 years, steady increases on most of the metrics have been achieved, and most exceed our expectations. In addition, the department is working to increase the visibility of the research program, which we believe will have a positive impact on the reputation and rank of the department. The student quality and placement metrics (metrics 7-11) are all positive indicators that the program is also performing well on this front. The incoming student credentials are on par with the top 10 programs in country, and hence the number of external fellowships is also increasing. The PhD student placement numbers are encouraging, where we are seeing higher fractions moving into academia. Diversity is a challenge that the department continually addresses on an individual grass-roots level. The teaching oriented metrics (metrics 12-14) are all positive. In particular, the nearly two-fold increase in the number of courses from 2003 to 2011 is in direct response to the 2003 external review recommendations.

The program is performing very well, although we have not yet achieved the goal of #1 public program; however, this goal has forced the department to analyze the measures used by the ranking institutions, and provides guidance as we strive to make necessary adjustments.
4.6.2 Outcome 2 - Research will be of High Quality

Overall, 93-97% of the faculty have established well-funded research programs, with high funding, student advising and publication rates. The number of PhD student graduations is on the order of 10 per year. We expect this number to increase as the enrollment is increasing, and the average time to degree in 2008 - 2010 was 4.3 years. Over the last five years, the department has maintained high funding levels and established a suite of new advanced laboratories and research centers. These accomplishments provide unique opportunities for attracting talented students.

4.6.3 Outcome 3 - Applicants will be Diverse and of High Quality

The quality of the PhD students admitted into the Aerospace Engineering program is considered very high. The incoming average GPA is 3.7, and the average GRE > 1300, which routinely leads the college, and the quantitative scores are on par with the peer public universities and private universities. The average time to graduation is 4.3 years (reported in the THECB 18-Characteristics in Table 4.4), ~90% pass the AFQE and 94% of PhD candidates complete the program. Lastly, the PhD students are highly competitive for national and local fellowships, where over the last 5 years the number of fellowships has significantly risen (from 7 to 17). In terms of diversity, the department has an open application process, and our student body diversity is tracking national averages.

4.6.4 Outcome 4 – Graduates of the Program will be of High Quality

PhD graduate placement is taken as an indicator of quality, where over the last five years, 18% were placed in academia, 44% in private industry (44%), 5% in government labs and 33% in post-doctoral research positions. The number of publications per faculty rose from 2.6 to 3.8. Most of these publications are with students, and hence the increase is taken as evidence of improved output quality. These metrics are clear indicators that the graduates have produced important research results, and that our graduates are highly sought.

4.6.5 Outcome 5 – Graduates will Master the Depth of Knowledge Required of a PhD

Graduates of the program first have to be admitted through a highly selective process, pass the required examinations, perform supervised research and successfully defend their dissertation. The process and standards of the faculty help ensure that our PhD graduates achieve the necessary understanding and ability for critical thinking to enable a successful career. Hence, successful completion of the dissertation research process is taken as evidence that the students have the knowledge required of a PhD. In addition, PhD student placement is taken as evidence that the students have acquired marketable skill sets required of PhD students.

4.6.6 Outcome 6 – Graduates will Communicate Information Effectively

Graduates of the program must write and orally defend their dissertation. The students receive communication training in Aero 681. Successful defense of the PhD dissertation is taken as evidence that the students can communicate effectively. In addition, PhD student placement is taken as evidence that the students have successfully communicated their results and abilities to employers.
4.7 THECB 18 Characteristics Assessment Results

The Texas Higher Education Coordinating Board (THECB) has adopted a policy requiring all public Texas universities to publish certain statistics describing their doctoral programs. We consider the Aerospace Engineering Department at University of Texas (UT) as our peer program in the state of Texas. Hence, the THECB for the TAMU and UT Aerospace Engineering Departments are summarized in Table 4.4. The TAMU data are in the yellow entries, and the UT entries are in the orange. The data comparisons indicate that the two programs are performing similarly. The notable differences are that UT has double the research funding, and TAMU produces nearly twice the publications. The other major difference is the teaching load. However, there is likely a difference in interpretation as these are relatively new requirements, and/or there is a typographical error.

Table 4.4 THECB 18-Characteristics of Texas Public Doctoral Programs

<table>
<thead>
<tr>
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<th>Characteristics of Texas Public Doctoral Programs</th>
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<tbody>
<tr>
<td>1</td>
<td>Number of Degrees Per Year</td>
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<tr>
<td></td>
<td>Average, 2007-2009</td>
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<td></td>
<td>Three-year average of the number of degrees awarded per academic year</td>
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<td>2007-2008</td>
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<td>3 Year Average</td>
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<td>2</td>
<td>Graduation Rates</td>
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<td></td>
<td>Starting Cohorts: 1998-2000</td>
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<td>Three-year average of the percent of first-year doctoral students who graduated within ten years. First-year doctoral students: those students who have been coded as doctoral students by the institution and have either completed a master's program or at least 30 SCH towards a graduate degree.</td>
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<tr>
<td></td>
<td>% Graduating within 10 Years</td>
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<td>Years with Cohort greater than 0</td>
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<td>3</td>
<td>Average Time to Degree</td>
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<td>Students Starting 1998-2000</td>
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<td>Three-year average of the registered time to degree (all first-year doctoral students within ten years) (2) Registered time to degree: The number of semesters enrolled starting when a student first appears as a doctoral student until he/she completes a degree, excluding any time taken off during graduate study. The number of years is obtained by dividing the number of semesters by three.</td>
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<tr>
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<td>Average Years to Degree</td>
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<td>4.28</td>
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<td>4</td>
<td>Employment Profile</td>
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<td>(in field within one year of graduation) For each of the three most recent years, the number and percent of graduates by year employed, those still seeking employment, and unknown</td>
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<td>Employed</td>
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<td>2007-2008</td>
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<td>2008-2009</td>
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<td>2009-2010</td>
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<td>5</td>
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<tr>
<td></td>
<td>GPA greater than or equal to 3.2/4.0; GRE (verbal+quantitative) greater than or equal to 1250</td>
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<td>Consistent with minimum university criteria</td>
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<td></td>
<td><a href="http://registrar.utexas.edu/catalogs/grad09-11/ch04/eng/grad09.ase.ch.html">http://registrar.utexas.edu/catalogs/grad09-11/ch04/eng/grad09.ase.ch.html</a></td>
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<tr>
<td>6</td>
<td>Percentage Full-time Students</td>
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<td>FTS/number of students enrolled for the last three fall semesters.</td>
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<td>Fall 2008</td>
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<td>Fall 2009</td>
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<td>Fall 2010</td>
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<tr>
<td></td>
<td>3 yr average</td>
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Table 4.5 THECB 18-Characteristics (Continued)

| 7 | Average Institutional Financial Support Provided | $18,800.00 | $21,065.00 |  
|   | For those receiving financial support, the average monetary institutional financial support provided per full-time graduate student for the prior year, from assistantships, scholarships, stipends, grants, and fellowships. Does not include tuition or benefits.  
| 8 | Percentage Full-Time Students with Institutional Financial Support: | 94.00% | 94.00% |  
|   | In the prior year, the number of full-time students with at least $1,000 of annual support/the number of full-time students.  
| 9 | Number of Core Faculty | 32 | 33 |  
| 10 | Student Core Faculty Ratio | Fall 2008: 2.2 | Not Available |  
|   | Three-year average of full-time student equivalent (FTSE), three-year average of full-time faculty equivalent (FTFE) of core faculty. Core faculty: Full-time tenured and tenure-track faculty who teach 50 percent or more of the course load and whose work is integrally related to the doctoral program.  
|   | Core faculty: All faculty involved in teaching, advising, and the administration of the doctoral program.  
|   | This step is included to ensure that doctoral programs can be assessed annually.  
| 11 | Core Faculty Publications | 177 | 15 |  
| 12 | Core Faculty External Grants | Three-year average of the number of faculty receiving external funds, average external funds per faculty, and total external funds per program per academic year. All external funds received from any source including research grants, training grants, gifts from foundations, etc., reported at expenditures.  
| 13 | Faculty Teaching Load | 23.7 | 166.88 |  
| 14 | Faculty Diversity | Core faculty by ethnicity (White, Black, Hispanic, Other) and gender, updated when changed |  
|   | Male | Female | Male | Female |  
|   | White | 22 | 2 | 22 | 1 |  
|   | Black | 0 | 0 | 0 | 0 |  
|   | Hispanic | 2 | 0 | 0 | 1 |  
|   | Other | 6 | 0 | 6 | 0 |  
| 15 | Student Diversity | Enrollments headcount by ethnicity (White, Black, Hispanic, Other) and gender in program in the prior year |  
|   | Male | Female | Male | Female |  
|   | White | 20 | 5 | 20 | 0 |  
|   | Black | 0 | 0 | 0 | 0 |  
|   | Hispanic | 7 | 3 | 7 | 1 |  
|   | Other | 22 | 3 | 22 | 3 |  
| 16 | Date of Last External Review | 2002-2003 | SACS 2005 |  
| 17 | External Program Accreditation |  
|   | Name of body and date of last program accreditation review, if applicable, updated when changed |  
|   | Not Applicable |  
| 18 | Student Publications/Presentations | 228 | 140 |  
|   | For the three most recent years, the number of discipline-related refereed papers/publications, invited creative/performance accomplishments, book chapters, books, and external presentations per year by students/FIs.  


4.8 Summary of the Impact of the Assessment Process

In summary, the department employs three tools to assess the performance of the PhD program. The first is the internal assessment, which is focused on establishing and tracking annually a series of quantitative metrics and desired program outcomes. This step is in place to ensure that
the department has a high quality program and is producing high quality PhD graduates. Second, the department reports, and compares to UT Austin, the THECB 18-Characteristics. This step ensures that the department is meeting state requirements. Lastly, the external review of the doctoral program provides an independent assessment and comparison to national programs.

The Office of Graduate Studies, in the Guidelines for Academic Program Review document asks that reviews comment on the effectiveness of the Aerospace Engineering Departments usage of the assessment process. There are two very clear pieces of evidence to demonstrate that the department is making effective use of the assessment results. The first is the clear improvement across all of the metrics shown in Table 4.4. The second is the profound impact of the 2003 Program Review on the current state of department, where a large fraction of the changes and growth of the program was the direct result of addressing the weaknesses identified in the review. Lastly, we have provided a brief synopsis of our view on the specific OGS questions below:

1. **What evidence exists to show that the Aerospace Engineering Department is measuring student learning outcomes, research strengths and service to the university?**

The three assessment tools explained in Section 4.2 are used to assess the PhD program. The internal assessment is used to define, organize, and track educational and research metrics and outcomes. The Aerospace Engineering Graduate Program Office examines these data annually, and reports the results to the Aerospace faculty via department meeting and annual retreats. Table 4.2 is an example of the data collected. In addition, the THECB 18-Characteristics reporting requirement (Table 4.4) necessitates data collection and evaluation with our state peers. The external review provides an independent assessment of the PhD program productivity as compared to national peers.

2. **What evidence exists to show that the Aerospace Engineering Department is using assessment results to improve the curriculum and instruction, strengthen research and service, promote diversity and globalization, and to evaluate the effectiveness of graduate (PhD) training?**

*Improvements to the Curriculum and Instruction:* Both the internal and external assessment results have been used to strengthen the curriculum, where, for example, in response to the 2003 External Review, the department has nearly doubled the number of graduate courses most of which are highly specialized to prepare our student in modern research challenges. Student evaluation results are administered for every course and subsequently used by the department head to assess instruction.

*Strengthen Research.* By broadening our faculty, as suggested in the 2003 external review, the departmental research productivity has significantly increased (both funding levels and publications) (see Fig. 2.7). Also, we actively track PhD student placement as an indicator of the quality of the PhD training. In addition, the College returns 54% of the research IDC to the department.
Service. The department head also works to include all faculty members in service activities as exemplified by the Aerospace Vision Committee described in Section 4.5.1. In addition, the graduate students are exposed to service through the Aerospace Graduate Student Council, which is an advisory group made up of elected officials from the graduate student body. The College of Engineering tracks national and international technical committee service.

Promote Diversity and Globalization. The department continually assesses student diversity and actively works to engage potential students to improve diversity. For the most part recruiting for diversity is addressed by individual faculty and through the Graduate Programs Offices. Globalization is not currently an outcome or metric tracked by the department for the PhD program. However, many of our faculty and the research results are of international prominence. Also, the department provides funds for international visiting scholars (students, faculty and visiting scientists). Hence, globalization occurs naturally through our research activities.

Evaluation of Effectiveness of PhD Training. The effectiveness of PhD training is directly assessed via Outcome 4 and Metrics 7 – 11 as described in the previous two sections. The data indicated that the PhD graduation rates are increasing and more students are entering into academia, which is taken as evidence that our peer institutions value our students.

3. What evidence exists to show that the Aerospace Engineering Department is using assessment of teaching, research and service to improve each activity and to make decisions about the use of technology, facilities and hiring?

The first part of this question concerning the use of assessment to enhance teaching, research and service was addressed above for question #2. In terms of decisions on the use of technology, facilities and hiring, the curriculum enhancement through faculty hires (metric 13) was the direct result of the 2003 external review. We feel that the external review results provided the necessary guidance to enable the department to optimize the impact of the Reinvestment Program to fill gaps in the curriculum and research identified in the 2003 review. Also, the investment of department and College funds in laboratory development is based on the assessment of the research thrust areas and faculty performance; this point is described in more detail above.

4. What evidence exists to show that the Aerospace Engineering Department is using objective assessment processes to decide how to allocate fiscal, physical and human resources?

In 2004, the Aerospace Engineering department was designated a signature program by the College of Engineering, and the utilization of the corresponding resources was closely aligned with the recommendations from 2003 External Review Panel assessment. Second,
the department utilized assessment results associated with the first metric described in Section 4.6.1 to alter the administrative procedures. Specifically, the department identified five cross-discipline research thrusts. The thrust leaders then form a research advisory committee for the Department Head, and research-related resource allocations are determined with input from this advisory committee. For details concerning the new organization of the department, see Section 2.3.1. Lastly, the department established, in 2011, an Aerospace Engineering Resource Allocation Committee, which consists of the departmental Executive Committee.

4.9 Future Goals for the Doctoral Program

The future goals of the Doctoral Program are closely tied with overall goals of the department. As described above, the department has undergone significant faculty growth over the last 8-years, and this growth is continuing to have a growing positive impact on the research metrics described above. We believe that the major growth period has ended. Hence, our new goals are focused on exploitation of the recent growth to enhance the degree programs. The two areas that have received the most recent attention are summarized below.

**Departmental Administration.** The Aerospace Engineering Department defined a strategy (see Section 2.2 and the Appendix) to help achieve and maintain the departmental goal of being among the best-ranked Aerospace Engineering Department within the United States. A new matrix organization was established, which would maintain the three departmental disciplines (Aerodynamics and Propulsion, Dynamics and Control and Materials and Structures) as the core foundation (Section 2.3), with the addition of five cross-disciplinary research thrust areas to increase national visibility and provide broad foundations to compete for center level research support. As mentioned above, three of the five thrust areas have achieved center-level funding, i.e., Controlled Intelligent Materials and Structures, Hypersonic Vehicle Systems, and Space Exploration and Sensing Systems. Hence, an immediate goal for the faculty, which directly impacts the doctoral program, is to elevate the Autonomous Aerospace Vehicle Systems and Aerospace Propulsion and Energy Systems research thrust areas. It is our belief that extension of our efforts to five active center level research thrusts will provide both stability and the necessary resources to advance the graduate program such that we can increase the research metrics. The Research Advisory Committee and the Department Head will critically assess the viability of the thrust areas annually. These assessments will provide guidance on new/replacement hires, new laboratories, etc.

**Student Body.** Our overarching goal is to provide unique educational opportunities to well qualified graduate students. We feel that the student body should be more heavily weighted towards PhD students to help with the increased research and teaching requirements. We propose a target of 2/3 PhD students and 1/3 MS students, with a corresponding increase in enrollment from 140 to nominally 180 students, which translates into increasing our student advising goals to 4 PhD and 2 MS students per faculty. This PhD/MS ratio is consistent with the current trends within the Office of Graduate Studies, where College tuition support for teaching assistants is restricted to PhD students. With the proposed PhD/MS student demographics, the research and teaching duties will rest primarily on the PhD students, while the MS program will provide opportunities for more
applied research and continuing education for industry. The department, with the College of Engineering, is exploring distance education MS programs to help achieve the MS program goals.

We will continue to strive to increase domestic enrollment to 60%. We feel this is goal is in line with current hiring trends within aerospace engineering. We also believe that international students add intellectual diversity to the program, which enriches the program for all involved.

In terms of financial support, the departmental goal is that 50% of the graduate student body be Graduate Research Assistants, and the remainder funded through a combination of Graduate Teaching Assistants, major fellowships and industry support. We are also continually survey graduate stipend rates, and the College range allows for competitive offers.

Although consistent with national trends, the PhD student diversity among women and underrepresented groups remains a challenge, and hence the department will continue to actively recruit on both fronts, as resources are available. Our goal is to increase the student body to 20% women and 10% underrepresented groups. An action plan to directly address this perceived shortcoming is required. This is also true for the faculty diversity.

In terms of student placement, we are developing new plans to increase our students’ competitiveness for academic positions. This includes creating additional opportunities for teaching experiences including teaching fellows, assistant lecturers and a mentoring course for PhD students. We hope that by providing opportunities such as this, our students will have strengthened resumes and will be inspired to pursue teaching as a career.
Appendices

A. 2003 Program Review

A.1 Program Review Committee Findings

REVIEW OF GRADUATE PROGRAMS
in
AEROSPACE ENGINEERING
at
TEXAS A&M UNIVERSITY
March 2003

EXECUTIVE SUMMARY

A three-member, outside Review Team visited Texas A&M University on March 16-19, 2003 to conduct a review of the graduate programs in Aerospace Engineering at the request of the Office of Graduate Studies following the published guidelines for such an activity. This document presents the results of that review in the format described in the guidelines based both on the visit and the very detailed Self-Study document provided beforehand.

The guidelines ask that five specific questions be addressed, and we will answer them here. Yes, the program is advancing the state of the profession. Yes, the education of the students is effective. Yes, the program responds to the needs of the profession. Next, the program is viewed highly by experts in the field, as evidenced by the high national ranking. We feel less able to answer whether the program meets the goals of Texas A&M University, but we judge the strategic plan for the department to be sound.

The first two sections of our report address the current status of the department and the relationship to others in the college. Both are judged to be in good order.

The next section discusses strengths, which can be summarized as: high research funding, high output of publications and graduate degrees, very prominent Dynamics & Control group, strong leadership, good laboratories, strong cross-disciplinary interactions, TiiMS program, opportunities with STC, good relations with graduate students and quality graduate student work spaces.

The Review Team also identified some areas of weakness as: recent decrease in critical mass in the leadership of the D&C group, PhD programs of study are narrow with insufficient math and science, limited advanced course offerings, structure of the qualifying exam, thin coverage of aerospace propulsion and air vehicles, lack of a thrust area in autonomous vehicles, too few GA slots, lack of tuition waivers, high percentage of international students and insufficient diversity.

Based on our findings, a number of specific recommendations are proposed: expand the breadth and math/science content of PhD program of study, expand advanced and special topics course offerings, establish cooperative teaching efforts in the fluids area with ME and CE, re-examine the Qualifying Examination, address the weakness in coverage of aerospace propulsion and air vehicles including autonomous vehicles, develop plan of action to increase the percentage of US graduate students, develop a plan of action to improve diversity, fill the Slattery and Weisenbaker Chairs with aerospace faculty in the Structures and D&C areas, add an experienced CFD/Propulsion person to the Fluids group, add a faculty member in design/systems integration, add a young faculty member to the D&C group, press for increase in graduate assistant positions (GANT and GAR) and tuition waivers, insure effective and balanced representation on all decision-making committees and produce a comprehensive document covering all policies and procedures for graduate programs.
STATUS OF DEPARTMENT

Since the first course in aerodynamics was introduced in the College of Engineering at Texas A&M in 1929 to the founding of the Department in 1940, to the present, the department has always taken pride in the education of future contributors to aerospace technology at both the undergraduate and graduate level. This has led to the current status of the department as a highly recognized and regarded program, both nationally and internationally.

The Department currently has 21 tenure/tenure track faculty who reside in three disciplinary groups. These groups are the aerofluids, dynamics and control, and the solids and structures groups, respectively. In terms of size, the solids and structures group is the largest, followed by dynamics and control and by aerofluids. Historically, the solids and structures group has been the cornerstone group on which the department has built its programs. The dynamics and control group, while smaller, has been very successful in building a national/international reputation based upon recruiting key leading/senior individuals in this area. This has had a significant impact on the department’s external recognition as a leader in this key technology area. This area should also play an important role in new areas as aerospace technology at the air platform level transitions from conventional platforms toward uninhabited autonomous micro air vehicles. It should be noted, however, that the group has recently sustained the loss of two senior faculty members (Ward and Alfriend), which impacts research productivity and growth. The aerofluids group is represented by a small but solid core of dynamic young faculty members. They all have arrived at A&M within a similar time frame and are refreshingly energetic, and bright, and they should mature as leaders with time.

A number of interesting cooperative ventures initiated within the department appear to be important in implementing the long-term growth of department as well as providing synergism between the respective three groups. These include:

a. The Commercial Space Center for Engineering, recently renamed the Space Technology Center, as a national quality facility for fostering growth in the space thrust area.

b. It should also be noted that a thrust area addressed in the Department Strategic Plan, notably the recently approved Aerospace Design Safety/Security and Integration Center, (ADSSI) represents a significant potential growth area.

c. Another initiative, the Aerospace Vehicle Systems Institute (AVSI) represents an important example of potential cooperation between the department and industry.

d. The TiiMS is a new synergistic institute involving all groups of the faculty, and promising rapid and large growth.

The combined undergraduate/graduate student body exceeds 500 and is healthy both in numbers, enthusiasm and ability. Since our review has been focused principally on the graduate program, comments are focused on the Masters and Doctoral degree programs. The department currently offers the degree of Master of Science with both a thesis and a non-thesis option, as well as the degree of Master of Engineering. The latter program appears to be seldom exercised. The Master of Science degree program offers students options for pursuing course work for transition to industry/government job opportunities as well as those focused on research in the private/government sector. It was not clear from the information provided what portion of the Masters degree students elected for the thesis versus the non-thesis option, however judging by the number of Masters theses, the thesis option appeared more vibrant. The Doctoral program consists of Doctor of Philosophy and Doctor of Engineering degrees. The latter program again is seldom elected by students with emphasis placed on the PhD degree. This program represents a solid program in total number of hours and research requirements. However, additional course work focusing on added math and science content should be considered. In addition, the core disciplinary groups are encouraged to engage in developing additional core courses at the special topics 689 level. These course additions should provide a wider breadth of options for students and enhance the degree program.
The graduate student body enjoys an excellent rapport with the faculty, with such comments made as there is easy access to the faculty. Over eighty percent of the current graduate school enrollment is international, and this should be re-examined for building a strong domestic base. In addition, approximately one-half of the graduate student body is in the dynamics and control area. The solids and structures programs have room to grow and the emerging aero fluids group should increase its enrollment as they mature. The graduate students are housed in excellent facilities and enjoy access to current state-of-the-art computer facilities. A comment should be made regarding an important sidebar issue which focuses on the protocol and timing of the qualifying exam for the Doctor of Philosophy degree program. The department is encouraged to revisit this examination program for timing and content, as well as successful completion of the examination.

In summary, the department enjoys a fine reputation, currently ranking 14th nationally. The vision is to become a top ten department in national ranking. This can be achieved by the judicious hiring of key faculty. The addition of six key faculty members as addressed in the department’s strategic plan should be followed for building the department to this national level. The graduate student population is healthy, but care should be exercised to ensure a much larger domestic student body. Finally, the department bi-annually meets with its industry/government external board which can provide assistance in meeting the department’s long term vision for growth and excellence.

RELATIONSHIP OF DEPARTMENT TO OTHERS IN THE COLLEGE

An extremely healthy relationship exists between the Department and others within the college and within other colleges. Some examples of these relationships follow: Over time, the department has built a strong relationship with the Mechanical and Civil Departments in teaching Mechanics and Materials courses (MEMA). This program has enjoyed outstanding success by promoting joint teaching as well as by introducing students to other faculty members. One area of growth for such collaboration between these departments could also be exercised in the fluids area. This would enhance the number of courses available to students in the PhD program.

STRENGTHS

The Aerospace Engineering Dept. at Texas A&M Univ. has many strengths that position it well for rapid progress in the future. Here, we list several of the items that appear most important to us.

First, the department has a very high level of average research funding per faculty member. The current figure places them in the very top group in the college. Indeed, this figure places the department very high amongst the highest ranked programs in the country. This matter is very important, because it provides the necessary support for graduate students, faculty time, equipment, etc. needed for a top-ranked program.

Second, the department has a very high productivity in terms of archival publications and graduate degrees per faculty member. This is the “output” that corresponds to the “input” of outside funding mentioned above and the two are in good balance. They are making good use of the support received.

Third, The Dynamics & Control group in the department has prominence at the national and international level. This is very important for many reasons, not the least of which is attracting first-class graduate students.

Fourth, the department has strong, effective leadership from the Department Head and key, senior faculty. They are developing a sound plan to move the program rapidly forward.

Fifth, there are strong laboratories in place suitable for the traditional missions of an aerospace engineering program. New thrust areas will likely need new laboratory facilities.

Sixth, there are good cross-disciplinary interactions between faculty within the department and those in other departments and universities.
Seventh, the TiiMS program provides an exemplary example of the fruits of such interactions. The funding and visibility of this program provide a strong potential for national prominence.

Eighth, The STC offers a great and unique opportunity for valuable industry/government/university interactions. The department is moving swiftly to capitalize on this opportunity.

Ninth, the department is finalizing the definition of Thrust Areas for future development, and the choices are appropriate.

Tenth, there relationships between the graduate students and faculty are cordial and helpful.

Last, the quality of the office space for graduate students is exemplary. This is very important for graduate student recruitment.

WEAKNESSES

Every program can be expected to exhibit some weaknesses that need to be addressed. We have chosen to highlight a few items for consideration for corrective action.

First, there has been a recent and significant decrease in the critical mass at the top of the D&C group. If this is not corrected quickly, the national and international prominence of this group will be at risk.

Second, the Programs of Study for PhD students are too narrow and are lacking in sufficient math and science. These matters are very important to assure that students are fully prepared for a long career in a rapidly changing discipline.

Third, the course offerings in advanced and special topics are very limited. This impacts the item above.

Fourth, there are problems with the protocol and structure of the Qualifying Exam. The students are quite concerned with this matter.

Fifth, there is very thin coverage of aerospace propulsion and air vehicles in the department.

Sixth, there is no Thrust Area selected for autonomous vehicles. This is viewed as an oversight, since that area is receiving great emphasis nationwide.

Seventh, the department has too few state-supported GA slots for a program of this size.

Eighth, the lack of Tuition Waivers for all funded graduate students is a handicap for student recruiting.

Ninth, the percentage of international students in the graduate student body is much too high. The situation is especially worrisome at the PhD level.

Last, there is insufficient diversity in the faculty and the graduate student body.

RECOMMENDATIONS

The Doctoral Program Review Guidelines specify that the recommendations be organized under three headings: Overall-programmatic, Resources, and Structure. The recommendations are listed in these categories, but numbered consecutively.

OVERALL-PROGRAMMATIC:

1. **Expand the breadth and math/science content of PhD program of study.**
   It is recommended that some math and science from an approved list of courses, and some graduate course work from one or more related areas outside the area of thesis research be included in every approved degree plan.

2. **Expand advanced and special topics course offerings.**
   It was noted that PhD students were offered a sparse selection of advanced courses or special topics courses in the dynamics/controls and fluids areas. For new faculty, and for current faculty who develop new subjects of research, the 689 special topics course route provides a productive
means of charting the way to future research-based courses. Thus, the addition of new faculty will help accomplish this recommendation.

3. Establish cooperative teaching efforts in the fluids area with ME and CE.
   This has been successful for many years for the Solids group through the MEMA program. It will aid in expanding the advanced fluids course offerings, in facilitating cross-department fluids research activities, and in attracting graduate students from other departments to exciting research topics in aerospace fluids.

4. Re-examine the Qualifying Examination.
   The qualifying examination is more flexible and more constructive than perceived by the graduate students. The specifics of philosophy, administration, and consequences of this examination should be provided in writing to the graduate students at the beginning of their program.

5. Address the weakness in coverage of aerospace propulsion, air vehicles, and autonomous vehicles.
   New faculty should alleviate a major part of this recommendation. Existing research and cooperative projects involving current faculty and new faculty can be promoted and publicized.

6. Develop plan of action to increase the percentage of US graduate students.
   As noted by everyone contacted, the percentage of foreign graduate students is unacceptably high, especially in the PhD program. A specific, multi-pronged plan including targeted fellowships, supplemental stipends, aggressive personal recruitment, and even set-aside positions for US citizens may be required.

7. Develop a plan of action to improve diversity.
   The diversity of both the faculty and graduate student body should be addressed by a formal plan designed to move toward a demography approaching that of the state population.

RESOURCES:

8. As possible, immediately fill the Slattery and Weisenbaker Chairs.
   It is recommended that the department work with the College to assure that the Slattery and Weisenbaker Chairs are assigned to Aerospace Engineering to be filled at once, the Slattery Chair with a Solids group senior faculty member, and the Weisenbaker Chair with a Dynamics/Controls senior faculty member.

9. Add an experienced faculty member to the Fluids group, with preference for CFD/Propulsion specialty.
   An experienced, young faculty member with a developed research program should be added to the strong group of four young fluids researchers to enable this group to take advantage of the research opportunities for team projects available to them. A CFD modeling specialty with application to propulsion would be ideal, though several other areas would complement the current talent.

10. Add a young faculty member to the Dynamics/Controls group to insure continued national prominence.
    The senior leader of this group shows incredible energy and productivity. A young faculty member added now will have several years to benefit from working with this leader. This, along with the addition of the senior faculty envisioned for the Weisenbaker Chair, will provide for the continued prominence and long-term growth of this group.

11. Add a faculty member in design/systems integration to provide synergism among the three core groups.
    The department described a vision of a Design, Safety/Security, and Integration Thrust that encompassed this type position. It will take advantage of the department’s strengths in the STC (CSCE), Flight Simulation and Flight Mechanics Laboratories, the Aerospace Vehicle Systems Institute, and will involve faculty from all three groups: Dynamics and Controls, Fluids, and Solids.
12. Press for increase in funded graduate assistant positions (GANT and GAR) and tuition waivers for graduate assistants.
By both the standards of nationally ranked aerospace engineering departments and the other engineering departments in the College, Aerospace Engineering appears to be grossly under funded in this area. Resources applied here will help attract graduate students who will address the recommendations 6 and 7 above.

STRUCTURE:

13. Insure effective and balanced representation on all decision-making committees in the department.
The three discipline groups (solids, dynamics/controls, and fluids) will vary over time in relative strength. While at this time the department shows excellent cohesiveness and high morale, the potential exists for an imbalance of power among the groups to give rise to a slighting of younger faculty in a group with less voice in the senior councils. Careful attention now can avoid this future problem.

14. Produce comprehensive policies and procedures document for graduate programs.
A clear and comprehensive policies and procedures document for graduate programs is needed to specify uniform standards and rules and to eliminate misunderstandings.

Joseph A. Schetz, PhD  Robert D. Culp, PhD  Robert Sierakowski, PhD
Fred D. Durham Chair  Professor  Chief Scientist
Virginia Tech  The Univ. of Colorado  Eglin Air Force Base
Blacksburg, VA  Boulder, CO  Eglin AFB, FL
The Department of Aerospace Engineering conducted a Doctoral Program Review in spring 2003. The department’s self-study developed for this review may be found at the website: http://ogs.tamu.edu/faculty/program-review-self-study/AerospaceEngrSelfStudy-March2003.pdf. The Appendix of the present report also provides the following: the Review Committee’s Report, the department’s response to the review committee’s findings, and the June 24, 2004 memo from Dean Rick Giardino, Office of Graduate Studies, to Dean G. Kemble Bennett, College of Engineering which provides the Aerospace Engineering Doctoral Program Review Post-Review Summary.

This four-year status report summarizes key issues, concerns and reviewer recommendations contained in the final report and describes how the department has dealt with and responded to these during the past four years. This report only considers issues that were not addressed or resolved at the time of the 2003/04 review. For completeness, the reviewer’s recommendations (in italics) and department’s response are cited verbatim below, followed in each case by the actions taken by the department in the past four years and the current status for each reviewer recommendations.

Summary

Following the doctoral program review in 2003, it was noted by Dean Giardino, Office of Graduate Studies, that the Department of Aerospace Engineering is one of the strongest engineering departments in the Look College of Engineering in terms of both academic excellence and research accomplishments of its faculty, and that the program continues to grow in reputation and external research funding and has one of the highest ratios of faculty research dollars to faculty in the college. Since 2003, the department was named a “Signature Program” in the College of Engineering which has provided the resources and stimulus to make significant progress in many areas including:

- increasing the department’s faculty both in numbers (from ~22 to 31) as well as the faculty quality, depth and breadth of technical expertise,
- adding three women faculty members,
- increasing the size the graduate program (to approximately 125 students),
- improving the quality of new admitted students (average GRE V+Q = 1,331; Verbal=551 and Quantitative=780),
- increasing female enrollment (female enrollment > 20% of total enrollment),
- increasing US enrollment as a percentage of total (US enrollment > 50% of total),
- making modest increases in diversity enrollment,
- improving and increasing the graduate course offerings, and
- continuing a strong research program (in research volume as well as scholarly publications).

The USNWR ranking of the TAMU Aerospace Engineering program has also improved significantly during the past four years from 15th in the nation in 2004 to a ranking of 9th in 2007 (5th when considering public institutions).

For each recommendation made by the review panel (14 total), this report is organized as follows: the 2003 review panel’s recommendation (in italics), followed by the department’s 2004 response, and followed by the actions taken since the review and current status (2004 - present).

OVERALL-PROGRAMMATIC:
1. **2003 Review Panel Recommendation:** Expand the breadth and math/science content of PhD program of study.

   *It is recommended that some math and science from an approved list of courses, and some graduate course work from one or more related areas outside the area of thesis research be included in every approved degree plan.*

**2003 Response to Reviewers:** The department agrees that additional math and science courses would in general be beneficial for the majority of our students. The department is presently considering a requirement for a core of math and science courses.

**Actions Taken Since Review and Current Status:** After further review by the Aerospace Engineering Graduate Affairs Committee, as well as the faculty, it was decided that a math requirement was not presently needed. This is based on two factors. First, the Aerospace Engineering Fundamentals Qualifying Examination (AFQE) policy recommends that all students complete AERO 601, 603 and 622 in preparation for taking the required AFQE exam. Second, a review of the past graduate degree programs reveals that the majority of PhD students will have completed a number of math and/or science courses as part of their M.S. and subsequent PhD program. Therefore, specifically requiring students to take some math or science from an approved list of courses will not significantly change what courses PhD students are already completing.

2. **2003 Review Panel Recommendation:** Expand advanced and special topics course offerings.

   *It was noted that PhD students were offered a sparse selection of advanced courses or special topics courses in the dynamics/controls and fluids areas. For new faculty, and for current faculty who develop new subjects of research, the 689 special topics course route provides a productive means of charting the way to future research-based courses. Thus, the addition of new faculty will help accomplish this recommendation.*

**2003 Response to Reviewers:** The department acknowledges a need to provide a greater offering of advanced courses in the aerodynamics/fluids and dynamics/controls areas. New courses have been recently added including: Digital Control of Aerospace Systems, Estimation of Dynamic Systems, Advanced Dynamics and Control of Aerospace Systems, Experimental Aerodynamics, and Turbulence Modeling. However, there is a clear need to provide more courses especially in the dynamics/controls area where graduate enrollment is expected to increase, and in the aerodynamics/fluids area where graduate enrollment needs to increase in order to make a more viable program area. Neither of these can be achieved without the addition of new faculty. Due to the current shortage of faculty, we have focused on teaching the basic core graduate courses and have tried hard to offer a few advanced courses. With the addition of new faculty, we will be offering more advanced courses.

Fortunately, the prospect of increasing faculty in all areas is a distinct possibility with the anticipated faculty positions that the President and Dean of Engineering are planning to provide over the next four years. Aerospace Engineering has been designated as a Signature program by the College of Engineering and thus we anticipate being able to strengthen our faculty significantly. These new faculty positions are critical to the department’s growth in national reputation and ranking.

**Actions Taken Since Review and Current Status:** Since 2004 to the present, a significant number of new advanced and special topics courses have been introduced and are listed in the table below. The new courses are typically offered as “689 Topics in …” courses” (once or twice) and then converted to regular catalog courses.

### New 689 Course Offerings in Aerospace Engineering

<table>
<thead>
<tr>
<th>Semester</th>
<th>Instructor</th>
<th>Enrollment</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring 04</td>
<td>Mortari</td>
<td>6</td>
<td>Spacecraft Attitude Determination</td>
</tr>
<tr>
<td></td>
<td>Hurtado</td>
<td>6</td>
<td>Advanced Dynamics &amp; Control of Aerospace Systems (became AERO 628 in fall 04)</td>
</tr>
<tr>
<td></td>
<td>Girimaji</td>
<td>8</td>
<td>Turbulence Processes</td>
</tr>
<tr>
<td>Spring 05</td>
<td>Mortari</td>
<td>7</td>
<td>Spacecraft Attitude Determination (became AERO</td>
</tr>
</tbody>
</table>
Fall 05  Karpetis  6  High-Speed Combustion
Lagoudas  10  Multifunctional Materials (Now taught as AERO 606 by Ounaies)
Strouboulis  7  Generalized Finite Element Methods

Spring 06  Chakravorty  8  Dynamics & Control
Saric  6  Stability and Transition
Girimaji  10  Turbulence Processes (will become AERO 640 in fall 2008)

Fall 06  Bowersox  10  High-Speed Viscous Flows
Bhattacharya  9  Optimization of Aerospace Systems

Spring 07  Chakravorty  5  Dynamics and Control
Fall 07  Bhattacharya  6  Optimization of Aerospace Systems (to become AERO 636)
Karpetis  8  Laser Diagnostics
Saric  18  Perturbation Methods

Note that the table above lists only the new 689 courses, i.e., it does not include the already established AERO, MEMA and MSEN courses taught the aerospace engineering faculty during the time period above. Many of the 689 special topics courses introduced since 2004 have been converted to regular catalog courses (AERO 606, 628, 640, 650) or are in the approval process for conversion to a regular catalog course (AERO 636).

3. **2003 Review Panel Recommendation: Establish cooperative teaching efforts in the fluids area with ME and CE.**

   *This has been successful for many years for the Solids group through the MEMA program. It will aid in expanding the advanced fluids course offerings, in facilitating cross-department fluids research activities, and in attracting graduate students from other departments to exciting research topics in aerospace fluids.*

   **2003 Response to Reviewers:** The faculty has discussed the need for greater cooperative teaching efforts in both the aerodynamics/fluids and dynamics/controls areas with the mechanical, civil, electrical and computer engineering departments. The faculty are exploring graduate courses that serve common interests, courses that might be cross-listed, courses that could be team taught, and perhaps offering courses that would be of interest to not only students in aerospace engineering but also to students in the departments mentioned previously.

   One reason that the cooperative teaching efforts have worked well in the structures/materials area (MEMA courses) is that the department presently has faculty strength that allows Aerospace Engineering faculty to teach the MEMA courses and thus interact with other faculty that teach these MEMA courses (mechanical and civil engineering faculty). Unfortunately, the department does not have adequate faculty strength in the aerodynamics/fluids and dynamics/controls areas, and thus the expansion of advanced courses in these areas is hampered until we have additional faculty positions.

   **Actions Taken Since Review and Current Status:** The number of faculty has increased in both the aerodynamics/fluids and dynamics/controls area since 2004, and as outlined above a significant number of new courses are being offered. However, this has not prompted any significant further collaboration in cooperative teaching efforts in the fluids areas with ME or CE faculty. Students in Aerospace Engineering do take appropriate coursework in other engineering departments. In addition, students from other engineering departments are taking the new aerospace engineering course offerings listed above.

4. **2003 Review Panel Recommendation: Re-examine the Qualifying Examination.**

   *The qualifying examination is more flexible and more constructive than perceived by the graduate students. The specifics of philosophy, administration, and consequences of this examination should be provided in writing to the graduate students at the beginning of their program.*
2003 Response to Reviewers: Overall, the faculty are quite satisfied with the scope, content and structure of the exam; and we believe that it is providing an excellent mechanism for improving the quality of our doctoral program. The philosophy, administration, content and consequences of this examination are provided in writing to the PhD students at the beginning of their program, and then reiterated several times during the student’s first year (the qualifying exam is taken at the end of the student’s first year). To enhance our student’s understanding of the nature of the qualifying examination, the department will ask the group of students who just completed the qualifying exam to provide input as to how the process could be improved or how the department could communicate the intent of the exam in a better way.

Actions Taken Since Review and Current Status: The AFQE policy was carefully reviewed during the period 2005-06 by both the Graduate Affairs Committee and faculty. A new policy was published in fall 2006, and further clarified for fall 2007. The new policy clearly explains the philosophy, administration, and consequences of this examination. The AFQE policy is provided to prospective and new PhD students in both written form and on the department’s webpage; it is also discussed in detail with new graduate students during the New Graduate Student Orientation typically held during the first week of classes each semester.

5. 2003 Review Panel Recommendation: Address the weakness in coverage of aerospace propulsion, air vehicles, and autonomous vehicles.
New faculty should alleviate a major part of this recommendation. Existing research and cooperative projects involving current faculty and new faculty can be promoted and publicized.

2003 Response to Reviewers: As stated previously, there are certain areas of air and autonomous vehicles wherein the department should strengthen both its course offerings and research programs but this can only be accomplished by refocusing current faculty or adding new faculty. Over the next four years, we anticipate adding new faculty in these areas (1-2) if the positions are provided by the university.

Actions Taken Since Review and Current Status: New faculty have been hired to address these particular teaching and research areas (aerospace propulsion, air vehicles, and autonomous vehicles) as appropriate and include: Dr. Adonios Karpetis who has expertise in high-speed combustion, microcombustion, propulsion, turbulence, two-phase flows and laser diagnostics; Dr. Suman Chakravorty with expertise in autonomous robotic mapping and planning, stochastic dynamical systems, space-based high resolution imaging systems, and reinforcement learning and applications; Dr. Tamas Kalmar-Nagy with expertise in control of autonomous vehicles, networked control systems, systems with delay and nonlinear dynamics; Dr. Helen Reed (aero-fluids area) with expertise in autonomous rendezvous & docking of satellite systems, and micro aerial vehicles and unmanned aerial systems; and Dr. William Saric (aero-fluids area) with expertise in flight test engineering. Additional faculty hired since 2004 include Drs. Raktim Bhattacharya and David Hyland (dynamics and control area) and Drs. Amine Benzerga, Yongmei Jin and Zoubeida Ounaies (materials and structures area).

6. 2003 Review Panel Recommendation: Develop plan of action to increase the percentage of US graduate students.
As noted by everyone contacted, the percentage of foreign graduate students is unacceptably high, especially in the PhD program. A specific, multi-pronged plan including targeted fellowships, supplemental stipends, aggressive personal recruitment, and even set-aside positions for US citizens may be required.

2003 Response to Reviewers: The need to increase the percentage of US graduate students is clear. In Aerospace Engineering, the number of US graduate applicants is a small pool. However, we can increase our numbers by attracting those US students who would otherwise choose another university to attend. This can be accomplished in several ways:
- We deliberately refrain from accepting as many international students.
- We use more aggressive personal recruitment procedures including personal contacts by faculty immediately when an application is received, inviting potential candidates for a campus visit (requires travel funds), deliberate faculty recruiting of potential students when they visit other
institutions for seminars and research collaboration, and more deliberate recruiting of our own BS undergraduates.

- We use our current US graduate students to help recruit potential US students.
- We invite good US undergraduate students for a campus visit.
- We use targeted fellowships for US citizens. Unfortunately, this requires either TAMU or external fellowships since the Aerospace Engineering department has NO departmental fellowships.
- We deliberately set aside any available GANT positions for US citizens. Currently, the number of GANT positions available is approximately one-half of what the department would desire (in order to provide adequate support to faculty in the classroom).

The university can assist this recruitment process by a) providing travel funds for faculty to travel to other institutions, b) providing travel expenses to students for a campus visit, and c) providing greater numbers of graduate fellowships which target US student groups.

**Actions Taken Since Review and Current Status:** Utilizing the recruitment and admissions procedures noted above, the number and percentage of US citizens in the graduate program has increased significantly during the period 2003 to 2007 and this is summarized in the table and chart below.

### Graduate Enrollment 2003-2007

<table>
<thead>
<tr>
<th>Year</th>
<th>MS</th>
<th>PhD</th>
<th>Total</th>
<th>MS</th>
<th>PhD</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>20</td>
<td>5</td>
<td>30</td>
<td>27</td>
<td></td>
<td>68</td>
</tr>
<tr>
<td>2004</td>
<td>30</td>
<td>6</td>
<td>36</td>
<td>26</td>
<td></td>
<td>64</td>
</tr>
<tr>
<td>2005</td>
<td>43</td>
<td>4</td>
<td>48</td>
<td>30</td>
<td></td>
<td>64</td>
</tr>
<tr>
<td>2006</td>
<td>37</td>
<td>8</td>
<td>45</td>
<td>26</td>
<td></td>
<td>59</td>
</tr>
<tr>
<td>2007</td>
<td>43</td>
<td>15</td>
<td>58</td>
<td>17</td>
<td></td>
<td>54</td>
</tr>
</tbody>
</table>

During the period 2003 to 2007, the US graduate enrollment as a percentage of total graduate enrollments has increased from 27% to 52%. Both the MS and PhD graduate student enrollment has increased, although the department would desire that the percentage of US PhD graduate students increase even further. This is particularly necessary as the department continues to increase the number of research projects that have ITAR restrictions which require US citizenship for students to be funded from these projects.

![US Enrollment as a % of Total Enrollment](chart)

In 2006, the College of Engineering developed the National Excellence Fellowship program to attract top US students with fellowships that provide $40K/year. This new program has allowed the Aerospace Engineering Department to attract one new US student in 2007. In 2006, the department was successful in obtaining funding from the Bradley Foundation which provides one $25K Bradley Fellowship each year.

In 2007, the Dean of Engineering received help from the University to provide an add-on of $100/mo to enhance graduate student (GAT) salaries. This is being continued in 2008 but due to financial constraints
is not being expanded. However, the department has also increased the starting level of most new research assistant (GAR) salaries by $100/mo to make salaries between different types of graduate assistant as uniform as possible. Starting with September 1, 2008, the recommended starting salary for MS and PhD. Students (GARs and GANTs) is $1,600/month. PhD students are eligible for a salary increase when they successfully complete the AFQE (qualifying) exam.

The Department places a very high priority in assisting graduate students to apply for and be successful in obtaining major national fellowships (at least $25K/year). The chart below shows the number of first-time awards for major fellowships received by Aerospace Engineering graduate students during the period 2004 – 2008.

While the upward trend in fellowships shown in the previous chart is good, it is desirable that the department further develop local resources which can further attract more top US students. Toward that end, the Department and Department Head will focus on development activities to secure scholarships, fellowships and endowments for the department.

During the past 2-3 years, the department has increased the number of “campus visits” for recruiting potential graduate students. In a typical year, approximately 12-15 students have been brought to campus for 2-day visits. These visits have been supported financially by the College of Engineering (COE Graduate Invitational), the Office of Graduate Studies, and the Department. The yield rate has been quite good (>60%) and the department plans to place a high priority on recruiting graduate students through campus visits and also plans to increase the number of students brought to campus for two-day campus visits.

7. **2003 Review Panel Recommendation: Develop a plan of action to improve diversity.**

   The diversity of both the faculty and graduate student body should be addressed by a formal plan designed to move toward a demography approaching that of the state population.

   **2003 Response to Reviewers:** As stated previously, the department aggressively recruited a female faculty candidate this past spring. Unfortunately, this recruitment requires that we solve the two-body problem and provide a position for her husband. In the end, despite the recruitment efforts of the department, the college of engineering, the college of science and the VPR’s office, we were unsuccessful.

   As new faculty positions become available, the department will make every effort possible to diversify the faculty by:

   - vigorously recruiting female and minority candidates, not only through the appropriate advertising outlets but by specifically identifying appropriately qualified faculty candidates at other institutions and “going after them,” and
   - searching for qualified candidates in industry and government labs that may not be considering faculty positions.
While we do this, we must keep in mind that the real issue in a high technology area such as aerospace engineering is the lack of qualified diversity candidates.

To diversify the student body, we will begin to do the following:

- establish greater dialogue between faculty at TAMU and those at predominantly Hispanic and African American institutions,
- visit institutions (3-person team, one from each area) like Texas A&M at Prairie View, the University of Texas at El Paso, etc. and give seminars on our departmental research activities,
- use our current female and minority graduate students to help recruit potential female and minority students,
- have faculty visit other US institutions to recruit students,
- invite good undergraduate female and minority students for a campus visit,
- target advertisement toward these student groups, and
- make minority students feel more welcome.

The university can assist this process by a) providing travel funds for faculty to travel to these institutions, b) providing travel expenses to students for a campus visit, and c) providing greater numbers of graduate fellowships which target these student groups.

Actions Taken Since Review and Current Status: During the period 2003-07, the department has been able to increase both the women graduate enrollment and minority graduate enrollment as a percentage of the total graduate enrollment. As can be seen in the charts below, the women enrollment as a percentage of total enrollment has increased from 13% to 22%. During the same time period, the minority graduate enrollment as a percentage of total graduate enrollment has increased from 3% to 7%. Both of these trends are positive; however, the department would desire to further increase both the women and minority enrollments and particularly the minority enrollment.

![Women Enrollment as a % of Total Enrollment](chart1.png)

![Minority Enrollment as a % of Total Enrollment](chart2.png)

During the past four years, the department has added three new female faculty members (Reed, Ounaies and Jin) and it is expected that female graduate applicants will increase due to the addition of the female faculty members.

During the past four years, the university and college faculty reinvestment program has allowed the department to expand its faculty both in numbers as well as diversity. Future faculty positions will only come from the Dean of Engineering since the university faculty reinvestment program has concluded. Recruitment of qualified female and under-represented groups will be a priority for any new faculty
positions in engineering as well as aerospace engineering. In general, the recruitment of qualified female and under-represented faculty is difficult because of the small pool size; however, the department will nonetheless make this a high priority when recruiting new faculty.

While the department has made some progress to increase both female and minority enrollments, it is clear that we have to continue with the strategy laid out above (bulleted items). To improve enrollments, this strategy has to focus on increasing the number of qualified applicants through more proactive recruiting which the department will continue. In addition to the above strategies, we plan to use our graduate webpage to showcase the achievements of some of the aerospace engineering department’s recent women and minority graduates and through this encourage more women and minority applicants. The pre-engineering agreement with TAMU at Laredo offers the opportunity to recruit top Hispanic students from Texas. Through this program, the department will strive to develop greater numbers of Hispanic students that apply for the graduate program. In addition, the department has been able to fund 1-2 minority students per year as recipients of the TAMU Diversity Fellowships (about 75 diversity fellowship awarded in the university).

RESOURCES:

8. **2003 Review Panel Recommendation**: As possible, immediately fill the Slattery and Wisenbaker Chairs. It is recommended that the department work with the College to assure that the Slattery and Wisenbaker Chairs are assigned to Aerospace Engineering to be filled at once, the Slattery Chair with a Solids group senior faculty member, and the Wisenbaker Chair with a Dynamics/Controls senior faculty member.

**2003 Response to Reviewers**: The review committee has incorrectly reported that the Wisenbaker Chair needs to be filled. In actuality, Dr. Alfriend currently holds the Wisenbaker Chair. In addition, neither chair is designated or reserved for a particular discipline area in the department.

A search was conducted this past fall and spring to fill the Slattery Chair. Unfortunately, the search committee identified no qualified candidates. Consequently, the search will be reinitiated in the near future. It is anticipated that the Slattery Chair may be coupled with the available URETI/AUF position open in the department, or with one of the positions that we anticipate being made available by the College of Engineering during this next year (part of the department’s Signature program designation).

**Actions Taken Since Review and Current Status**: The Slattery Chair was filled in 2004 with the appointment of Dr. Dimitris Lagoudas to this chair position.

At this time, the department is pleased to have the support of the College of Engineering in providing several professorships and chair positions to the department. Aerospace Engineering faculty holding professorships and chairs include the following:

<table>
<thead>
<tr>
<th>Faculty Member</th>
<th>Endowed/Titled Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terry Alfriend</td>
<td>Royce E. Wisenbaker ‘39 Chair in Engineering</td>
</tr>
<tr>
<td>John Junkins</td>
<td>Regents Professor; Royce Wisenbaker Chair</td>
</tr>
<tr>
<td>Dimitris Lagoudas</td>
<td>John and Bea Slattery Chair of Aerospace Engineering</td>
</tr>
<tr>
<td>John Slattery</td>
<td>TEES Distinguished Research Chair</td>
</tr>
<tr>
<td>David Hyland</td>
<td>Royce E. Wisenbaker ‘39 Chair in Engineering</td>
</tr>
<tr>
<td>Vikram Kinra</td>
<td>General Dynamics Professorship in Aerospace Engineering</td>
</tr>
<tr>
<td>William Saric</td>
<td>Stewart &amp; Stevenson Professor II in Engineering</td>
</tr>
<tr>
<td>Ramesh Talreja</td>
<td>Tenneco Professor</td>
</tr>
<tr>
<td>Rao Vadali</td>
<td>Stewart &amp; Stevenson Professorship I in Engineering</td>
</tr>
</tbody>
</table>
In order to attract and retain the highest quality faculty, the Department and Department Head will focus on development activities to secure faculty fellowships, professorships, chairs and other endowments for the department.

9. **2003 Review Panel Recommendation:** Add an experienced faculty member to the Fluids group, with preference for CFD/Propulsion specialty.

   An experienced, young faculty member with a developed research program should be added to the strong group of four young fluids researchers to enable this group to take advantage of the research opportunities for team projects available to them. A CFD modeling specialty with application to propulsion would be ideal, though several other areas would complement the current talent.

   **2003 Response to Reviewers:** The addition of a faculty member is in the department’s plan and priority ranking when new positions become available (anticipated for FY 04). Over the next four years, we anticipate adding at least three faculty in the aerodynamics/fluids area as they become available through the College of Engineering and the President’s initiative to add new faculty.

   **Actions Taken Since Review and Current Status:** Through the University’s faculty enhancement program under the direction of President Robert Gates and the naming of the department as a Signature Program in the Dwight Look College of Engineering, four new aerospace engineering faculty have been added in the aero-fluids area since 2004. These include Professors Adonios Karpetis, Helen Reed, William Saric and Edward White. Both Drs. Reed and Saric are senior faculty. Prof. Reed filled the Department Head position and Prof. Saric serves as the Aero-fluids group leader. Prof. Saric was appointed a TAMU Distinguished Professor in 2008 and was also named to the National Academy of Engineering in 2007. Prof. Karpetis adds expertise to the faculty in the area of propulsion while Prof. White adds to the faculty in the area of laminar-to-turbulent transition and aerodynamic ice accretion. A complete listing of faculty by discipline area may be found at: [http://aero.tamu.edu/people2/faculty/by-areas-of-interest](http://aero.tamu.edu/people2/faculty/by-areas-of-interest).

10. **2003 Review Panel Recommendation:** Add a young faculty member to the Dynamics/Controls group to ensure continued national prominence.

    The senior leader of this group shows incredible energy and productivity. A young faculty member added now will have several years to benefit from working with this leader. This, along with the addition of the senior faculty envisioned for the Wisenbaker Chair, will provide for the continued prominence and long-term growth of this group.

   **2003 Response to Reviewers:** As with the aerodynamics/fluids group, the addition of a faculty member in the dynamics/controls group is in the department’s plan and priority ranking when new positions become available (anticipated to be in FY 04). Over the next four years, we anticipate adding three to four faculty in the dynamics/control area as they become available through the College of Engineering and the President’s initiative to add new faculty. When the Wisenbaker Chair becomes available, it may be possible to couple the Chair with one of these new positions.

   **Actions Taken Since Review and Current Status:** Through the University’s faculty enhancement program under the direction of President Robert Gates and the naming of the department as a Signature Program in the Dwight Look College of Engineering, the department has been able to add three faculty to the dynamics/control group. These include Professors Raktim Bhattacharya, Suman Chakravorty and Tamas Kalmar-Nagy. All three of these faculty are junior faculty and they add depth and breadth in various research areas including stochastic robust and optimal control, uncertainty management in networked dynamical systems, real-time systems, cooperative control, autonomous robotic mapping and planning, space-based high resolution imaging systems, reinforcement learning and applications, control of autonomous vehicles, networked control systems, systems with delay and nonlinear dynamics. A complete listing of faculty may be found at: [http://aero.tamu.edu/people2/faculty/by-areas-of-interest](http://aero.tamu.edu/people2/faculty/by-areas-of-interest).

11. **2003 Review Panel Recommendation:** Add a faculty member in design/systems integration to provide synergism among the three core groups.

    The department described a vision of a Design, Safety/Security, and Integration Thrust that encompassed this type position. It will take advantage of the department’s strengths in the STC (CSCE), Flight
Simulation and Flight Mechanics Laboratories, the Aerospace Vehicle Systems Institute, and will involve faculty from all three groups: Dynamics and Controls, Fluids, and Solids.

2003 Response to Reviewers: This is a thrust area that was accepted by the faculty in their recent planning process. To accomplish this goal requires, as usual, a faculty addition. We anticipate that the goal may be achieved sometime during the next four years as we receive additional faculty positions from the College of Engineering as part of our Signature designation by the college.

Actions Taken Since Review and Current Status: The department continues to view such a position as important and will continue to search for the right faculty member who can provide synergism among the three core groups.

12. 2003 Review Panel Recommendation: Press for increase in funded graduate assistant positions (GANT and GAR) and tuition waivers for graduate assistants.
By both the standards of nationally ranked aerospace engineering departments and the other engineering departments in the College, Aerospace Engineering appears to be grossly under funded in this area. Resources applied here will help attract graduate students who will address the recommendations 6 and 7 above.

2003 Response to Reviewers: The review panel has correctly identified a critical need in additional funded graduate assistant positions (GANTs). In comparison to other departments both at TAMU and nationwide, we estimate that a program of our size should have on the order of 15 GANT/GAT positions. Unfortunately, given the current FY03 departmental academic operating budget, the department is limited to approximately 7-8 GANT positions. The only solution is additional academic funding. To make matters worse, the 6.3% reduction in the departmental academic budget (overall reduction of $143K) that was recently mandated for FY04 in engineering, will require that we further reduce our already meager GANT allocation from approximately $130K to $60K. Such a trend in reduction of departmental operating budgets (including GANT sources) can only have serious damaging efforts to our graduate program (as well as our ability to provide adequate undergraduate instruction where GANTs are utilized).

Actions Taken Since Review and Current Status: With the fall 2005 semester, the university adopted a program which provides a form of tuition waiver to teaching and research assistants. For teaching assistants on academic funds (Graduate Assistant Non-Teaching, or GANT; and Graduate Assistant Teaching, or GAT), the university pays the student’s cost of resident (in-state) tuition up to 9 credit hours (considered a full-time load). In addition, for Graduate Assistant Research (GAR), the faculty member’s research contract/grant pays the student’s cost of resident tuition up to 9 credit hours (considered a full-time load). Graduate students also receive health insurance benefits.

To enhance the competitiveness of graduate student stipends, the College of Engineering was successful in obtaining funds from the university which allow for increases in salary for teaching assistants (GANTs and GATs). Consistent with these GANT/GAT salary increases, the department has also increase the typical stipend level for GARs to $1,600/month. It is important to note that approximately 95% of all graduate students have financial assistance in one form or another through fellowships, research assistantships or teaching assistantships.

While the funding level for Graduate Assistant Research (GAR) positions from external research contracts and grants continues to be at a good level, the department and faculty must continue to seek additional funding in order to increase the department’s graduate enrollment at a rate which is consistent with the almost-50% increase in faculty over the past four years (as part of the faculty reinvestment program of the university). Funding for graduate students will remain a high priority for the department and faculty.

STRUCTURE:

13. 2003 Review Panel Recommendation: Insure effective and balanced representation on all decision-making committees in the department.
The three discipline groups (solids, dynamics/controls, and fluids) will vary over time in relative strength. While at this time the department shows excellent cohesiveness and high morale, the potential exists for an imbalance of power among the groups to give rise to a slighting of younger faculty in a group with less voice in the senior councils. Careful attention now can avoid this future problem.

2003 Response to Reviewers: The current department head is sensitive to this potential problem and concern. It is the intent to have both senior and junior faculty in advisory capacities to the department head so that all faculty levels and groups participate in important decisions.

Actions Taken Since Review and Current Status: With the addition of ten new faculty members since 2004, a good balance among the core discipline faculty groups has been achieved. In addition, the department head has developed and utilized an Executive Advisory Committee consisting of one senior faculty member from each of the three core discipline areas. The Executive Committee provides input to the Department Head from each group regarding a variety of departmental matters, and provides a formal means by which faculty in each group can bring matters before the Department Head. The new junior faculty hires are provided opportunities to participate in various departmental committees. In addition, monthly faculty meetings are held where the input and opinion of junior faculty members is encouraged and welcomed by the department head. In addition, each discipline group holds periodic meetings (varying from weekly to monthly) to discuss academic and research matters of importance to the group, matters which should be communicated to the Department Head, etc.

A clear and comprehensive policies and procedures document for graduate programs is needed to specify uniform standards and rules and to eliminate misunderstandings.

2003 Response to Reviewers: While the students are provided a comprehensive handbook of policies and procedures (approximately 50 pages), and they are made aware of various university and OGS sources for such information (e.g., web pages); the department can improve the information process. We anticipate forming a graduate advisory group that would recommend changes, additions, shortcoming in our handbook and other information sources. In addition, a “roadmap” of important milestones will be developed to supplement what is already provided by OGS. We also will develop procedures wherein the faculty are more involved with advising their students of schedule and administrative responsibilities.

Actions Taken Since Review and Current Status: A more comprehensive Policy and Procedures document for the Graduate Program has been developed. This document is provided to new graduate students in written form during the “new graduate student orientation” held during the first week of classes each semester and is also provided to students on the department’s website.
B. Graduate Program Policies and Procedures Document

DEPARTMENT POLICIES FOR GRADUATE PROGRAM

COUNCIL OF GRADUATE SCHOOLS
Texas A&M is a member of the US Council of Graduate Schools which has adopted April 15th as a critical date in the application review process. Basically stated, the council, to which every major institution is a member, states that students are not required to accept appointments prior to April 15th. And, it states that a student must obtain a release from the first institution to accept an offer from another institution after April 15th. We affirm that it is unethical for a student to continue pursuing offers if an offer has already been accepted within our program.

ENGLISH PROFICIENCY EXAM
International students (including those transferring from another US institution) are required to take the ELPE (English Language Proficiency Exam) upon arrival to Texas A&M to verify their communication skills. The tests are offered once a semester. If scores so indicate, students may be required to take additional courses through the TAMU English Language Institute (ELI).

Although a student has been verified or certified by the ELPE, if a faculty member feels that a student is still not proficient in any aspect of the English language, the faculty member may require the student to take ELI courses to improve English skills. Courses might consist of grammar, writing lab, reading, listening, vocabulary, or oral skills as the faculty member recommends. International students are, therefore, encouraged to make continuous improvement of their understanding, use and application of the English language.

GAR AND GANT RESPONSIBILITIES
Typically, funded graduate students are offered either Graduate Assistant - Research (GAR) or Graduate Assistant - Non-Teaching (GANT) appointments. Both positions require 20 hours of work per week. GARs are assigned research project activity (that may or may not be directly related to thesis research). GANTs are assigned course support duties such as grading or lab assistant for one or more courses. Students are reminded that additional research activities are expected as part of their academic program of study leading to their thesis or dissertation.

TERM OF APPOINTMENT
Appointments are usually for one year, but shorter appointments have been established in such cases that a trial period is needed or a limited funding source is present. Poor academic performance and/or unsatisfactory GANT/GAR performance are grounds for suspension of support. Continued financial aid is contingent upon satisfactory progress in your graduate program, and upon the availability of funds for graduate student support by your advisor or department.

AEROSPACE FUNDAMENTALS QUALIFYING EXAM (AFQE)
New and transfer Ph.D. students will take the AFQE in late May following the first academic year of study (usually Fall and Spring semesters—two semesters). The exam will cover fundamental material.
from the disciplines of solids/structures, aerodynamics/fluids, and dynamics/controls as well as the mathematics associated with such disciplines. The score from the AFQE, course performance, and recommendations from the student's advisor(s), will be used in a total evaluation of performance. Ph.D. students are encouraged to take AERO 601 (Fluid Mechanics), AERO 603 (Continuum Mechanics), and AERO 622 (Dynamics), or equivalent courses from prior degrees, as part of their first year study to prepare for the Exam. The AFQE is an exam on aerospace engineering fundamentals, and is NOT another final exam on the three courses listed above. Students who fail the written portion of the AFQE may be given one additional opportunity for satisfying the AFQE requirements by 1) satisfactorily completing an oral examination, or, 2) by retaking the written AFQE examination which will usually be given in early August following the May exam. For students who fail the written AFQE, the Graduate Affairs Committee makes the decision as to whether a subsequent oral or written exam is required. A student must pass the AFQE; failure mandates a change of program to M.S. or transfer to another department or university.

COURSE LOAD
A full course load of 9 credit hours is required to maintain an assistantship (6 credit hours in the 10-week summer session). These hours may include courses such as Research (AERO 691) and Seminar (AERO 681). The maximum course load for graduate students is 15 hours. International students are not always required by INS to register during the summer; however, if they are paid as an assistant, they must register for 6 hours in the 10-week session.

SEMINAR POLICY
Master's students are required to have a minimum of 2 hours of AERO or MEMA 681. Ph.D. students are required to have a minimum of 4 hours of AERO 681 or MEMA 681. Individual advisors may recommend more, but not less. The seminar courses may be used to satisfy degree program requirements (up to 2 hours for M.S., and up to 4 hours for Ph.D.). Some faculty, at their discretion, may require students to attend and/or register for seminar more often, or even every semester.

Suggestion: save some AERO 681 hours for latter terms when your research has matured (you will be asked to present your work at seminar).

ACADEMIC PERFORMANCE
Graduate students should maintain a GPA of 3.0 or better (some fellowships require a 3.2 or 3.5 GPA). Students who fall below a 3.0 are placed on scholastic probation, and such students must establish a written plan with the department's graduate advisor to remedy the situation. Prolonged probation will jeopardize a funded appointment and may lead to dismissal.

DEGREE PLAN REQUIREMENT
Master's students must have on file an approved degree plan prior to pre-registration for the 2nd semester after enrollment; Doctoral students must file prior to pre-registration of the 3rd semester. Failure to have an approved degree program will result in a student being blocked for registration by the Aerospace Engineering Department and the Office of Graduate Studies.

OFFICE AND LAB ASSIGNMENTS
We are able to provide most of our graduate students with superior office space. Our primary goal is to do our best to find every graduate student an office, but in some cases, it may not be exactly what the student prefers. We recognize that our teaching assistants need a place to meet with students, our research assistants need a place to think, and all graduate students need a place to study. Our policy is to be as fair and consistent as possible to all students when offices are assigned. Our priority policy gives funded Ph.D. students the highest priority, working down on the priority list to unfunded students.

Office assignments are provided by the department head's designee (currently, Ms. Karen Knabe). No one else, including your faculty advisor, may make assignment decisions. Each student must realize...
that offices are deemed a privilege, and abuse of the policy will result in loss of office. This includes manipulation of facts, disrespect of property, and disrespect to others. If you are assigned an office, you will also have a shared mailbox in the 6th floor kitchen. If you find that you do not need the office for any reason, in consideration of other students, please let Mrs. Knabe know so the office can be assigned to another student.

**EMAIL AND CONTACT INFORMATION**
The department has computing facilities, your advisor may provide research computers in assigned offices and TAMU has open computer labs. Important university and department announcements are now almost always sent through email to the student’s neo account. It is your responsibility to check this account often and to provide your correct address/phone/email contact to the payroll office, registrar and to the department graduate office.

**MULTIPLE FELLOWSHIP, STIPENDS, AND OTHER AWARDS**
Our department offers competitive financial support for its students. When possible, graduate students are nominated for multiple awards and sources of support from both TAMU and external organizations. These awards may include, but are not limited to, full or partial stipends, tuition support, supplemental grants, etc. Sources may come from the College of Engineering, the Board of Regents, the Office of Graduate Studies, our department, as well as private industry, or the government. We may submit a candidate’s name to several competitive award committees for consideration, in hopes that the student receives one. The department expects the student to notify us of cases in which multiple awards are received. The student will be allowed to keep the best possible situation (such as the highest fellowship offer and highest supplemental award). However, the department does not permit situations such as a combination of multiple full fellowships, multiple tuition grants, plus other supplemental awards. If in doubt about accepting an award, ask the graduate director. In general, students are not permitted to hold a major fellowship (stipend plus, in some cases, tuition and/or fees) and a full research assistantship at the same time.

**VACATIONS**
Graduate students do not earn official vacation time (but are eligible for health insurance), and they are expected to support their funded activity year-around except during the official campus holiday breaks.

Periods between academic terms are important work periods; and they are not holiday breaks. Assistantship holders are expected to work between academic terms. This is true for breaks between any academic terms other than official breaks.

If you have plans (such as personal travel) which may require additional time away from work, you must have permission, and you must coordinate with your advisor, in advance, a plan to accrue time to justify your absence. Failure to obtain permission may jeopardize your funding.

Research assistants (GAR’s) must see their advisors regarding vacation. Teaching assistants (GANT’s) and students on any other form of departmental support must see their assigned supervisor for permission to be absent. International students should always go to the International Student Services office before travel to see if their documents are in order. A month or more prior to your travel, discuss your plans with an ISS counselor and obtain special letters or other documents as required to avoid re-entry problems. Many of your questions can be answered at the ISS website!

http://iss.tamu.edu

Revised 7/2008
C. Faculty Resumes

C.1 Aerodynamics and Propulsion Faculty

Name and Academic Rank: Rodney Bowersox, Professor

Degrees with fields, institution, and date:
- PhD, Aerospace Engineering, Virginia Polytechnic Institute & State University, 1992
- M.S., Aerospace Engineering, Virginia Polytechnic Institute & State University, 1990
- B.S., Aerospace Engineering, Virginia Polytechnic Institute & State University, 1988

Number of years of service on this faculty: 7
- Date of original appointment: August 2002
- Dates of advancement in rank: Promoted Full Professor, October 2007

Other related experience:
- Texas A&M University, Aerospace Engineering, College Station, TX
  - Associate Depart. Head for Grad. Programs & Research Infrastructure, Jun 2009-Present
  - Professor, Oct. 2007 – Present
  - Director, National Aerothermochemistry Laboratory, Aug. 2005 - Present
  - Associate Professor, Aug 2002 – Sept 2007
- The University Of Alabama, Aerospace Engineering & Mechanics, Tuscaloosa, AL
  - Interim Department Head, Jan 2001 – Aug 2001
  - Associate Professor, Aug 2000 – Aug 2002
  - Assistant Professor, Aug 1997 – Aug 2000
- Air Force Institute of Technology, Aeronautics and Astronautics, WPAFB, OH
  - Assistant Professor, Jan 1993 – Aug 1997

Consulting, patents, etc.:

State(s) in which registered: None

Principal publications of last five years:
(* indicates Student under the Direction of Dr. Bowersox)


**Scientific and professional societies of which a member:**
- AIAA, Associate Fellow, ASME, Fellow

**Honors and awards:**
- Texas A&M College of Engineering Fellow, 2009
- Texas A&M Engineering ’43 Webb Faculty Fellow, 2005
- Fellow, ASME, 2004
- The Lockheed Martin Excellence in Teaching Award, Texas A&M University, 2004
- Associate Fellow, AIAA, 2003
- AIAA Outstanding Aerospace Engineering Faculty Member at U of A, 1999, 2001
- Col. Charles A. Stone Award for Leadership at US AFIT, 1995
- Phi Kappa Phi and Sigma Gamma Tau Honor Societies
- Scholastic All American, 1988
- Lucille and Gilbert Seay Academic Scholarship, 1987

**Professional development activities in the last five years:** Continuous

**Institutional and professional service in the last five years:**
- Department and University
- Associate Department Head for Graduate Programs and Research Infrastructure
- Department Executive Committee

**Percentage of time available for research or scholarly activities:** 40%

**Percentage of time committed to the program:** 100%

**Other:** Director, National Aerothermochemistry Laboratory, Aug. 2005 – Present
Name and Academic Rank: Paul G. A. Cizmas, Professor

Degrees with fields, institution, and date:
- PhD Mechanical Engineering and Materials Science, Duke University, 1995
- Dipl. Ing. Aerospace Engineering, Politehnica University, 1984

Number of years of service on this faculty, including date of original appointment and dates of advancement in rank: 12
- Date of original appointment: August 1998
- Dates of advancement in rank: Assoc. Professor, September 2004; Professor, September 2009

Other related experience (Teaching, Industrial, etc.):
- 10/95-7/98 Senior Engineer/Scientist, Westinghouse Electric Corporation, Science and Technology Center, Pittsburgh, Pennsylvania.
- 9/88-9/91 Assistant Professor, Aerospace Engineering, Politehnica University.

Consulting, patents, etc.: Southwest Research Institute

State(s) in which professionally licensed or certified, if applicable: None

Principal publications of last five years:


Scientific and professional societies of which a member:
- American Institute of Aeronautics and Astronautics (Associate Fellow)
- American Society for Engineering Education (Member)
Honors and awards:
- Herbert H. Richardson Faculty Fellow, Texas A&M University, 2008-2009.
- Brockett Professorship Award, Texas A&M University, 2007-2008.
- Texas Engineering Experiment Station (TEES) Select Young Faculty, 2004.
- Westinghouse Science and Technology 1997 Technical Publication Award.
- ASME Liquid Propulsion 1995 Best Paper Award.

Institutional and professional service in the last five years:
Appointed to the National Research Council Committee on Air Force/Department of Defense Aerospace Propulsion that was chartered in 2005 by the Director of Defense Research and Engineering to provide input on the needs of DoD propulsion for the next 15 to 20 years;
Session Chair for International Forum on Aeroelasticity and Structural Dynamics (IFASD), Seattle, WA, 2009;

Percentage of time available for research or scholarly activities: 60%

Percentage of time committed to the program: 100%

Professional development activities in the last five years: Continuous

Other: NA
Name and Academic Rank: Diego A. Donzis, Assistant Professor

Degrees with fields, institution, and date:
- B.Sc, Aeronautical Engineering, Universidad Tecnologica Nacional, 2001
- M.Sc, Aerospace Engineering, Georgia Institute of Technology, 2004
- Ph.D, Aerospace Engineering, Georgia Institute of Technology 2007

Number of years of service on this faculty, including date of original appointment and dates of advancement in rank: 1
- Date of original appointment: August 2009
- Dates of advancement in rank: NA

Other related experience (Teaching, Industrial, etc.):
- Visiting Scientist Intl. Centre for Theor. Physics, Italy Spring 2004,5,6
- University of Maryland Fluid Dynamics Post-doc 2007-2009

Consulting, patents, etc.: None

State(s) in which professionally licensed or certified, if applicable: None

Principal publications of last five years:

Scientific and professional societies of which a member:
- American Physics Society, American Institute of Aeronautics and Astronautics,
- American Society for Engineering Education

Honors and awards:
- Invited speaker at the DOE 2010 Scientific Discovery through Advanced Computing (SciDAC) Conference to be held July 11-15, 2010.
- 5K Club Award for paper in the TeraGrid ’08 conference.
- Invited to the TeraGrid Planning Workshop, Chicago, August 2007.
- Best graduates from Universities in Argentina in 2002 award by the National
• Academy of Engineering. Pre-engineering award 2001 by the Engineering Society of Argentina.

Institutional and professional service in the last five years:
• Chair Computing Environment Committee, Aerospace Department
• Member Engineering Faculty Advisory Committee (EFAC)

Professional development activities in the last five years: Continuous

Percentage of time available for research or scholarly activities: 60%

Percentage of time committed to the program: 100%

Other: NA
Name and Academic Rank: Sharath S. Girimaji, Professor

Degrees with fields, institution, and date:
   PhD, Mechanical and Aerospace Engineering, Cornell University, 1990.
   M.S., Mechanical and Aerospace Engineering, Cornell University, 1990.
   B.S., Mechanical Engineering, IIT Madras, India, 1983

Number of years of service on this faculty: 11
   Date of original appointment: November, 1999
   Dates of advancement in rank: None

Other related experience:
   1995 – 1999: Senior Staff Scientist, ICASE, NASA Langley Research Center, Hampton, VA

Consulting, patents, etc.:  
ICASE, Hampton, Virginia; Taitech, Dayton, Ohio

State(s) in which registered: None

Principal publications of last five years:

Scientific and professional societies of which a member:
   • American Institute of Aeronautics and Astronautics (Member)
   • American Physical Society (Member)

Honors and awards:
   • 2001 TEES Special Research Fellow, Texas A&M University
   • 1997 Visiting Fellow, Indian Institute of Science, Bangalore, India.
- 1996  Japanese Government Research Award for Foreign Specialist

**Institutional and professional service in the last five years:**

- Department Head Search Committee: 2004
- Graduate Committee, Department of Aerospace Engineering, Member: (2001- )
- Faculty Search Committee, Member: (2002- )
- Department head Search Committee member: (2003- )
- **Editorial Advisory Board:** Theoretical and Computational Fluid Dynamics, Springer-Verlag, 2002 - Present
- **Conference Organizer:**
  - Workshop on “Applications of Lattice Boltzmann method”, July 2002, College Station, TX.
  - Workshop on “URANS/PANS method for turbulence modeling”, October 2001, College Station,

**Conference Organizing Committee:**


**Percentage of time available for research or scholarly activities:** 30%

**Percentage of time committed to the program:** 100%

**Other:**

- Member of National Research Council review panel on AFOSR funding proposals and reviewer of proposals for NSF Fluids program, 1997 - 1999.
Name and Academic Rank: Adonios N. Karpetis, Associate Professor

Degrees with fields, institution, and date:
- PhD Mechanical Engineering, Yale University, 1998
- MPhil Mechanical Engineering, Yale University, 1996
- MSc Mechanical and Aerospace Engineering, Princeton University, 1992
- DIng Mechanical Engineering, Aristotle University, Thessaloniki, Greece, 1989

Number of years of service on this faculty, including date of original appointment and dates of advancement in rank: 6
  Date of original appointment: October 2004, Promoted to Associate Professor: September 2009

Other related experience (Teaching, Industrial, etc.):
- Post-doctoral Associate, Combustion Research Facility, Sandia Nat’l Labs, Livermore, CA
  10/98-7/00 Post-doctoral Associate, Mechanical Engineering, Yale University

Consulting, patents, etc.: None

State(s) in which professionally licensed or certified, if applicable:
None (US), Grade A (EU)

Principal publications of last five years:


Scientific and professional societies of which a member:
- American Institute of Aeronautics and Astronautics
- Optical Society of America
- American Society of Mechanical Engineers
- American Physical Society
- Combustion Institute

Honors and awards:
- Silver Medal of the Combustion Institute, 2004
- Invited plenary talk, 4th US National Combustion Meeting, 2005
Institutional and professional service in the last five years:
- Member, Departmental Graduate Affairs committee
- Member, Engineering Faculty Advisory Council
- Reviewer of many journals articles and research proposals in the areas Laser Diagnostics, Propulsion and Combustion

Percentage of time available for research or scholarly activities: 50%

Percentage of time committed to the program: 45%

Professional development activities in the last five years: Continuous

Other:
1 PhD, 2 MS students graduated, 2 PhD, 1 MS students currently enrolled. Conducted research and published with 7 undergraduate students during the last 5 years. Introduced General (AERO 212-500) and Honors (AERO 212-200) sections of Sophomore Thermodynamics into the departmental curriculum. Introduced new graduate courses in Laser Diagnostics (AERO 642) and High-Speed Combustion (AERO 641).
Name and Academic Rank: Othon K. Rediniotis, Professor

Degrees with fields, institution, and date:
- PhD, Engineering Mechanics, Virginia Tech, 1992
- MS, Engineering Mechanics, Virginia Tech, 1989
- BS, Mechanical Engineering, National Technical University of Athens, Greece, 1987

Number of years of service on this faculty, including date of original appointment and dates of advancement in rank: 15
- Date of original appointment: January 1995
- Dates of advancement in rank: Assoc. Professor, September 1999; Professor, September 2005

Other related experience (Teaching, Industrial, etc.):
- 1/93-12/94 Visiting assistant professor, Engineering Science and Mechanics Department, VPI&SU, Blacksburg, VA
- 9/88-4/12/92 Instructor, Engineering Science and Mechanics Department, VPI&SU, Blacksburg, VA.

Consulting, patents, etc.:
- Consulting: Aeroprobe Corp., Blacksburg, VA; Boeing Company/NASA Langley, Hampton, VA; Energy Innovations, Houston, TX; Boeing Company, Defense and Space Group, Philadelphia, PA; Shell Development Company, Houston, TX; United Technologies Research Center, East Hartford, CT; Norton Company, Worcester, MA; AT&T Bell Laboratories, Murray Hill, NJ; ICI Films Inc., Richmond, VA; ITT Electro-Optical Products, Roanoke, VA.


State(s) in which professionally licensed or certified, if applicable: None

Principal publications of last five years:
Scientific and professional societies of which a member:
- American Institute of Aeronautics and Astronautics (Associate Fellow)
- American Society of Mechanical Engineers (Member)
- Technical Chamber of Greece (Member)

Honors and awards:
- E.D. Brockett Professor, College of Engineering, Texas A&M University; Sept. 2005.
- TEES Fellow, College of Engineering, Texas A&M University; Sept. 2004.
- TEES Fellow, College of Engineering, Texas A&M University; Sept. 2000.

Institutional and professional service in the last five years:
- Chairman, Departmental Laboratory Equipment Fund committee
- Member, Departmental Promotion and Tenure committee
- Reviewer of many technical journals in the areas of Fluid Dynamics

Professional development activities in the last five years: Continuous

Percentage of time available for research or scholarly activities: 45%

Percentage of time committed to the program: 100%

Other:
- Founder, Orthochronos Forecasting, College Station, TX, 2008.
Name and Academic Rank: Helen L. Reed, Professor

Degrees with fields, institution, and date:

Number of years of service on this faculty: 6 years.

Date of original appointment: December 2004.

Dates of advancement in rank: Professor (tenure), December 2004.

Other related experience (Teaching, Industrial, etc.):
- 12/04-11/08  Department Head, Aerospace Engineering, Texas A&M University.
- 08/85-12/04  Arizona State University (ASU).
- 07/92-12/04  Professor, Mechanical & Aerospace Engineering (MAE).
- 08/85-06/92  Associate Professor, MAE. (Tenure awarded 04/88).
- 07/03-08/04  Vice Chair for Graduate Programs, MAE.
- 12/94-12/04  Associate Director, ASU / NASA Space Grant Program.
- 08/93-08/96  Director, Aerospace Research Center.
- 09/91-06/92  Associate Professor, Tohoku University, Sendai, Japan.
- 07/84-08/84  Summer Faculty, NASA/Langley Research Center.
- 07/83-08/83  Summer University Faculty, Sandia National Laboratories.
- 09/82-08/85  Assistant Professor, Mechanical Engineering, Stanford University.
- 06/77-12/81  Aerospace Technologist, NASA/Langley Research Center.
  Summer 1976  Mathematics Aid, NASA/Langley Research Center.

Consulting, patents, etc.: Currently consult: ManTech SRS Industries, Inc.; Lockheed Martin.

State(s) in which professionally licensed or certified, if applicable: None.

Principal publications of last five years:

Scientific and professional societies of which a member:
- American Institute of Aeronautics and Astronautics (Fellow).
- American Physical Society (Fellow).
- American Society for Mechanical Engineers (Fellow).
- American Astronautical Society (Member).
- American Society for Engineering Education (Member).
- AMSAT (Radio Amateur Satellite Corporation; Member).

Honors and awards:
AIAA/ASEE J. Leland "Lee" Atwood Award, bestowed annually upon an aerospace engineering educator in recognition of outstanding contributions to the profession, 2007.

Institutional and professional service in the last five years:

- Chair and Webmaster, Aerospace Department Chairs Association (ADCA).
- Member, AIAA Transition Study Group.
- Instructor, VKI (RTO/NATO) and AIAA Professional courses on “Stability and Transition”.
- Member, AIAA Academic Affairs Committee.
- Texas A&M Institutional Representative for USRA.
- Advisory committee for Aero programs at New Mexico State, Univ Washington, Virginia Tech.
- Member, AIAA Journal Editor in Chief Selection Committee.
- Member, AIAA Fellows Selection Committee.
- Member, Scientific Advisory Board, National Institute of Aerospace (NIA).
- Deputy Co-Chair, National Space Grant Student Satellite Program Steering Committee.
- Member, AIAA Fluid Dynamics Technical Committee.
- Member, Workshop with OSTP/NASA HQ on future National Aeronautics Policy.
- Originator of AIAA CFD Student Paper Competition, biannually at Summer meetings.
- SEDS Faculty Advisor. Texas A&M hosted “SpaceVision 2008 – SEDS Conference”.
- Texas A&M Service:
  - Chair of Nuclear Engineering Dept Head Search; College Strategic Planning Committee.
  - Aerospace Tenure & Promotion, Computing Environment, Aero-Fluids Search Committees.
  - Advisor and sponsor for several student organizations:
    - SEDS “Students for the Exploration and Development of Space”.
    - AggieSat Lab Student Satellite Program. Two full-time professional staff. Named “Registered Student Organization of Year for 2008-2009” by Department of Student Activities of The Association of Former Students. See http://aggiesat.org:
    - AFOSR/AFRL/AIAA University Nanosat Program: AggieSat1, AggieSat3.
    - LONESTAR: NASA Johnson sponsoring 8-year/4-mission program with Texas A&M and Univ Texas to develop autonomous rendezvous and docking technology. 1st launch (DragonSat/AggieSat2) is 5” cube to be released from STS 127 (launch 07/09). NASA Phase 0/I/II Safety Review 10/08 along with fit check into SSPL, Phase III Safety Review 02/09, flight unit delivered to NASA 02/09.

Percentage of time available for research or scholarly activities: 33%.

Percentage of time committed to the program: 100%.

Professional development activities in the last five years: Continuous.

Other:
At Arizona State, 2 major student satellites launched with the USAF: ASUSat1 – 13-pound nanosatellite on inaugural OSP SLV “Minotaur” in January 2000.
Three Corner Sat – Satellite constellation on Delta IV Heavy Demo mission in Dec 2004.
Name and Academic Rank: Jacques C. Richard, Sr. Lecturer; Associate Research Engineer

Degrees with fields, institution, and date:
- PhD  Aeronautical Engineering. Rensselaer Polytechnic Institute, 1987
- ME  Aeronautical Engineering. Rensselaer Polytechnic Institute, 1989
- BS  Aerospace Engineering. Boston University, 1984

Number of years of service on this faculty, including date of original appointment and dates of advancement in rank: 7.7
  Date of original appointment: January 2003
  Dates of advancement in rank:

Other related experience (Teaching, Industrial, etc.):
8/97-12/02 Assistant Professor, Chicago State University, Chicago, IL 60628.
1/96-8/97 Computational Scientist, Argonne National Laboratory, Argonne, IL 60439.
8/95-12/95 Lecturer, Northwestern University, Evanston, IL 60208.
1/89-6/95 Aerospace Engineer, NASA Glenn Research Center, Cleveland, OH 44135.

Consulting, patents, etc.: None

State(s) in which professionally licensed or certified, if applicable: None

Principal publications of last five years:

Scientific and professional societies of which a member:
- American Institute of Aeronautics and Astronautics (AIAA Senior Member, member since 1983)
- American Society for Mechanical Engineers (ASME, Member for 15yrs)
- American Physical Society (APS): Fluid, Plasma & Computational Physics Divisions 2002-
- American Society for Engineering Education (ASEE Member)

Honors and awards:
- NASA Teamwork Award; 2 NASA Performance Cash Awards
• Dr. A. T. Weathers National Technical Achievement Award

**Institutional and professional service in the last five years:**
- AIAA General Aviation Technical Committee,
- NSF Review Panels;
- Textbook reviews;
- Professional Development Workshops;
- Reviewer of many technical journals in the areas of Fluid Dynamics for ASME, AIAA, APS, ASEE and other journals and conferences

**Percentage of time available for research or scholarly activities:** 45%

**Percentage of time committed to the program:** 50%

**Professional development activities in the last five years:** Continuous

**Other:**
- Director and Principal Investigator of NSF Research Experience for Undergraduates (REU): AERO-U: Aerospace Engineering Research Opportunities for Undergraduates
Name and Academic Rank: William S. Saric, Distinguished Professor

Degrees with fields, institution, and date:
M.S. Mechanical Engineering, June 1965, University of New Mexico, Albuquerque, NM.

Number of years of service on this faculty: 5.5
Date of original appointment: September 2005
Dates of advancement in rank: Distinguished Professor, 2008

Other related experience:
Jan 2000 – Nov 2000: Arizona State University, Vice-Chair for Aerospace Engineering
Sept 1991 - July 1992: Tohoku University, Japan, Professor, Aeronautics and Astronautics.
Promoted to Professor, May 1979.

Consulting, patents, etc.:

State(s) in which registered: Virginia, Lic. No. 13427

Principal publications of last five years:

Scientific and professional societies of which a member:
• American Institute of Aeronautics and Astronautics (AIAA)
• American Society of Mechanical Engineers (ASME)
• American Physical Society (APS)
• Society of Engineering Science (SES)
• Society of Flight Test Engineers (SFTE)

**Honors and awards:**

• Member, National Academy of Engineering 2006
• Member, The Academy of Medicine, Engineering, and Science of Texas 2006
• Recipient of the MMAE Department, IIT Alumni Recognition Award 2005
• AIAA Fluid Dynamics Award 2003
• AGARD (NATO) Scientific Achievement Award 1996
• SES G.I. Taylor Medal 1993
• Fellow, AIAA 2005
• Life Fellow, ASME 1993
• Fellow APS 1982

**Institutional and professional service in the last five years:**

• Editorial Board, AIAA J. 2008–present
• Chairman, *AIAA Transition Study Group* (Fluid Dynamics TC), 2000 – present
• Journal and proposal referee
• University, College, Department Committees

**Professional development activities in the last years:** Continuous

**Percentage of time available for research or scholarly activities:** 50%

**Percentage of time committed to the program:** 100%

**Other:** None
Name and Academic Rank: Edward B. White, Associate Professor

Degrees with fields, institution, and date:
- PhD Aerospace Engineering, Arizona State University, 2000
- MS Mechanical Engineering, Case Western Reserve University, 1997
- MS Aerospace Engineering, Case Western Reserve University, 1995

Number of years of service on this faculty, including date of original appointment and dates of advancement in rank: 4
- Date of original appointment: January 2007 as Asst. Professor

Other related experience (Teaching, Industrial, etc.):
- 8/06-12/06 Asst. Prof., Mechanical and Aerospace Engineering, Case Western Reserve Univ.
- 8/00-7/06 Asst. Prof., Mechanical and Aerospace Engineering, Case Western Reserve Univ.

Consulting, patents, etc.: None

State(s) in which professionally licensed or certified, if applicable: None

Principal publications of last five years:

Scientific and professional societies of which a member:
- American Institute of Aeronautics and Astronautics (Senior Member)
- American Society of Mechanical Engineering (Member)
- American Physical Society (Member)

Honors and awards:

Institutional and professional service in the last five years:
- Member of AIAA Fluid Dynamics Technical Committee
- Aero/Fluids Representative, Department Graduate Committee
• Chairman, Department Equipment Committee
• Reviewer of many fluid dynamics/aerodynamics technical journals

Percentage of time available for research or scholarly activities: 40%

Percentage of time committed to the program: 100%

Professional development activities in the last five years: Continuous.

Other: None
C.2 Dynamics and Control Faculty

Name and Academic Rank: Kyle T. Alfriend, Research Professor

Degrees with fields, institution, and date:
PhD Engineering Mechanics, VA Tech, 1967
MS Applied Mechanics, Stanford University, 1964
BS, Engineering Mechanics, VA Tech, 1962

Number of years of service on this faculty, including date of original appointment and dates of advancement in rank:
14 years.
Date of joining: 1 January 1997

Other related experience (Teaching, Industrial, etc.):
1/94-12/96, Naval Postgraduate School, Visiting Chair Professor
3/85-12/93, General Research Corp, Group Director
3/83-3/85, CIA, Scientist
5/74-3/83, Naval Research Lab, Branch Head
9/73-5/74, NRC Senior Postdoc, NASA GSFC
9/67-8/73, Cornell University, Assistant Professor, Theoretical & Applied Mechanics

Consulting, patents, etc.:
AT&T, Numerica, Booz Allen Hamilton

State(s) in which professionally licensed or certified, if applicable: None

Principal publications of last five years: (Journals)


Scientific and professional societies of which a member:
AIAA, AAS, SIAM, ASEE

Honors and awards:
2010 Kyle T. Alfriend Astrodynamics Symposium
2008 Von Karman Lecture, Israel Aerospace Sciences Conference
2007 T.A. Wilson Lecture, Iowa State University
2005 AAS International Scientific Cooperation Award
2005 Appointed to the Air Force Institute of Technology Board of Visitors
2004 Appointed to the USAF Air University Board of Visitors
2004 Elected to the Academy of Excellence at Va Tech.
2004 Best Paper Award, AAS/AIAA Space Flight Mechanics Conference, Feb. 2004
2003 Elected charter member of the Texas Academy of Science, Engineering and Medicine
2002 Elected a member of the European Academy of Science
2000  Appointed the Wisenbaker II Chair Professor of Aerospace Engineering
1999  Elected to the National Academy of Engineering
1998  Elected member of the International Academy of Astronautics
1998  Awarded AIAA Mechanics and Control of Flight Award
1989  Awarded 1989 AAS Dirk Brouwer Award for outstanding contributions in Space Flight Mechanics and Astrodynamics
1988  Elected Fellow, AIAA
1985  Elected Fellow, AAS
1981  Navy Meritorious Civilian Service Award

Institutional and professional service in the last five years:
2011  Member of Review Team, Aerospace Engineering, Univ of Colorado
2010  NRC Committee on Review of NASA Debris Research
2009 - 2010  NASA Aeronautics & Space Engineering Board (ASEB)
2008 - 2008  NRL Space Research Review Board
2004 - 2004  Member, Air University Board of Visitors
2004 - 2004  Member, Air Force Institute of Technology Board of Visitors

Professional development activities in the last five years:

Percentage of time available for research or scholarly activities: 90%

Percentage of time committed to the program: 100%

Other:  None
Name and Academic Rank: Raktim Bhattacharya, Assistant Professor

Degrees with fields, institution, and date:
- PhD Aerospace Engineering, University of Minnesota, 2003
- MS Aerospace Engineering, University of Minnesota, 2000
- B.Tech Aerospace Engineering, Indian Institute of Technology, 1996

Number of years of service on this faculty, including date of original appointment and dates of advancement in rank:

Other related experience (Teaching, Industrial, etc.):
- 1/03 – 9/04 Post Doctoral Scholar, Control & Dynamical Systems, Caltech.
- 10/04 – 9/05 Senior Research Engineer, United Technology Research Center, Hartford, CT.

Consulting, patents, etc.:

State(s) in which professionally licensed or certified, if applicable: None

Principal publications of last five years: (Journals)

Scientific and professional societies of which a member:
AIAA, IEEE

Honors and awards:
- Best job award – United Technologies Research Center: Awarded for developing an engineering process for efficient embedded system design for UTC. UTC has currently adopted this in designing their embedded systems.

Institutional and professional service in the last five years:
- Associate Editor: IEEE International Conference on Control Applications (CCA), San Antonio, TX, Sep 3-5, 2008.
- Committee Member: AERO 220, AERO 320.
- Aerospace Computer Committee: Committee is responsible for improving existing computer related facilities, such as web page, email, data backup etc, in the Aerospace Engineering Department.
- Committee Member: PhD Qualifier for Waqar Mallik, Mechanical Engineering, Dr. Swaroop Darbha, Dr. Rajagopal.
- Committee Member: PhD Candidate Leslie Weitz, Aerospace Engineering. Advisor: Johnny Hurtado.
- Committee Member: PhD Candidate Carolina Restrepo, Aerospace Engineering. Advisor: Johnny Hurtado.
- Committee Member: PhD Candidate Ranjani Sridharan, Computer Science. Advisor: Rabi Mahapatra.
- Committee Member: PhD Candidate Roshnik Saha, Aerospace Engineering. Advisor Suman
Committee Member: PhD Candidate Sandip Singh, Aerospace Engineering. Advisor Suman Chakravorty.


Reviewer NASA Postdoctoral Program (administered by Oak Ridge Associated Universities), 2008.

Professional development activities in the last five years:
Averaged three technical presentations each year; Chaired several technical sessions in reputed conferences; Attend numerous technical presentations; Invited by several universities to give presentations.

Percentage of time available for research or scholarly activities: 50%

Percentage of time committed to the program: 100%

Other: Graduated 1 Ph.D, 4 M.S. Former Ph.D student is currently with Raytheon.
Name and Academic Rank: Suman Chakravorty, Associate Professor

Degrees with fields, institution, and date:
- PhD Aerospace Engineering, University of Michigan, 2004
- B.Tech Mechanical Engineering, Indian Institute of Technology, 1997

Number of years of service on this faculty, including date of original appointment and dates of advancement in rank: 6 years
- Appointed Assistant Professor on Aug. 2 2004, Associate Professor: September 2010

Other related experience (Teaching, Industrial, etc.):
- N/A

Consulting, patents, etc.:
- N/A

Principal publications of last five years:


Scientific and professional societies of which a member:
- Member, AIAA, IEEE

Honors and awards:
- Best Paper in conference award, 2006 Astrodynamics Specialist Conference, Breckenridge, CO
- Best Paper in session award, ACC 2006, 2008

Institutional and professional service in the last five years:

Reviewer

Session chair
American Control Conference (ACC), IEEE/ASME Conference on Advanced Intelligent Mechatronics (AIM), AIAA Guidance, Navigation and Control Conference (GNC)

International Program Committee
2010 IEEE International Symposium on Intelligent Control (ISIC), Pacifico Yokoham, Japan

Percentage of time available for research or scholarly activities: 45%

Percentage of time committed to the program: 100%

Professional development activities in the last five years: Continuous

Other: N/A
Name and Academic Rank: John Hurtado, Associate Professor

Degrees with fields, institution, and date:
- PhD, Aerospace Engineering, Texas A&M University, 1995
- M.S., Aerospace Engineering, Texas A&M University, 1991
- B.S., Aerospace Engineering, San Diego State University, 1988

Number of years of service on this faculty: 10
  Date of original appointment: January 2001, Promoted to Associate Professor in September 2007

Other related experience:
- 1995-1997, Sandia National Laboratories, Albuquerque, NM, Senior Member of Technical Staff, Experimental Structural Dynamics Department
- 1997-2000, Sandia National Laboratories, Albuquerque, NM, Senior Member of Technical Staff (1997-1999); Principle Member of Technical Staff (1999-2000) Intelligent Systems, Sensors, and Controls Department

Consulting, patents, etc.:


State(s) in which registered: None

Principal publications of last five years:

Scientific and professional societies of which a member:
- American Institute of Aeronautics and Astronautics (Associate Fellow)
- American Astronautical Society (Member)

Honors and awards:
• 2010-11 Association of Former Students College-Level Distinguished Achievement Award
• 2009-10 BP Teaching Excellence Award within the College of Engineering
• 2010 Thomas U. McElmurry Teaching Excellence Award, Aerospace Engineering Department
• Sandia National Laboratories Individual Performance Award as a member of the Microchemlab Team for “Exceptional achievement in the development of breakthrough technologies and systems concepts and designs,” February 1999.
• Sandia National Laboratories Individual Performance Award for “Excellence in modal testing of the EKV payload,” July 1996.

Institutional and professional service in the last five years:
• Faculty Search Committee, Department of Aerospace Engineering, Aerospace Structures Position, June 2009 - March 2010.
• Undergraduate Affairs Committee, Department of Aerospace Engineering, 2009-Present.
• AFQE Dynamics & Control Coordinator, Department of Aerospace Engineering: 2002-present.
• Task Force for Faculty Performance Evaluations, Texas A&M University, November 2009 - Present.
• Davidson Fellows Scholarship Reviewer, April 2009.

Professional development activities in the last years:
Averaged one technical presentation each year. Attend numerous technical presentations.

Percentage of time available for research or scholarly activities: 50%

Percentage of time committed to the program: 100%

Other: None
Name and Academic Rank: David Hyland, Royce E. Wisenbaker Chair, Professor, Department of Aerospace Engineering, Professor of Physics.

Degrees with fields, institution, and date:
- PhD, Aeronautics and Astronautics, Massachusetts Institute of Technology, 1973
- M.S., Aeronautics and Astronautics, Massachusetts Institute of Technology, 1971
- B.S., Aeronautics and Astronautics, Massachusetts Institute of Technology, 1969

Number of years of service on this faculty: 8
Date of original appointment: September 2003

Other related experience:
- Associate Vice Chancellor of Engineering, Deputy Director of TEES (Texas Engineering Experiment Station), Associate Dean of the Dwight Look College of Engineering (2003-2005)
- Professor and Head, Aerospace Engineering Department, University of Michigan, 1996-2003
- Senior Scientist, Harris Corporation, 1992-1996
- Lead Scientist of Structural Control Group, Harris Corporation, 1983-1992
- Staff Engineer, MIT Lincoln Laboratory, 1974-1983
- Staff Engineer, Cambridge Collaborative, Inc., 1973-1974
- Research Associate, MIT Lincoln Laboratory, 1969-1973

Consulting, patents, etc.:
- Harris Patent Awards (6)

State(s) in which registered: None

Principal publications of last five years:

Scientific and professional societies of which a member:
- American Institute of Aeronautics & Astronautics
- Institute of Electrical and Electronics Engineers
- American Astronomical Society

Honors and awards:
- Harris Government System Sector Executive Incentive Program Award, Awarded 1987
- Harris ASD Engineering Award for Outstanding Individual Contribution, Awarded 1986
- Harris Patent Awards (6)
• NASA Honorary Superior Accomplishment Award (1991)
• Thomas U. McElmurry Excellence in Teaching Award (2006)

Institutional and professional service in the last five years:
Chairman of the Board of Directors, Texas Space Grant Consortium
TAMU representative for the Universities Space Research Association (USRA)

Professional development activities in the last years: Continuous

Percentage of time available for research or scholarly activities: 45%

Percentage of time committed to the program: 100%

Other: None
Name and Academic Rank: John Junkins, Distinguished Professor, Regents Professor

Degrees with fields, institution, and date:
- BAE, Aerospace Engineering, Auburn Univ, (1965);
- MS Engineering, UCLA (1967);
- PhD Engineering, UCLA (1969)

Number of years of service on this faculty: 25
- Date of original appointment: September 1985
- Dates of advancement in rank: TEES Distinguished Chair Professor, 1985-1989; George J. Eppright Chair Professor, 1989; Distinguished Professor, 1998; Regent’s Professor, 2002; Royce E. Wisenbaker Chair in Engineering, 2006.

Other related experience:
- Assistant and Associate Prof., U. of Virginia (1970-1977);
- McDonnell Douglas Astronautics Company, (1966-1970);

Consulting, patents, etc.:

State(s) in which registered: Texas, License #64161

Principal publications of last five years:

Journals: (>200, only 14 recent papers published since 2009 are listed)


Scientific and professional societies of which a member:
National Academy of Engineering; International Academy of Astronautics; American Inst of Aeronautics and Astronautics (Fellow, just elected Honorary Fellow); American Astronautical Soc (Fellow); Institute of Navigation.

Honors and awards:

Institutional and professional service in the last five years:
**Institutional**: Director, Center of Mechanics and Control; Distinguished Professors Executive Committee, Member: (1999-2009); Aerospace Engineering Dept Head Search Committee (2003-2004); Chair of Engineering Chair Council, TAMU (2003-2008); Member of the TAMU Presidential Search Advisory Committee (2009-2010); Member of the College of Engineering Strategic Planning Committee (2008-2010); Member of the Academic Master Plan Steering Committee and Research Roadmap Committee (2008-2010).

**Professional**: NAE Peer Committee, Section 1; The Air Force Science Advisory Board (2005-2008); The Aeronautics and Space Engineering Board (ASEB) (2001-2004); Board of Governors, Texas Academy of Medicine, Engineering and Science (2003-2008).

Professional development activities in the last years: Continuous

Percentage of time available for research or scholarly activities: 45%

Percentage of time committed to the program: 100%

Other: None
Name and Academic Rank: Tamás Kalmár-Nagy, Assistant Professor

Degrees with fields, institution, and date:
- PhD Theoretical and Applied Mechanics, Cornell University, 2002
- M.Sc Engineering Mathematics, Technical University of Budapest, 1995

Number of years of service on this faculty, including date of original appointment and dates of advancement in rank: 4.5
- Date of original appointment: January 2006

Other related experience (Teaching, Industrial, etc.):
- 9/2002-8/2005 Research Engineer, United Technologies Research Center

Consulting, patents, etc.: None

State(s) in which professionally licensed or certified, if applicable: None

Principal publications of last five years:
1. Zhao, S., Kalmár-Nagy, T., Center Manifold Analysis of the Delayed Lienard Equation, Recent Advances in DDEs, Balachandran et al. eds, pp. 203-219, 2009
7. Kalmár-Nagy, T. and Erneux, T., Approximation of small and large amplitude oscillations of $x''+(1+x'^2)x=0$, Journal of Sound and Vibration, 313, 3-5, pp. 806-811, 2008

Scientific and professional societies of which a member:
- American Society of Mechanical Engineers

Honors and awards:

Institutional and professional service in the last five years:
- ASME, Member, Technical Committee on Multibody Systems and Nonlinear Dynamics
- ASME, Member, Technical Committee on Sound and Vibration
- Associate Editor, Fluctuation and Noise Letters, 2007-
- Associate Editor, Mathematical Problems in Engineering, 2007-
• D&C Faculty Position Search Committee, Spring 2007

Percentage of time available for research or scholarly activities: 50%

Percentage of time committed to the program: 45%

Professional development activities in the last five years: Continuous

Other:

Undergraduate advising:
Robotic Space Exploration 2006-2007 (SEI) 10 students
Teleoperation 2007-2008 (SEI) 10 students
AggieChopper 2007-2008 4 students
Artificial Vision for Lunar Exploration 2008-2009 (SEI) 8 students
SAE team 2008-2009 6 students
USRG, summer 2009 1 student
Name and Academic Rank: Daniele Mortari, Associate Professor

Degrees with fields, institution, and date:
Dr. Eng. Nuclear Engineering, University of Rome (Italy), 1981.

Number of years of service on this faculty: 8
Date of original appointment: August 2002, Associate Professor: September 2007

Other related experience:
1983-1990 Consultant for the San Marco Project, for several companies under ESA and Aeritalia contracts, and for the Computer Control System Company in Rome, Italy.
1992-2002 Assistant Professor at the Aerospace School of Engineering of University “La Sapienza” of Rome, Italy.
1998-2001 Visiting Professor teaching “Aerospace Systems” at the Faculty of Electronic Engineering of the University of Perugia, Italy.
1998-2001 Visiting Associate Professor researching at the Department of Aerospace Engineering of the Texas A&M University, College Station, Texas.

Consulting, patents, etc.:

State(s) in which registered: None

Principal publications of last five years:

Scientific and professional societies of which a member:
• Associate Fellow, American Institute of Aeronautics and Astronautics, member of American Astronautical Society, Sigma Xi, IEEE Aerospace and Electronic Systems Society, and Phi Beta Delta, Honorary Association.

Honors and awards:
• NASA Group Achievement Award (for the San Marco Spacecraft).
• NASA Group Achievement Award (for the New Millennium ST6 Inertial Stellar Compass).
• 2007 IEEE Judith A. Resnik Award.

Institutional and professional service in the last five years:
• Associate Editor, AAS Journal of the Astronautical Sciences (Jan. 03-present).
• Distinguished Speaker, IEEE Distinguished Lectures Program (Feb. 05-present).
• International Advisory Board, Italian Space Mission FLORAD (Jan. 04-present).
• Associate Editor, IEEE Transactions on Aerospace & Electronic Systems (Apr. 06-present).
• Associate Editor, International Journal of Navigation and Observation (Oct. 06-present).
• AAS Space Flight Mechanics Technical Committee (Sep. 2006-present).
• IEEE Judith A. Resnik Award Committee (Oct. 07-present).
• Mini-symposium organizer, Algebraic Geometry Applied to Celestial Mechanics, of SIAM Conference on Applied Algebraic Geometry, Oct. 6-9, 2011, North Carolina State University, Raleigh, NC.

Professional development activities in the last years:
13 invited seminars, chaired 3 conference sessions, organized 2 international conferences, and attended numerous technical presentations.

Percentage of time available for research or scholarly activities: 40%

Percentage of time committed to the program: 100%

Other: None
Name and Academic Rank: Thomas Pollock, Associate Professor

Degrees with fields, institution, and date:
- B.S., Metallurgical Engineering, Virginia Tech, 1971
- M.S., Materials Science, Texas The University of Virginia, 1974
- PhD, Materials Science, Texas The University of Virginia, 1977

Number of years of service on this faculty: 33
  Date of original appointment: 1977
  Date of advancement in rank: 1983

Consulting, patents, etc.:
- Patents: 1 awarded
  Designed two optical testing laboratories (StarVision Technologies, 2006 and Spacecraft Engineering Research Center, TEES, 2008)

States in which registered as a professional engineer: Texas

Principal Publications of the Last Five Years:
2. "Processing of TiNi from Elemental Powders by Hot Isostatic Pressing", M.D.

Scientific and professional societies of which a member: SPIE

Honors and awards:
- Ford fellowship, 2001 – 2003

Institutional and professional service during the past five years:
- Member, Ford Committee for Undergraduate Design Education
- Principal author of a proposal for a new Engineering Design Center for Texas A&M University College of Engineering. A $94M project.
- Member, Boeing Interdisciplinary Design Project
- Faculty advisor to the Texas A&M Solar Motorsports Team, 2003 - 2007. Participant in 2003 and 2005 American Solar Challenge Races. Each race is run on public highways for a distance of approximately 2500 miles. During the 2003 race from Chicago to Los Angeles, Dr. Pollock donated more than 600 hours of his time to this endeavor.
Percentage of time available for research and scholarly activities: 40%

Percentage of time committed to the program: 100%

Professional development activities during the last five years:
- Developed a new graduate course: Optical methods in aerospace engineering
- Taught two undergraduate courses for the first time
- Accumulated several CEUs per year as required of all Texas PEs.

Other: Chief Engineer and principal hardware designer of a shuttle-based experiment
Name and Academic Rank: Jonathan D. Rogers, Assistant Professor

Degrees with fields, institution, and date:
- BS, Physics, Georgetown University (2006);
- MS Aerospace Engineering, Georgia Institute of Technology (2007);
- PhD Aerospace Engineering, Georgia Institute of Technology (2009)

Number of years of service on this faculty: New Fall 2011

Other related experience:
- Research Engineer II, Georgia Institute of Technology, Department of Aerospace Engineering, May 2010 – August 2011.
- Research Engineer II, Georgia Institute of Technology, Department of Aerospace Engineering, May 2010 – Present.
- Teaching Fellow, Georgia Tech Department of Aerospace Engineering, 2011
- Staff Engineer, Central Intelligence Agency, Washington, DC, October 2009 - May 2010.
- Graduate Research Assistant, Georgia Institute of Technology, Department of Aerospace Engineering, August 2006 - December 2009 (Research Advisor, Professor Mark Costello)
- FAA-Licensed Private Pilot, Instrument Multi-Engine Ratings

Consulting, patents, etc.:

State(s) in which registered:

Principal publications of last five years:

Conference Proceedings

Archival Technical Reports

Journals:


Scientific and professional societies of which a member:
- Member, American Institute of Aeronautics and Astronautics
- Member, Institute of Navigation
- Member, American Society of Mechanical Engineers

Honors and awards:
- Innovation and Achievement Award, National Reconnaissance Office, 2004.
- Kidwell Medal, Georgetown University, 2006.
- Phi Beta Kappa, Georgetown University Chapter, 2006.

Institutional and professional service in the last five years:
  Institutional: (new faculty)
  Professional: Reviewing Activities for Archival Journals
  - Journal of Spacecraft and Rockets, 2010
  - Journal of Guidance, Control, and Dynamics, 2010

Professional development activities in the last years: Continuous

Percentage of time available for research or scholarly activities: ____%

Percentage of time committed to the program: 100%

Other: None
Name and Academic Rank: James D. Turner, Research Professor

Degrees with fields, institution, and date:
- ME  Engineering Physics, University of Virginia, 1976
- BS  Physics, George Mason University, 1974

Number of years of service on this faculty, including date of original appointment and dates of advancement in rank: Five
- Date of original appointment: Adjunct Professor, June 2003; Research Professor, September 2009

Other related experience (Teaching, Industrial, etc.):
- 1/09-Present, Director of Research, LASR (Land Air Space Robotics Lab).
- 5/06-Present, Director of Operations for CASS (Consortium of Autonomous space Systems)
- 7/03-12/08, Visiting Scientist & Adjunct Professor, TAMU Aerospace Engineering.
- 12/01-6/02, Adjunct Professor, UI Mechanical Engineering
- 12/97-12/01, Division Manager for Virtual Proving Ground, NADS (National Adv. Driving Simulator)
- 12/96-9/99, NSF Multi-University I/UCRC for Virtual Proving Grounds, NADS.
- 6/09-12/10, Director of Marketing, StarVision Technologies.
- 11/03-5/06, Dynacs Military & Defense Positions
  - 11/03-5/06, Manager, Business Development (Civil/Commercial/Military Space)
  - 6/05-5/06, Government Security Committee.
  - 6/05-5/06, Technology Control & Security Officer.
- 12/92-Present, President Amdyn Systems.
- 6/84-12/92, Photon Research Associates, Boston Division Positions.
  - 6/91-12/92, Vice President Technology, Moldyn, Subsidiary of PRA.
  - 6/92-12/92, Division Manager.
  - 6/84-6/92, Dynamics and Control Group Leader.
- 12/79-6/84, Dynamics Section Chief, The Charles Stark Draper Laboratory, Inc.

Consulting, patents, etc.:
- Patent: Molecular Dynamics Simulation Method and Apparatus #5,424,963, 6/13/95

State(s) in which professionally licensed or certified, if applicable: None

Principal publications of last five years:
2. Turner, J. D., “Geometric Solution for Transforming Cartesian to Geodetic Coordinates,” Accepted for Publication in The Journal of the Astronautical Sciences, 007.


**Scientific and professional societies of which a member:**
- American Institute of Aeronautics and Astronautics (Associate Fellow)
- American Astronautical Society (Fellow)

**Honors and awards:** None

**Institutional and professional service in the last five years:**
- Reviewer of many technical journals in the areas of Dynamics and Control
- Member, AIAA Astrodynamics Technical Committee

**Percentage of time available for research or scholarly activities:** 40%

**Percentage of time committed to the program:** 100%

**Professional development activities in the last five years:** Continuous

**Other:** One former PhD student has distinguished university faculty appointment.
Name and Academic Rank: Srinivas R. Vadali, Professor, Stewart & Stevenson-I Professor

Degrees with fields, institution, and date:
- PhD Engineering Mechanics, Virginia Tech, 1983
- ME Aeronautical Engineering, Indian Institute of Science, 1978
- BS Mechanical Engineering, Sambalpur University, India, 1976

Number of years of service on this faculty, including date of original appointment and dates of advancement in rank: 25
- Date of original appointment: January 1986
- Dates of advancement in rank: Assoc. Professor, September 1991; Professor, September 1995

Other related experience (Teaching, Industrial, etc.):
- 1/95-12/95 Visiting professor at the Air Force Research Laboratory, Kirtland Air Force Base, New Mexico during 1995 (IPA).
- 8/83-4/85 Assistant Professor, Aerospace Engineering, Iowa State University.
- 5/83-7/83 Research Associate, Department of Engineering Science and Mechanics, Virginia Tech.

Consulting, patents, etc.: None

State(s) in which professionally licensed or certified, if applicable: None

Principal publications of last five years:


**Scientific and professional societies of which a member:**
- American Institute of Aeronautics and Astronautics (Associate Fellow)
- American Astronautical Society (Fellow)
- American Society for Engineering Education (Member)

**Honors and awards:**
- Distinguished Alumnus, Department of Aerospace Engineering, Indian Institute of Science, 2009
- Jerry B. Davis Faculty Fellow, 1996, College of Engineering.
- Texas Engineering Experiment Station (TEES) Fellow 1994, 2001
- Stewart and Stevenson-I Professor, 2002-Present.
- E. D. Brockett Professor, 2002-2003

**Institutional and professional service in the last five years:**
- Vice President Technical, American Astronautical Society, 2007-2011
- Associate Director, Texas Space Grant Consortium
- Chairman, Departmental Promotion and Tenure committee
- Reviewer of many technical journals in the areas of Dynamics and Control
- Member, AAS Space Flight Mechanics Technical Committee

**Percentage of time available for research or scholarly activities**: 40%

**Percentage of time committed to the program**: 100%

**Professional development activities in the last five years**: Continuous

**Other**: Three former PhD students have university faculty appointments.
Name and Academic Rank: John Valasek, Associate Professor

Degrees with fields, institution, and date:
California State Polytechnic University, Pomona, Aerospace Engineering, B.S., 1986
University of Kansas, Aerospace Engineering, M.S., 1991
University of Kansas, Aerospace Engineering, PhD, 1995

Number of years of service on this faculty: 14
Date of original appointment: August 1997
Dates of advancement in rank: September 2003

Other related experience:

May-Aug. 1997, AFSOR Summer Faculty Research Fellow, Air Force Research Laboratory, Dayton, OH. Researched mechanics and control of Pneumatic Vortex Control (PVC) technology for aircraft.


Consulting, patents, etc.:
Consultant, S4Tec Corporation, Mineral Wells, TX. Modeling, analysis, control synthesis, simulation, and implementation of a digital flight control system for the Eclipse 500 Jet.


State(s) in which registered: Kansas

Principal publications of last five years:
Scientific and professional societies of which a member:
- American Institute of Aeronautics and Astronautics (AIAA), Associate Fellow
- Institute of Electrical and Electronics Engineers (IEEE), Senior Member
- American Astronautical Society (AAS), Member
- Sigma Gamma Tau Aerospace Engineering Honor Society (SGT), Member
- Society of Industrial and Applied Mathematics (SIAM), Member
- American Society of Engineering Educators (ASEE), Member

Honors and awards:
- Charles W. Crawford Service Award, Texas A&M College of Engineering, 2010
- Outstanding Alumnus of the Year, Calif. State Polytechnic University, Pomona, 2009
- Sustained Service Award, AIAA Headquarters, 2008
- Distinguished Achievement Award for Teaching, University Level, TAMU Association of Former Students, 2008
- National Faculty Advisor Award, AIAA Headquarters, 2005
- Center Team Award, SATS Project Team, NASA Langley Research Center, 2005

Institutional and professional service in the last five years:
- National President, Sigma Gamma Tau, 2006 – 2009
- Honors Faculty, 2003 - present
- Faculty Senator, Texas A&M University, 2004 – 2007
- Faculty Advisor, AIAA Student Branch, 2000 - 2009
- Faculty Advisor, Sigma Gamma Tau Student Chapter, 2000 - present

Professional development activities in the last years: Continuous

Percentage of time available for research or scholarly activities: 40%

Percentage of time committed to the program: 50%

Other: Committee Chair to 32 completed graduate degrees
C.3 Materials and Structures Faculty

Name and Academic Rank: A. Amine Benzerga, Associate Professor

Degrees with fields, institution, and date:
  B.S. (5 years) SUP’AERO, Toulouse France, 1995 Aerospace Engineering
  M.S. Université Paul Sabatier, Toulouse France, 1995 Mechanical Engineering

Number of years of service on this faculty: 6.5 months

Other related experience:
  Industry 2 years
  Academia – other – 3 years

Consulting, patents, etc.:
  Gaz de France

State(s) in which registered: None

Principal publications of last five years:


Scientific and professional societies of which a member:
  • ASME

Honors and awards:
  • 2008 National Science Foundation CAREER Award Recipient
  • 2004 Visiting Scholar, Pembroke College; Visiting Assistant Professor, Cambridge University
  • 2000 PhD with Highest Honors from Ecole Nationale Superieure des Mines de Paris (France)
Institutional and professional service in the last five years:
  • Editorial Board Member of International Journal of Theoretical and Applied Multiscale Mechanics.
  • Member of the Fracture Mechanics Committee of the Applied Mechanics Division, ASME.

Percentage of time available for research or scholarly activities: 40%

Percentage of time committed to the program: 100%

Professional development activities in the last years: Continuous

Other: None
Name and Academic Rank: James Boyd, Associate Professor

Degrees with fields, institution, and date:
PhD, Aerospace Engineering, Texas A&M University, 1994
M.S., Bioengineering, Texas A&M University, 1988
B.S., Mechanical Engineering, University of Texas at Austin, 1983

Number of years of service on this faculty: 10

Other related experience:
Assistant Professor, Department of Mechanical Engineering, The University of Illinois at Chicago, August 1994 – August 2000

Consulting, patents, etc.:
None

State(s) in which registered:
None

Principal publications of last five years:

Scientific and professional societies of which a member:
ASME

Honors and awards:
NSF CAREER Award, 1999, titled “Interdisciplinary Mechanics for MEMS”. The objective is to develop electromechanics with moving boundaries and apply the theory to MEMS fabrication.

Institutional and professional service in the last five years:
Institutional Service:
- Member of the College of Engineering Honors and Awards Committee, 2005-2006
- Reviewer for College of Engineering Faculty Service Award, Summer and Fall 2006
- Reviewer for College of Engineering TEES Select Young Faculty Award, Summer and Fall 2006
- Reviewer for College of Engineering Presidential Teaching Award, Spring 2006
- Member of the Faculty Senate Sp 2002 – Spring 2005
- AERO ABET Committee Spring 2003-present
- AERO Search Committees Fall 2003-Spring 2009
- AERO Admission Representative to the Materials Science and Engineering Program, Fall 2003-Spring 2005
- AERO representative to the Engineering Faculty Advisory Committee (EFAC), Spring 2004 – 2008
- Chairman, Engineering Faculty Advisory Committee (EFAC), Fall 2005, Spring 2006
- Secretary, Engineering Faculty Advisory Committee (EFAC), Fall 2006, Spring 2007
- AERO Equipment Committee, Chair, Fall 2003-Spring 2007
- AERO Space Committee, Spring 2004-present
- Professional Service: Reviewer for the Following Journals:
  - IEEE Sensors Journal
  - Journal of Applied Mechanics
  - Journal of Damage Mechanics
  - Journal of Colloid and Interface Science
  - Journal of Engineering Materials and Technology
  - Journal of Intelligent Material Systems and Structures
  - Journal of Micromechanics and Microengineering
  - Mechanics and Materials
  - Smart Materials and Structures

Percentage of time available for research or scholarly activities: 40%

Percentage of time committed to the program: 100%

Professional development activities in the last five years: Continuous

Other: None
Name and Academic Rank: Walter Haisler, Professor and Associate Department Head for Undergraduate Programs and Outreach

Degrees with fields, institution, and date:
- B.S., Aerospace Engineering, Texas A&M University, 1967
- M.S., Aerospace Engineering, Texas A&M University, 1968
- PhD, Aerospace Engineering, Texas A&M University, 1970

Number of years of service on this faculty: 40
- Professor and Associate Department Head for Undergraduate Programs and Outreach: June 2009 - Present
- Professor and Director of Graduate Programs: October 2001 – May 2009
- Professor and Interim Head, June 2003 – November 2004
- Professor and Head, June 1985 – January 1995
- Professor and Interim Head, July 1984 – May 1985
- Professor, 1980 – present
- Associate Professor, 1975 – 1980
- Assistant Professor, 1970 – 1975

Other related experience:
- Director of Engineering Accreditation and Assessment, Dwight Look College of Engineering, Texas A&M University, September, 2006 – present, part time assisting college with ABET accreditation, college-wide assessment activities, QEPC, SACS and related academic and curriculum matters.
- Consulting with various industry and government laboratories.

Consulting, patents, etc.:
- Consulting: David Ehrenpreis Engineers
- Patents: none

State(s) in which registered: Texas

Principal publications of last five years:
1. “Preparing for an ABET Accreditation Visit at Both the Program and College Level,” Best Assessment Processes Symposium, April 3-4, 2009, Indianapolis, Indiana.

Twenty-five journal publications and thirty-five conference publications and presentations prior to 1990.

Scientific and professional societies of which a member:
- American Institute of Aeronautics and Astronautics (Associate Fellow)
- American Astronautical Society (Fellow)
- American Society of Civil Engineers (Fellow)
- American Society for Engineering Education

Honors and awards:
- Dwight Look College of Engineering Faculty Fellow, 2004
- The Charles W. Crawford Award, Dwight Look College of Engineering, Texas A&M University, 2001
- The John Leland Atwood Award, American Institute of Aeronautics and Astronautics / American Society for Engineering Education, 1990
- Elected Fellow, American Astronautical Society, 1986
- Elected Fellow, American Society of Civil Engineers, 1985
- Selected as Halliburton Professor of Aerospace Engineering, Texas A&M University, 1984-85
- Selected as Senior TEES Research Fellow, Texas A&M University System, 1984
- Elected Associate Fellow, American Institute of Aeronautics and Astronautics, 1983
• Selected as TEES Research Fellow, Texas A&M University System, 1982-83, 1983-1984
• General Dynamics Excellence in Teaching Award, Texas A&M University, 1980
• Houston Oil and Minerals Award for Meritorious Teaching of Engineering at Texas A&M University, Houston Oil and Minerals Corporation, Houston, Texas, 1977
• Outstanding Achievement in Teaching Award, Student Engineers' Council, Texas A&M University, 1977
• PVP Literature Award, American Society of Mechanical Engineers, 1975
• Certificates of Recognition for the Creative Development of Technology, National Aeronautics and Space Administration, 1974, 1975, and 1979
• Outstanding Faculty Award, Texas A&M University, Student Engineers' Council, 1974
• Faculty Distinguished Achievement Award in Teaching, Association of Former Students of Texas A&M University, 1972
• Outstanding Faculty Member Award, Student Engineer's Council of Texas A&M University, 1972

Institutional and professional service in the last five years:
• Visitor for AIAA, Accreditation Board for Engineering and Technology, 1992-present
• TAMU Institutional Representative, NASA Texas Space Grant Consortium, 1992-present
• Member, Council of Institutions, University Space Research Association, 1986-Present
• Atwood Award Committee, AIAA (1993-present)
• ABET coordinator for College of Engineering, Texas A&M University, January 2003 – present
• Director, Office of Graduate Programs, Department of Aerospace Engineering, Texas A&M University, October 1, 2001 – May 2009
• Coordinator for ENGR 21x Course Sequence, College of Engineering, Texas A&M University, July 1998 – present
• Coordinator for ENGR 214, College of Engineering, Texas A&M University, 1997 – present
• Member, Graduate Processing Committee, TAMU, 2002 – present
• Member, ENGR 111/112 Revision Committee, College of Engineering, TAMU, 2003

Professional development activities in the last five years: Attended ASEE and AIAA conferences.

Percentage of time available for research or scholarly activities: 5%

Percentage of time committed to the program: 50%

Other: None
Name and Academic Rank: Vikram Kinra, Professor

Degrees with fields, institution, and date:
B.S., Mechanical Engineering, Indian Institute of Technology, Kanpur, India, 1967
M.S., Mechanical Engineering, Utah State University, Logan, 1968
PhD, Engineering Mechanics, Brown University, Providence, Rhode Island, 1975

Number of years of service on this faculty: 28
Date of original appointment: September 1982
Dates of advancement in rank: Professor, September 1990;

Other related experience:
Associate Director, Center for Mechanics of Composites, 1990 - 1995
Director, Center for Mechanics of Composites, 1995 - 1998
General Dynamics Professor, 1995-Present.
Asst Professor, Dept of Mechanical Engineering, University of Colorado, Sept 1975 August 1982

Consulting, patents, etc.:

State(s) in which registered: None

Principal publications of last five years:

Scientific and professional societies of which a member:
- American Institute of Aeronautics and Astronautics (Assoc. Fellow)
- American Society of Mechanical Engineers (Fellow)
- The American Society for Nondestructive Testing
- Acoustical Society of America/American Institute of Physics
- American Society for Engineering Education
- American Academy of Mechanics (Fellow)

Honors and awards:
- Distinguished Teaching Award, 1998, Association of Former Students, Texas A&M University.
- Lockheed Martin Award for Excellence in Engineering Teaching, 1997, Texas A&M University.
- Distinguished Alumnus Award, 1995, College of Engineering, Utah State University.
- Senate Proclamation Number 2012, 1994, Honored by the Senate of the State of Texas.
- Senior Research Fellow, 1993, Texas Engineering Experiment Station.

Institutional and professional service in the last five years:
- Chair, Faculty Search Committee, 2009.

Professional development activities in the last years: Continuous

Percentage of time available for research or scholarly activities: 25%

Percentage of time committed to the program: 50%

Other: None
Name and Academic Rank: Dimitris Lagoudas, Professor and Department Head

Degrees with fields, institution, and date:
Diploma, Mechanical Engineering, Aristotle University of Thessaloniki, Greece, 1982
PhD, Applied Mathematics, Lehigh University, 1986

Number of years of service on this faculty: 18
Date of original appointment: July 1992
Dates of advancement in rank: Professor, October 1999

Other related experience:
Director, Texas Institute for Intelligent Bio-Nano Materials and Structure Center, 2002-present

Consulting, patents, etc.:
Robins, Kaplan, Miller & Ciresi, LLP, 2001 –
Medtronic, 2001-
“SMA UMAT,” Software License (2003), Invention Disclosure

State(s) in which registered: Texas, License #79047; Greece

Principal publications of last five years:


Scientific and professional societies of which a member:
- American Academy of Mechanics
- SPIE — The International Society for Optical Engineers
- American Society of Mechanical Engineers
- American Institute of Aeronautics and Astronautics, Senior Member
- Society of Engineering Science
- American Society for Engineering Education
Honors and awards:
- Associate Fellow, American Institute of Aeronautics and Astronautics, 2000.
- Texas A&M University Faculty Fellow, 2000-2005.
- TEES Charles W. Crawford Service Award, 2003.
- William Sweet Smith Prize, IMechE, 2008

Institutional and professional service in the last five years:

**Department Level**
- Executive Council Committee
- Departmental Awards Committee
- Director, Materials and Structures Lab

**College Level**
- Tenure and Promotion Committee
- Participant in the MSEN program – seminars, infrastructure, IGERT co-PI

**University Level**
- Director, TiiMS, a TEES/TAMU/Aero Institute, 2002-
- Site Director, SMA-RT, 2008-
- Council of Principal Investigators Executive Committee, 2008-

Active participant in organizing symposia, chairing sessions and presenting at the following conferences:
- SPIE – Smart Structures and Materials;
- AIAA – SDM;
- ASME – McMAT (Applied Mechanics and Materials Conference);
- ASME – SMASIS (Smart Materials, Adaptive Structures and Intelligent Systems;
- SES- Shape Memory Alloys-Mechanisms, Multifunctionalities and Applications;
- TiiMS (annual and mid-year conferences);

Percentage of time available for research or scholarly activities: 30%
Percentage of time committed to the program: 100%
Professional development activities in the last five years: Continuous

Other: Serve as Department Head; Implementing Study-Abroad Program
Name and Academic Rank: Mohammad Naraghi, Assistant Professor

Degrees with fields, institution, and date:
BS, Civil Engineering, Sharif University of Technology, 2004
MS Civil Engineering/Mechanics of Materials & Structures, Sharif University of Technology, 2004
PhD Aerospace Engineering/Structures & Materials, University of Illinois at Urbana Champaign, 2009

Number of years of service on this faculty: New Spring 2012

Other related experience:
2. Graduate Research Assistant, Advisor: Professor I. Chasiotis, 2005-2009, University of Illinois at Urbana-Champaign
3. Graduate Research Assistant, Advisor: Professor M.T. Kazemi, 2002-2004, Sharif University of Technology, Iran
4. Lab Assistant: Experiments in Micro/Nano Science and Engineering, Northwestern University, 2010
5. Teaching and Lab Assistant: Contact Mechanics and Scanning Probe Microscopy (SPM). Fundamental / theoretical background in connection with practical operations in SPM, University of Illinois at Urbana Champaign, 2007
6. Teaching assistant: Aerospace Structures I, Aerospace Engineering Department, University of Illinois at Urbana Champaign, IL, 2005.
7. Teaching assistant: Dynamics, Department of Civil Engineering, Sharif University of Technology, Tehran, Iran 2000.

Consulting, patents, etc.:

State(s) in which registered:

Principal publications of last five years:

Book Chapter

Journals:

Conference Proceedings:

Scientific and professional societies of which a member:

Honors and awards:
1. Roger A. Strehlow Memorial Award for outstanding research accomplishment.
5. Invited participant to the Cell Mechano-sensitivity Workshop organized by Center for Cellular Mechanics (CCM), University of Illinois at Urbana-Champaign, July 30 – Aug 3 2007.
6. Second place award (Dr. Tavakoli award), in the civil engineering Olympiad, a nation-wide sci. competition, Iran 2004.
7. Second place award, in Iran physics Olympiad, a nation-wide scientific competition, Iran 1998.

Institutional and professional service in the last five years:
Institutional: (new faculty)

Professional:
1. Session Organizer for the SEM conference of 2011 on Graphene/CNT based Hierarchical Structures to be held in June 2011 in Uncasville, CT.
2. Cochair in Society for Experimental Mechanics Conference held in Indianapolis, Indiana, June 7 - 10, 2010

Professional development activities in the last years: Continuous
Percentage of time available for research or scholarly activities: ____%
Percentage of time committed to the program: 100%
Other: None
Name and Academic Rank: Thomas Strganac, Professor

Degrees with fields, institution, and date:
- PhD Engineering Mechanics, Virginia Polytechnic Institute & State University, 1987
- M.S. Aerospace Engineering, Texas A&M University, 1980
- B.S. Aerospace Engineering, North Carolina State University, 1977

Number of years of service on this faculty: 21 years
- Date of original appointment: August 1989
- Dates of advancement in rank: Awarded Tenure in 1996, Promotion to Professor Rank in 2005

Other related experience:
- 1982 - 1989 Research Engineer - aerostructural dynamics, NASA - LaRC, Hampton, VA
- 1975 - 1982 Aerospace Engineer - flight analysis, NASA - GSFC, Wallops Island, VA
- 2002 – 2003 Visiting Scientist, Air Force Research Laboratory, WPAFB, OH
- 2007 Welliver Fellow, The Boeing Company, Everett, Washington

Consulting, patents, etc.:
- Instructor, AIAA, Professional Short Course Series, 1999.-
- NextGen, Inc., 2007-present.
- University of Illinois, 2007-present
- Tao of Systems Integration, Inc. 2010-present

State(s) in which registered: Texas, License No. 70808

Principal publications of last five years:

Scientific and professional societies of which a member:
- American Institute of Aeronautics and Astronautics

Honors and awards:
- Boeing Welliver Faculty Fellow, 2007
- Ruth and William Neely '52 Dow Chemical Fellow (TEES Faculty Fellow Program), 2006
• Tenneco Award for Teaching Excellence, 2003
• TEES Research Fellow
• AIAA Associate Fellow, 1996
• AIAA Outstanding Faculty Advisor, AIAA Region IV, 1991 – 1992
• Faculty Development Leave / IPA with AFRL, 2002-2003
• A&M Namesake, Camp Strganac, A&M Fish Camp, 2010

Institutional and professional service in the last five years:
• Director of Undergraduate Programs for Aerospace Engineering, 2004 - 2006
• Chairman, Computing Environment Committee, 2007 - 2010
• Associate Editor, AIAA Journal of Aircraft, 2001 – present
• University Honor Council, 2008-present
• Association of Former Students Distinguished Achievement Awards Committee, 2008-2009
• Member, Design Faculty Search Committee, 2009

Professional development activities in the last years:
• Welliver Fellow, The Boeing Company, 2007

Percentage of time available for research or scholarly activities: 35%

Percentage of time committed to the program: 100%

Other: None
Name and Academic Rank: Theofanis Strouboulis, Professor

Degrees with fields, institution, and date:
B.S., Civil Engineering, National Tech. Univ., Athens, Greece, 1980
M.S., Engineering Mechanics, University of Texas, 1981
PhD, Engineering Mechanics, University of Texas, 1986

Number of years of service on this faculty: 22
Date of original appointment: September 1988
Dates of advancement in rank: Associate Professor, September 1994 and Professor, September 2001.

Other related experience:
Research Engineer, Computational Mechanics Co., 1988, Austin, Texas.

Consulting, patents, etc.:
State(s) in which registered: Texas

Principal publications of last five years:


Books


Scientific and professional societies of which a member:
IACM (International Association for Computational Mechanics), Member.
SIAM (Society for Industrial and Applied Mathematics), Member.

Honors and awards:
Received the Meritorious Teaching Award for Assistant Instructor by the College of Engineering of the University of Texas at Austin in May, 1986.

Institutional and professional service in the last five years: None
Professional development activities in the last years: None
Percentage of time available for research or scholarly activities: 40%
Percentage of time committed to the program: 100%
Other: None
Name and Academic Rank: Ramesh Talreja, Professor

Degrees with fields, institution, and date:
- Doctor of Technical Sciences, 1985, The Technical University of Denmark, Solid Mechanics
- PhD, 1974, The Technical University of Denmark, Solid Mechanics
- M.S., 1970, Northeastern University, Boston, Civil Engineering
- B.E., 1967, University of Bombay, India, Civil Engineering

Number of years of service on this faculty: 9
Date of original appointment: September 2001

Other related experience:
- Professor of Aerospace Engineering, Georgia Institute of Technology, 1991-2001
- Docent (Lecturer of Special Qualifications), The Technical University of Denmark, 1988-1991
- Lektor (Lecturer), The Technical University of Denmark, 1978-1988
- Research Scientist, Risø National Laboratory, Denmark, 1978-1983
- Scientist, The Technical University of Denmark, 1971-1978

Consulting, patents, etc.:
- Dow Chemical Co., Midland, Michigan; Damage in Advanced Polymer composites, July 1990.
- Ameron International, South Gate, Ca., 1998.

State(s) in which registered: None

Principal publications of last five years:

Scientific and professional societies of which a member:
- ASME, American Academy of Mechanics. ASEE, Sigma Xi.

Honors and awards: 40 Total
- Scientific Committee Member, Sixth Conference in Experimental Techniques and Design in Composite Materials, Vicenza, Italy, June 18-20, 2003.
- Appointed as Visiting Professor at University of Sheffield, UK, September 2003.
- Scientific Advisory Board Member, Eleventh International Conference on Fracture, Turin, Italy, March 2005.
- Advisory Committee Member, International Conference on Recent Developments in Structural Engineering, RDSE-2007, Manipal, India, August 30-September 1, 2007.
- Honorary Degree: “Diplome of Honour” awarded by University of Patras, Greece, 2007
- Scientific Committee Member, 8th International Conference on Durability of Composite Systems, Porto, Portugal, July 16-18, 2008.

Institutional and professional service in the last five years:
- Editor-in-Chief, Int Journal of Aerospace Engineering
- Editorial Board Member, 7 journals
- Reviewer of many technical journals
- Technical Session Chair of Conference Sessions

Professional development activities in the last years:
Given keynote and invited lectures (3-5 per year), chaired sessions (5-7 per year) and attended numerous technical presentations.

Percentage of time available for research or scholarly activities: 50%

Percentage of time committed to the program: 100%

Other: None
Name and Academic Rank: John Whitcomb, Professor

Degrees with fields, institution, and date:

- PhD  Materials Engineering Science, VPI & SU, 1988
- M.S.  Mechanical Engineering, Stanford University, 1976
- B.S.  Mechanical Engineering, North Carolina State University, 1973

Number of years of service on this faculty: 21

- Date of original appointment: December 1989
- Dates of advancement in rank: Professor, September 1995

Other related experience:

- Research Engineer at NASA Langley Research Center, Mechanics of Materials Branch from January 1974 to November 1989

Consulting, patents, etc.:

- Computer Software

State(s) in which registered: Texas, License # 69717

Principal publications of last five years: 86 total


Scientific and professional societies of which a member:

- ASME Structures and Materials Committee Member, 1994 – Present (Chair 2002 – 2003)
- ASME Structures and Materials Committee Member, 1994 – Present (Vice Chair 2001 – 2002)
• American Institute of Aeronautics and Astronautics, 1990 - Present
• American Society of Mechanical Engineers, 1996 - Present
• American Academy of Mechanics, 1991 - Present
• American Society for Composites, 1993 - Present
• Society of Engineering Science, 1994 - Present
• U.S. Association for Computational Mechanics, 1993 - Present
• International Association for Computational Mechanics, 1994 – Present
• American Society for Engineering Education
• ASME AMD Educational Technical Committee, since 1999

Honors and awards:
1986 Group Achievement Award - Member of the Solid Rocket Motor Improved Field Joint Assessment (SIFT), November 1986.
1986 Certification of Appreciation from NASA Headquarters.
1994 Texas Engineering Experiment Station Research Fellow, September 1994.
2000 Associate Fellow, American Institute of Aeronautics and Astronautics.
2002 Texas Engineering Experiment Station Research Fellow.
2005 Halliburton Professor.
2008 College of Engineering Faculty Fellow.
2008 Texas Engineering Experiment Station Senior Fellow.

Institutional and professional service in the last five years:
• Member of departmental tenure and promotion committee
• Member of departmental computer committee
• Member of College Tenure & Promotion Committee

Professional development activities in the last years: Continuous

Percentage of time available for research or scholarly activities: 35%

Percentage of time committed to the program: 100%

Other: None
D. Sample Degree Plans
Student identification information has been intentionally removed.

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is submitted for the approval of the Office of Graduate Studies.

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Total hours listed for credit: 64.00

Additional course work may be added to this proposed course of study by an Advisory Committee, if such additional work is needed to correct deficiencies in academic preparation.
The Department of Aerospace Engineering offers graduate work and research programs in aeronautical/aerospace engineering. Programs leading to the degrees of MEng, MS and PhD are available. The department also offers courses and faculty supervision for students pursuing the Doctor of Engineering degree. Major areas of interest are aero/fluid dynamics, computational fluid dynamics, fluid-structure interaction (aeroelasticity), flight mechanics, astrodynamics, spacecraft/aircraft dynamics and control, computational mechanics, solid mechanics, micromechanics, nanomechanics, composite materials, bio-nano materials, aging aircraft and structures. A foreign-language is not required for any of the aerospace degree programs.

The aerodynamics and propulsion related research within the department includes airfoil and wing analyses, boundary layer stability, turbulence, combustion, propulsion, and flow-control for aircraft, land vehicles, wind turbines and other applications. A major focus within the department is viscous flows across the speed regimes ranging from incompressible subsonic to hypersonic. Fundamental transition research is performed within the NASA/AFOSR National Hypersonic Science Center in Laminar-Turbulent Transition, where experiments are conducted using world-class quiet-flow facilities that include the Klebanoff/Saric Low Disturbance Tunnel and the NASA Langley/TAMU Mach 6 Quiet Tunnel. Several research aircraft are available for full-scale flight research. The Texas A&M University National Aerothermochemistry (TAMU-NAL) Laboratory is a graduate research facility for conducting leading research in support of national interests in high-speed gasdynamics, unsteady flows, and flows with thermal and chemical non-equilibrium effects. The Flight Research Laboratory houses several piloted aircraft for basic and applied research.

Research involving dynamics and control of autonomous intelligent vehicles, formation flying of spacecraft and other problems in astrodynamics is performed in the Center for Mechanics and Control. The Land, Air and Space Robotics (LASR) laboratory enables sensing and control research with emphasis on high fidelity emulation of close proximity motions of two or more vehicles. LASR is being utilized to research spacecraft on-orbit proximity operations, autonomous aerial refueling of UAVs, and astronaut supervision of robots for surface operations on the Moon or Mars. Research related to satellite design, responsive space systems, and autonomous rendezvous and docking is conducted by the AggieSat Lab Student Satellite Program. The Department has a two-observatory facility on the grounds of the Physics Department’s Astronomy Teaching Observatory, which is used for research on fine resolution interferometric imaging of space objects via photonic quantum correlations.

Investigations of materials and structural mechanics problems are undertaken in the Center for Mechanics of Composites. Research on nanomaterials, multifunctional material systems, multiscale modeling and integrated adaptive structures is coordinated by the Texas Institute for Intelligent Materials and Structures for Aerospace Vehicles (TiiMS). Research in the Electroactive Materials Characterization Laboratory focuses on processing microstructure-property relationships in smart materials with the goal of developing new materials with unique combinations of mechanical, electrical, and coupled properties for uses that range from advanced electronic devices and autonomous system concepts to the aerospace, automotive, medical and consumer industries. Numerical simulations of complex fluid and solid mechanics problems are efficiently obtained with University and supporting departmental computational facilities. Courses relating to structural mechanics and materials listed at the end of this section are contained within the Dwight Look College of Engineering listing. The mechanics and materials courses are administered by the Department of Aerospace Engineering and are taught by faculty from the Departments of Aerospace, Civil and Mechanical Engineering.

**Aerospace Engineering (AERO)**

601. **Principles of Fluid Motion.** (4-0). Credit 4._ Formulation of equations of motion for fluid flow; theoretical and numerical solution methods for potential (ideal) flow; application to thin and thick airfoil and wing aerodynamics; complex variable methods for potential flow. Prerequisite: Approval of instructor.

602. **The Theory of Fluid Mechanics.** (3-3). Credit 4._ Entry-level graduate course on the theory of fluid mechanics, with emphasis on viscous subsonic flows; concepts of boundary layer theory, flow stability, transition and turbulence;
laboratory includes elements of measurement techniques, numerical methods and physical modeling. Prerequisite: MATH 601 or registration therein.

603. Continuum Mechanics. (3-0). Credit 3. Development of field equations for analysis of continua (solids as well as fluids); conservation laws; kinematics, constitutive behavior of solids and fluids; applications to aerospace engineering problems involving solids and fluids. Prerequisite: Graduate classification. Cross-listed with MEMA 601.

605. Theory of Elasticity. (3-0). Credit 3. Analysis of stress and strain in two- and three-dimensions, equilibrium and compatibility equations, strain energy methods; torsion of noncircular sections; flexure, axially symmetric problems. Prerequisite: Graduate or senior undergraduate standing. Cross-listed with MEMA 601 and MEEN 603.

606. Multifunctional Materials. (3-0). Credit 3. This course will present an in-depth analysis of multifunctional materials and composites, and their novel applications. Prerequisites: Theory of elasticity or Continuum Mechanics MEMA 601 or MEMA 602/AERO 603, MSEN 601 or MEMA 609. Cross-listed with MEMA 606 and MSEN 606.

608. Nanomechanics. (3-0). Credit 3. Application of mechanics concepts to nano-scale behavior of materials. Review of continuum mechanics; Extensions to generalized continua; Nonlocal elasticity; Nano-scale plasticity. Focus on multi-scale modeling: Dislocation Dynamics; Quasi-Continuum method; Molecular dynamics with introductions to quantum mechanics and statistical mechanics. Prerequisite: AERO 603 or MEMA 601. Cross-listed with MEMA 608 and MSEN 608.

609. Sustainability Metrics and Life Cycle Assessment in Engineering. (3-0). Credit 3. Concepts of sustainability with associated metrics; application of systems engineering tools to facilitate assessment of viable options on products and processes; assessment of impact on the entire biosphere; product life cycle analysis. Prerequisite: Graduate classification.

612. Wave Propagation in Isotropic and Anisotropic Solids. (3-0). Credit 3. Mathematical and experimental methods of studying stress waves with emphasis on anisotropic solids, e.g., fiber-reinforced composite materials; waves in an unbounded medium, in a half-space, in rods; waves in a general anisotropic medium; wave surface, slowness surface, velocity surface, energy velocity and group velocity. Prerequisites: MEMA 601 or AERO 603. Cross-listed with MEMA 612.


617. Micromechanics. (3-0). Credit 3. Eigenstrains; inclusions, and inhomogeneities; Eshelby's solution for an ellipsoidal inclusion; Eshelby's equivalent inclusion method. Effective elastic properties of composites; composite spheres and cylinders models; bounds on effective moduli; Hashin-Shtrikman bounds; applications to fiber, whisker and particulate reinforced composites; introduction to micromechanics of inelastic composites and solids with damage. Prerequisites: MEMA 601, 602, or AERO 603, 605. Cross-listed with MEMA 625.

618. Mechanics of Active Materials. (3-0). Credit 3. Introduction to coupled field theories: constitutive response of materials with thermal and electromagnetic coupling; microstructural changes due to phase transformations; shape memory alloys; piezoelectric and magnetostrictive materials; active polymers and solutions. Micromechanics of active composites. Prerequisites: MEMA 601 or MEMA 602. Cross-listed with MEMA 626.

619. Materials Modeling of Phase Transformation and Microstructural Evolution (3-0) Credit 3. Computer modeling and simulation of microstructural evolution during various phase transformation processes in solid materials, including spinodal decomposition, ordering, martensitic transformation, ferroelectric and ferromagnetic domain evolution, dislocation dynamics, and crack propagation. Prerequisites: Graduate classification and approval of instructor. Cross-listed with MEMA 619 and MSEN 619.

620. Unsteady Aerodynamics. (3-0). Credit 3. Theoretical formulation of unsteady airfoil theory and techniques used for determining airloads on oscillating lift surfaces; exact solutions and various approximations presented and evaluated; application to problems of unsteady incompressible, subsonic and transonic flows about airfoils and wings. Prerequisite: Approval of instructor.

622. Spacecraft Dynamics and Control. (3-0). Credit 3. Elements of analytical dynamics; modeling different types of spacecraft and control systems, sensors, and actuators; stability; control system design; effects of flexibility; attitude and orbital coupling; environmental effects. Prerequisites: AERO 422 or ECEN 420.

623. Optimal Spacecraft Attitude and Orbital Maneuvers. (3-0). Credit 3. Application of optimization and optimal control techniques to spacecraft maneuver problems; computation of open loop and feedback controls for linear and nonlinear spacecraft dynamical systems; low-thrust and impulsive control, discretization methods, case studies. Prerequisite: AERO 423 or equivalent.
624. Celestial Mechanics. (3-0). Credit 3._ Analytical and numerical methods for computing spacecraft orbits under the influence of gravitational, aerodynamic, thrust and other forces; Keplerian two-body problem, perturbation methods, orbit determination, navigation and guidance for aerospace vehicles. Prerequisite: AERO 423 or equivalent.

625. Digital Control of Aerospace Systems. (3-0). Credit 3._ Analysis and design of discrete and sampled-data controllers unique to aircraft and spacecraft; modeling of aircraft and spacecraft, sources of uncertainties; requirements and specifications; direct digital design using MIMO optimal techniques; sample rate selection, multi-rate controllers; robustness. Prerequisite: AERO 422 or equivalent.

626. Estimation of Dynamic Systems. (3-0). Credit 3._ Traditional concepts and recent advances in estimation related to modern dynamic systems found in aerospace disciplines; least squares estimation, state estimation, nonlinear filtering, aircraft position and velocity tracking, attitude determination of spacecraft vehicles, gyro bias estimation and calibration. Prerequisites: AERO 310 or equivalent; STAT 211 or equivalent.

627. Principles of Structural Dynamics. (3-0). Credit 3._ Examination of flexible structures through a review of single degree-of-freedom dynamical systems followed by an in-depth study of continuous and multiple degree-of-freedom systems; emphasis on discrete modeling of structures for vibration analysis and dynamic analysis, with minimal development of methods such as finite elements. Prerequisite: Graduate classification.

628. Advanced Spacecraft Dynamics and Control. (3-0). Credit 3._ Review of fundamental principles; introduction to alternate and advanced methods of dynamics and control for aerospace systems; alternate methods for generating and analyzing equations of motion; techniques for complex multibody systems; variable speed control moment gyros; method of quadratic modes; focus on modeling techniques for aerospace systems. Prerequisite: AERO 622.

629. Experimental Aerodynamics. (3-0). Credit 3._ Review of fundamental principles in aerodynamics; basics of instrumentation, electronics, data-acquisition; experimental techniques in aerodynamics/fluid mechanics; pressure, skin friction, force and velocity measurement techniques in wind and water-tunnel testing; conventional and novel techniques in data-processing and systems modeling; smart systems in experimental aerodynamics. Prerequisite: AERO 601.

630. Introduction to Random Dynamical Systems. (3-0). Credit 3._ Building on basic probability theory, course covers theory and applications of discrete and continuous random processes. Particular attention shall be paid to the response of dynamical systems (discrete, linear and non-linear), to random input processes and their application to Engineering Systems. Prerequisite: Graduate student status.

631. Advanced Trajectory Optimization for Aerospace Systems. (3-0). Credit 3._ Numerical solution of optimal control problems (OCP) as a nonlinear programming problem (NLP); control of a nonlinear missile using SNOPT, trajectory generation, motion planning, atmospheric entry problems; elements of approximation, distributed and parallel computation techniques, dynamical systems, stability theory, parameter optimization. Prerequisites: Graduate classification; approval of instructor.

632. Design of Advanced Flight Control Systems – Theory and Application. (3-0). Credit 3._ Modeling, analysis, design and implementation of advanced flight control problems, specifically aerospace engineering applications; includes choice of controlled variables, reduction of controlled variables, design methodology, computational framework, implementation issues, and software environments using various toolboxes. Prerequisites: Graduate classification and approval of instructor.

633. Advanced Aerospace Multibody Dynamics. (3-0). Credit 3._ Techniques for modeling, simulation, and analyzing multibody dynamical systems; includes development of kinematic expressions for articulating bodies, adding and constraining degrees of freedom through mappings; familiarization with industry codes, such as DISCOS; appreciation of learned techniques on various systems, including omni-directional vehicles, Stewart platforms, and gyroscopically-stabilized walking robots. Prerequisite(s): AERO 622 or graduate classification and approval of instructor.

640. Turbulence Processes. (3-0). Credit 3._ Fundamentals of conservation, Lagrangian, transformation, variance properties; flow features: laminar, transition, turbulence regimes, characteristics, spectrum; statistical (filter/average) description: scales, Reynolds, arbitrary averaging, realizability; elementary turbulence processes: viscous, advective/inertial, role of pressure; elementary process models, viscous RDT, RDT for velocity gradients, equipartition of energy, restricted Euler equations; isotropic, homogeneous turbulence. May be taken 2 times for credit.

641. High-Speed Combustion for Propulsion. (3-0). Credit 3._ Study topics in combustion relevant to highspeed subsonic/supersonic air-breathing propulsion; emphasis on the structure of detonations and the operation of combustors under supersonic conditions; structure of shock-waves and the mixing/chemical kinetics that take place in high speeds. Prerequisite: Graduate classification.

642. Laser Diagnostics for Combustion and Propulsion. (3-0). Credit 3._ Laser diagnostics topics as applied to combustion and propulsion: brief exposition of fundamental electromagnetic theory; practice of basic experimental laser techniques used to measure thermochemistry; basic implementation of Raman and Rayleigh scatterings; Laser-Induced Fluorescence (LIF); detection methods, optical systems, noise contributions, and signal enhancement techniques will be discussed. Prerequisite: Graduate classification.
643. High-Performance Computational Fluid Dynamics. (3-0). Credit 3. Numerical simulations of fluid dynamics problems on massively parallel computers; focus on Direct Numerical Simulations (DNS) where all dynamically relevant scales are resolved; elements of both high-performance computing (HPC) and numerical methods to solve incompressible and compressible flows. Prerequisite: AERO 615 or approval of instructor.

649. Generalized Finite Element Methods. (3-0). Credit 3. Systemic introduction to the theory and practice of generalized finite element (FE) methods, including GFEM, the hp-cloud method, particle methods, and various meshless methods with similar character; precise formulation of the methods are presented; known theoretical results for convergence; important issues related to implementation, issues of numerical integration. Prerequisite: Graduate student status. Cross-listed with MEMA 649.

650. Spacecraft Attitude Determination. (3-0). Credit 3._ Spacecraft attitude determination systems; attitude and error parameterizations, attitude sensors, data processing and calibration; introduction to single- and three- axis attitude determination and to optimal attitude and error estimation: ECI motion and time definitions. Prerequisite: AERO 423 or equivalent.

660. Nonlinear Flight Dynamics. (3-0). Credit 3._ Nonlinear equations of motion for coupled aircraft motions; coupled aerodynamic phenomena; application of the direct method of Lyapunov to nonlinear aircraft motions; elastic airplane equations of motion. Prerequisite: AERO 421 or approval of instructor.

672. Perturbation Methods in Mechanics. (3-0). Credit 3._ Develop approximate solutions to algebraic, differential, and integral equations; analysis of nonlinear oscillations, nonlinear waves, and boundary-layers; emphasis on combined numerical/perturbations techniques and reducing Partial Differential Equation (PDE) to Ordinary Differential Equation (ODE). Prerequisites: Graduate classification in aerospace, mechanical or civil engineering.

673. Boundary Layer Stability and Transition. (3-0). Credit 3._ Analytical, numerical, and experimental methods for the stability of bounded shear flows; includes techniques for estimating transition to turbulence and the control of transition through laminar flow control. Prerequisites: Graduate classification and AERO 601, 602, or 603 or approval of instructor.

674. Hypersonic Flow. (3-0). Credit 3._ Theoretical formulation of hypersonic flow theory; techniques for hypersonic flowfield analysis; high temperature effects, including both equilibrium and nonequilibrium flows; classical and modern computational methods. Prerequisite: AERO 303 or equivalent.

676. Aerothermochemistry. (3-0). Credit 3._ Fundamentals of kinetic theory, chemical thermodynamics and statistical mechanics; applications to high temperature chemically reacting equilibrium and nonequilibrium aerodynamic flows. Prerequisite: AERO 303 or equivalent.

677. Rarefied Gasdynamics. (3-0). Credit 3._ Analysis of phenomena occurring in low density flows emphasizing slip regime problems and solutions based on second-order solutions to the Boltzmann equation. Prerequisite: AERO 477 or approval of instructor.

681. Seminar. (1-0). Credit 1._ Selected research topics presented by the faculty, students and outside speakers. Prerequisite: Graduate classification.

684. Professional Internship. Credit 1 to 4._ Engineering research and design experience at government or industry facilities away from the Texas A&M campus; design projects supervised by faculty coordinators and personnel at these locations; projects selected to match student’s area of specialization. Prerequisites: Graduate classification and approval of committee chair and department head.

685. Directed Studies. Credit 1 to 12 each semester._ Special topics not within scope of thesis research and not covered by other formal courses. Prerequisite: Graduate classification in aerospace engineering.

689. Special Topics in... Credit 1 to 4._ Selected topics in an identified area of aerospace engineering. May be repeated for credit. Prerequisite: Approval of instructor.

691. Research. Credit 1 or more each semester._ Technical research projects approved by department head.

The following courses are described in the section entitled Mechanics and Materials (MEMA) on page 471 and are part of the curriculum in aerospace engineering.

608. Nanomechanics. (3-0). Credit 3.
609. Materials Science. (3-0). Credit 3.
616. Damage and Failure in Composite Materials. (3-0). Credit 3.
625. Micromechanics. (3-0). Credit 3.
635. Structural Analysis of Composites. (3-0). Credit 3.
641. Plasticity Theory. (3-0). Credit 3.
646. Introduction to the Finite Element Method. (3-0). Credit 3.
647. Theory of Finite Element Analysis. (3-0). Credit 3.
689. Special Topics in… Credit 1 to 4.

The following courses are described in the section entitled Materials Science and Engineering (MSEN) on page 456 and are part of the curriculum in aerospace engineering.

608. Nanomechanics. (3-0). Credit 3.
F. Syllabi for Courses Taught in the Last Five Years

AERO 601-Principles of Fluid Motion

Catalog Data:  AERO 601-Principles of Fluid Motion
Credits:  4-0

Formulation of equations of motion for fluid flow; theoretical and numerical solution methods for potential (ideal) flow; application to thin and thick airfoil and wind aerodynamics; complex variable methods for potential flow.

Prerequisite:  Approval of instructor.

References:  Karamcheti, K. *Principles of Ideal-Fluid Aerodynamics*
Katz, J. and Plotkin, A., *Low-Speed Aerodynamics: From Wing Theory to Panel Methods*

Course Content:

Vector and Tensor Calculus and Notation
Derivation of Basic Equations and Fundamental Theorems
Incompressible Flows
Euler's Equations for an Ideal Fluid
Stream Functions
Velocity Potential
Integration of Euler's Equations in Special Cases
Circulation and Vorticity, Bernoulli's Equation
Rotational and Irrotational Flow

Analytic Determination of Potential Flow Past Bodies:
Uniform Flow
Sources and Sinks
The Potential Vortex
The Doublet
Superposition of Flow Patterns
Kutta-Joukowski Law
Rankine Body

General Solution of the Incompressible, Potential Flow Equations

Panel Methods
Source, Doublet, Vortex Distributions
Small Disturbance Theory
Singularity Elements and Influence Coefficients
Two-Dimensional Numerical Solutions
Unsteady Incompressible Potential Flow

Complex Variable Methods, Conformal Mapping
Complex Variable Review, Contour Integration
The Complex Potential Function
Force and Moment Formulae - Blasius Equation
Conformal Transformation
The Behavior of Laplace Equation in a Conformal Mapping
The Kutta-Joukowski Transformation
The General Airfoil Equation, Flat Plate, Circular Arc, Symmetric and
Cambered Airfoil

Grading:  
Homework: 30%  or  Homework: 25%  
Midterm Exam: 35%  
Final Exam: 35%  
Midterm Exam: 25%  
Final Exam: 25%  
Project: 25%
AERO 602-Theory of Fluid Mechanics

Catalog Data: AERO 602-Theory of Fluid Mechanics
Credits: 3-3
Entry-level graduate course on the theory of fluid mechanics with emphasis on viscous
subsonic flows; concepts of boundary layer theory, flow stability, transition and turbulence;
laboratory includes elements of measurement techniques, numerical methods and physical
modeling.

Prerequisite: MATH 601 or registration therein.

Textbook: Frank White, Viscous Fluid Flow

Goals: Special emphasis is placed on a project which is intended to familiarize the student with the
philosophy and techniques of a combined theoretical-numerical-experimental approach of a
problem. All the projects are selected from a pool of practical topics of current interest and
application in areas spanning from surface ship and underwater vehicle hydrodynamics to
uninhabited air vehicle aerodynamics. Topic descriptions will be handed out in class.

Grading: Homework: 25%
Test: 35%
Project: 40%

Topics:
Review of Fundamental Equations and Theorems
Nondimensionalization of Fundamental Equations
Exact Solutions of the Navier-Stokes Equations
    Couette Flows and Steady Poiseuille Flows
    Unsteady Flows with Stationary and Moving Boundaries
    Flows with Suction and Injection
    Similarity Solutions (Stagnation Flows & Flow Over a Rotating Disk)
    Creeping Flows
Numerical Solutions of the Navier-Stokes Equations
Elements of Flow-Diagnostics
Boundary Layers
    Boundary Layer Equations and Terminology
    Flat Plate Boundary Layers
    Similarity Solutions (Blasius Solution & Falkner-Skan Flows)
    Free-Shear Flows
    Integral Methods (Pohlhausen Method & Thwaites Method)
    Axisymmetric Flows
    3-D Boundary Layers
Numerical Solutions of the Boundary Layer Equations
Measurement Techniques for Boundary Layers
Stability Theory
    Linearized Stability of Viscous Flows
    Orr-Sommerfeld Equation
    Inviscid Stability
    Viscous Stability
    Transition to Turbulence
    Transition Criteria
Turbulent Flows
    Reynolds Equations and Terminology
Turbulent Boundary Layer Equations
Law of the Wall
Law of the Wake
Turbulent Pipe Flows
Boundary-Free Turbulent Flows
Statistical Theory of Turbulence
Structure and Definition of Turbulence
Coherent Structures
Spectral Analysis
Turbulence Modeling
Flow-Diagnostics for Turbulent Flows
Catalog Data: AERO 603-Continuum Mechanics
Credits: 3-0
Development of field equations for analysis of continua (solids as well as fluids); conservation laws; kinematics, constitutive behavior of solids and fluids; applications to aerospace engineering problems involving solids and fluids.

Prerequisite: Graduate Classification. Cross-listed with MEMA 602.


Goals: Present a comprehensive treatment of the Mechanics of Continuous Media (solids and fluids). Introduce the algebra for Tensors and the calculus for Tensor fields. Introduce the concepts of deformation and motion of a continuum as well as deformation gradient, strain, traction and stress. Develop the basic conservation principles in local and global form for continuous media, develop the fundamental linear and nonlinear constitutive theories for solids and fluids and formulate well posed Boundary Value Problems (BVP) for modeling solid and fluid systems.

Grading: Homework: 40%
Midterm exam: 30%
Final exam: 30%

Prerequisites by Topic: Understanding of advanced calculus, linear algebra, matrix theory, dynamics and strength of materials

Topics: 1. Introduction, 1.5 lecture hour
2. Tensors, 6 hours
3. Kinematics of a Continuum, 6 hours
4. Stress, 6 hours
5. The Elastic Solid, 7.5 hours
6. Newtonian Viscous Fluid, 7.5 hours
7. Integral Formulations of General Principles, 3 hours
8. Non-Newtonian Fluids, 3 hours

Laboratory: None
AERO 606-Multifunctional Materials

Catalog Data:  AERO 606-Multifunctional Materials  (MEMA 606, MSEN 606)
Credits: 3-0
This course will present an in-depth analysis of multifunctional materials and composites, and their novel applications.

Prerequisites:  Theory of elasticity or Continuum Mechanics MEMA 601 or MEMA 602/AERO 603, MSEN 601 or MEMA 609. Cross-listed with MSEN 606/MEMA 606.

Goals:  The overall course objective is to provide students with a comprehensive look into the state of the art in multifunctional materials and structures.

- Introduce multifunctionality as exhibited by synthetic materials and biological material systems.
- Demonstrate how resulting properties in multifunctional materials are related to molecular and atomic level mechanisms that translate into useful macroscopic properties.
- Establish principles for deriving multifunctional constitutive response, emphasizing scale transitions.
- Use characterization tools for multifunctionality.

Textbook:  Course materials consist of lecture notes and articles from the current literature.

Grading Scale:

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<tr>
<th>Component</th>
<th>Percentage</th>
<th>Grade</th>
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<tr>
<td>Homework, labs quizzes</td>
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<td>90-100</td>
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<tr>
<td>Midterm</td>
<td>30%</td>
<td>80-89</td>
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<tr>
<td>Project</td>
<td>35%</td>
<td>70-79</td>
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<td>60-69</td>
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<tr>
<td>Below 60</td>
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Topics:

1. Introduction to multifunctional materials and their applications:
   a. Biological materials exhibiting multifunctionality (e.g. bone, marine organisms, etc.)
   b. Bioinspired synthetic materials
   c. Aerospace, medical and MEMS applications
2. Coupled fields in multifunctional materials; constitutive relations.
   a. Microscale mechanisms
   b. Constitutive models for macroscale representation of response
3. Classes of multifunctional materials
   a. Electroactive polymers and composites.
   b. Nanostructured and nanoreinforced polymers
   c. Carbon nanotube and carbon nanotube-based composites
   d. Magnetoactive materials.
   e. Shape and magnetic shape memory alloys.
   a. Lab familiarity with applicable characterization such as microscopy, mechanical, magnetic and electrical characterization.
   b. Mechanical, thermal, electrical and magnetic response
   c. Sensing and actuation performance
5. Multifunctionality at different length scales – from nano to macro.
   a. Difference between bulk and nanoscale properties will be presented
   b. Coupling between nanoscale properties and macroscale performance
6. Applications in design of multifunctional structures.

Calendar:  Course Outline with Approximate Times Assigned to Each

<table>
<thead>
<tr>
<th>Topic</th>
<th>Hours</th>
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<tr>
<td>1. Multifunctional materials and their applications.</td>
<td>6</td>
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<tr>
<td>2. Coupled fields; constitutive relations.</td>
<td>6</td>
</tr>
<tr>
<td>3. Classes of multifunctional materials.</td>
<td>6</td>
</tr>
<tr>
<td>4. Characterization of multifunctional materials.</td>
<td>6</td>
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</tbody>
</table>
5. Multifunctionality at different length scales.
6. Applications in design of multifunctional structures.
7. Project/lab
8. Midterm.

Total

Laboratory: None
AERO 615-Numerical Methods for Internal Flow

Catalog Data: AERO 615-Numerical Methods for Internal Flow
Credits: 3-0

Present methods for solving internal flow problems for viscous and inviscid compressible flow; Euler and Navier-Stokes solvers, boundary conditions formulation, combustion simulation, basics of parallel processing.


Prerequisites: MATH 601 or approval of instructor.
Attendance Policy: Attendance deemed important, but not counted as part of grade.

Goals: At the end of this course, students will be able to:

- Have a good understanding of the basic rules for code development
- Understand the implication of the governing equation character on the numerical algorithm
- Develop grid generation algorithms for different configurations of internal flows
- Develop a numerical algorithm for the solution of Euler equations
- Understand the methodologies used to develop high resolution methods
- Understand the methodologies used to solve the Navier-Stokes equation and the models used to simulate turbulence
- Understand the methods used to increase computational efficiency and reduce turnaround time.

Topics and Hours:

<table>
<thead>
<tr>
<th>Topic</th>
<th>Hours</th>
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<tbody>
<tr>
<td>1. Basics of Code Development for Unix/Linux</td>
<td>2</td>
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<tr>
<td>2. Governing Equations for Internal Flows</td>
<td>2</td>
</tr>
<tr>
<td>3. Discretization of Governing Equations</td>
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<td>4. Grid Generation</td>
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<td>5. Lax Equivalence Theorem</td>
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<tr>
<td>6. Euler Equations</td>
<td>4</td>
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<td>7. Characteristics of Euler Equations</td>
<td>3</td>
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<tr>
<td>8. Godunov's Method</td>
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<tr>
<td>9. Approximate Riemann Solvers</td>
<td>3</td>
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<tr>
<td>10. High Resolution Methods</td>
<td>3</td>
</tr>
<tr>
<td>11. Reynolds-averaged Navier-Stokes Equations</td>
<td>3</td>
</tr>
<tr>
<td>12. Turbulence Modeling</td>
<td>3</td>
</tr>
<tr>
<td>13. Multigrid Method</td>
<td>3</td>
</tr>
<tr>
<td>14. Preconditioning</td>
<td>3</td>
</tr>
<tr>
<td>15. Basics of Combustion Simulation</td>
<td>2</td>
</tr>
<tr>
<td>16. Introduction to Parallel Processing</td>
<td>2</td>
</tr>
<tr>
<td>Total hours</td>
<td>45</td>
</tr>
</tbody>
</table>

Grading:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework</td>
<td>50%</td>
</tr>
<tr>
<td>Final Test</td>
<td>50%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
</tbody>
</table>

Laboratory: None
AERO 616 – Damage & Failure in Composite Materials

Catalog Data: AERO 616 / MEMA 616 – Damage & Failure in Composite Materials
Credits: 3-0
Mechanisms and models related to damage and failure in composite materials subjected to mechanical loads. Cross-listed with MEMA 616.

Prerequisites: Courses in composite materials, elasticity.

Goals: To provide understanding of the physical mechanisms of damage and failure in composite materials and to give an in-depth treatment of the methods of analysis of damage, its evolution, and the ensuing failure.

Textbook: Selected papers and handout notes.

Grading: Grading Scale:

<table>
<thead>
<tr>
<th>Project</th>
<th>Percentage</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30%</td>
<td>90-100</td>
</tr>
<tr>
<td>2</td>
<td>35%</td>
<td>80-89</td>
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<tr>
<td>3</td>
<td>5%</td>
<td>70-79</td>
</tr>
<tr>
<td></td>
<td></td>
<td>60-69</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Below 60</td>
</tr>
</tbody>
</table>

Topics/Calendar:

1. Observations of damage and measurements of materials response (stress-strain behavior) caused by damage. General definition of damage. (Lecture 1-2)
2. Single vs. multiple cracking. The Aveston-Cooper-Kelly (ACK) analysis. (Lecture 3-4)
3. Variational analysis of transverse cracking in laminates. (Lecture 5-7)
4. Micromechanics applied to damage in composites. (Lecture 8-9)
5. Continuum damage mechanics: damage characterization, thermodynamics based theories, experimental characterization. (Lecture 10-16)
6. Evolution of damage in static and cyclic loading. (Lecture 17-20)
7. Fracture mechanics based analysis of damage evolution. (Lecture 21-22)
8. Mechanisms based analysis of damage evolution. (Lecture 23-24)
10. Guided self-study, as needed.

Laboratory: None
AERO 617 / MEMA 625-Micromechanics

Catalog Data:            AERO 617- Micromechanics
Credits:  3-0
Eigenstrains; inclusions, and inhomogeneities; Eshelby’s solution for an ellipsoidal
inclusion; Eshelby’s equivalent inclusion method. Effective elastic properties of
composites; composite spheres and cylinders models; bounds on effective moduli; Hasin-
Shtrikman bounds; applications to fiber, whisker and particulate reinforced composites;
introduction to micromechanics of inelastic composites and solids with damage.

Prerequisite:            MEMA 601, 602, or AERO 603, 605. Cross-listed with MEMA 625.


Goals:                 The course will present an in-depth analysis of the effective thermomechanical response
of heterogeneous media. The main objective is to develop a methodology for calculating
the constitutive response at the macroscale of composite materials in terms of microscale
parameters, e.g., shape and volume fraction of heterogeneities, as well their own
constitutive properties. Applications will be presented for continuous fiber and
particulate composites, composites with microcracks, for both random and periodic
microstructures. Comparison of the different averaging schemes and elements of
homogenization methods for periodic composites will be presented.

Grading:                Homework 25%
                        Midterm 25%
                        Project 25%
                        Final 25%

Prerequisites by Topic: 1. Advanced and vector calculus, linear algebra, matrix theory
2. Basic knowledge of elasticity, continuum mechanics, conservation laws,
   Kinematics and constitutive equations

2. Elastic fields due to eigenstrains. Eshelby’s inclusion problem.
3. Elastic fields due to inhomogeneities. Eshelby’s equivalent inclusion
   problem.
5. Composite cylinders and composite spheres models.
7. Mori-Tanaka averaging scheme.
8. Generalized self-consistent scheme; Comparison of different approaches.
9. Bounds on effective moduli: Voigt, Reuss and Hashin-Shtrikman
   Bounds.
11. Composite laminates with periodic cracks.
12. Effective mechanical properties of solids with periodic microstructure
   (homogenization).
13. Effective thermal properties.

Laboratory:            None
AERO 618 / MEMA 626-Mechanics of Active Materials

Catalog Data: MEMA 626 / AERO 618-Mechanics of Active Materials
Credits: 3-0
Introduction to coupled field theories; constitutive response of materials with electromagnetic coupling; microstructural changes due to phase transformations; shape memory alloys; active polymers and ionic solutions; electrodiffusion; multifunctional nanocomposites.

Prerequisites: MEMA 601 (Theory of Elasticity) or MEMA 602 (Continuum Mechanics)

Goals: The course will particularly emphasize:

1. Introduction; notation; review of kinematics, momentum, linear elasticity
2. Coupled electro-mechanical field equations; piezoelectricity; Gauss law; boundary conditions; material symmetries.
3. Piezoelectric structures and devices; transducers; vibration control
4. Shape memory alloys; martensitic phase transformations
5. Electroactive multifunctional nanocomposites
6. Actuation, energy storage, and electrical power from polymer electrolyte/carbon electrode supercapacitors.

Textbook: Non-Eqilibrium Thermodynamics, deGroot and Mazuer

Grading:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
<th>Grade Range</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework</td>
<td>25%</td>
<td>90-100</td>
<td>A</td>
</tr>
<tr>
<td>Project</td>
<td>25%</td>
<td>80-89</td>
<td>B</td>
</tr>
<tr>
<td>Midterm</td>
<td>25%</td>
<td>70-79</td>
<td>C</td>
</tr>
<tr>
<td>Final exam</td>
<td>25%</td>
<td>60-69</td>
<td>D</td>
</tr>
<tr>
<td>Below 60</td>
<td></td>
<td></td>
<td>F</td>
</tr>
</tbody>
</table>

Grading Scale:

- A: 90-100
- B: 80-89
- C: 70-79
- D: 60-69
- F: Below 60

Topics/Calendar:

<table>
<thead>
<tr>
<th>Outline</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Introduction. Notation.</td>
<td>2</td>
</tr>
<tr>
<td>3. Fundamental definitions for electricity and magnetism.</td>
<td>3</td>
</tr>
<tr>
<td>4. Maxwell's equations with emphasis on low frequency conditions.</td>
<td>6</td>
</tr>
<tr>
<td>5. Balance of linear and angular momentum.</td>
<td>2</td>
</tr>
<tr>
<td>6. Conservation of energy.</td>
<td>2</td>
</tr>
<tr>
<td>7. Second law of thermodynamics. Thermodynamic potentials. Entropy production.</td>
<td>4</td>
</tr>
<tr>
<td>8. Thermodynamically reversible active materials:</td>
<td></td>
</tr>
<tr>
<td>A. Thermoelasticity</td>
<td>1</td>
</tr>
<tr>
<td>B. Piezoelectricity</td>
<td>5</td>
</tr>
<tr>
<td>9. Thermodynamically irreversible active materials:</td>
<td></td>
</tr>
<tr>
<td>A. Shape memory alloys</td>
<td>8</td>
</tr>
<tr>
<td>B. Ionic diffusion materials:</td>
<td></td>
</tr>
<tr>
<td>1. Ionomeric polymer metal composites</td>
<td>5</td>
</tr>
<tr>
<td>2. Double-layer capacitors</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>42</td>
</tr>
</tbody>
</table>

Laboratory: None
AERO 620-Unsteady Aerodynamics

Catalog Data:  AERO 620-Unsteady Aerodynamics  
Credits 3-0  

Theoretical formulation of unsteady airfoil theory and techniques used for determining airloads on oscillating lift surfaces; exact and various approximations presented and evaluated; application to problems of unsteady incompressible and compressible, subsonic and transonic flows about airfoils and wings; various aspects of numerical simulation of unsteady flows.


Prerequisites:  Approval of instructor.

Attendance Policy:  Attendance deemed important, but not counted as part of grade.

Goals:  At the end of this course, students will be able to:

1. Understand the importance of unsteady effects on aerospace vehicles.
2. Predict unsteady airloads due to: (1) flow unsteadiness; (2) oscillating lift surfaces; and (3) flow unsteadiness and oscillating lift surfaces.
3. Numerically compute three-dimensional unsteady flows using lattice methods.
4. Numerically compute unsteady flows on wings and turbomachinery airfoils using CFD methods.

Topics and Hours:

<table>
<thead>
<tr>
<th>Topic</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Review of governing fluid mechanic equations of motion with emphasis on unsteady effects. The Reynolds transport equation, the conservation equations and the unsteady Bernoulli equation. Unsteady incompressible potential flow.</td>
<td>3</td>
</tr>
<tr>
<td>2. Kinetic energy of unsteady flows and Kelvin impulses. Apparent mass concepts. Physical interpretation of the velocity potential.</td>
<td>3</td>
</tr>
<tr>
<td>3. Unsteady thin airfoil theory. Response of two-dimensional airfoil to unsteady motion and gusts.</td>
<td>3</td>
</tr>
<tr>
<td>4. Unsteady thin airfoil theory. Superposition principals, Duhamel's superposition integral.</td>
<td>3</td>
</tr>
<tr>
<td>5. Kernel function methods. Use of Fourier transform and Green’s theorem to derive kernels. Acceleration potential methods for three-dimensional planar wings.</td>
<td>3</td>
</tr>
<tr>
<td>6. Three-dimensional wing theory. Doublet lattice method. Vortex lattice method.</td>
<td>3</td>
</tr>
<tr>
<td>7. Unsteady vortex lattice method. Compressibility effects.</td>
<td>3</td>
</tr>
<tr>
<td>8. Compressibility effects continued. Compressible doublet. Possio’s integral equation.</td>
<td>3</td>
</tr>
<tr>
<td>9. Computational fluid dynamics (CFD) techniques applied to unsteady flows. Consistency and stability.</td>
<td>3</td>
</tr>
<tr>
<td>10. Lax-Wendroff scheme. ADI scheme. Nonlinear CFD schemes.</td>
<td>3</td>
</tr>
<tr>
<td>11. Shock motion and the importance of numerical conservation. Linearized methods. Shock capturing vs. shock fitting.</td>
<td>3</td>
</tr>
<tr>
<td>12. Introduction to turbomachinery aeroelasticity.</td>
<td>3</td>
</tr>
<tr>
<td>13. Unsteady aerodynamics of turbomachinery blade rows.</td>
<td>3</td>
</tr>
<tr>
<td>15. Exams</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total hours</strong></td>
<td><strong>45</strong></td>
</tr>
</tbody>
</table>
Grading:

- Midterm Exam: 30%
- Final Exam: 30%
- Homework: 40%
- Total: 100%

Note 1: Homework is to be turned in by 5 pm on the assigned day, in the bin for AERO 620 in Room 701. Late homework will be penalized 25 points out of a total of 100 points for each day it is late.

Note 2: Students are encouraged to discuss with each other how to approach the homework problems but each student must re-think, privately prepare and write up his/her final solution to each problem. The homework solutions submitted must represent your work that you have carefully thought through and you must be prepared to explain each answer in detail.

Note 3: Makeup exams must take place during the approved academic calendar period and no later than one week from the date of the original exam.

Laboratory: None
AERO 622-Spacecraft Dynamics and Control

Catalog Data: AERO 622-Spacecraft Dynamics and Control  
Credits: 3-0  
Emphasis on fundamental principles and analytical methods of dynamics. Focus on dynamics of rigid and flexible body systems. Analysis of dynamical systems. Attitude control of aerospace systems.

Prerequisites: AERO 422 or ELEN 420

Grading: Grades will be awarded based on performance of homework, examinations, and projects. I anticipate that there will be two examinations and two projects. I will grade according to a conventional 10-point system and curve when appropriate.
Homework: 10%
Projects: 40%
Examinations: 50%

Textbook: None

References: There is no required text for this class, but you are strongly encouraged to purchase one. I will occasionally hand out copied notes from a few texts, with permission of the authors, of course. There are some excellent texts that you may enjoy reading.


Topics:

1. Particle Kinematics
   a. Geometry
   b. Coordinate Systems (Cartesian, Polar, and Spherical)
   c. Vector Expressions and Vector Referrals
2. Parameterizations of Rotations and Orthogonal Projections
   a. Euler Angles
   b. Properties of the Direction Cosine Matrix
   c. Euler's Principal Rotation Theorem and Euler Parameters
   d. Rodriguez Parameters and Modified Rodriguez Parameters
3. The Fundamental Principles of Motion—Newtonian and Eulerian Mechanics
   a. Particle Dynamics
   b. Rigid Body Dynamics
   c. Translational and Rotational Equations of Motion
   d. Torque-Free Motion of a Rigid Body
4. Analytical Mechanics
   a. Lagrangian Mechanics and Lagrange’s Equations of Motion
   b. Hamiltonian Mechanics
   c. Constrained Dynamical Systems
5. Introduction to Flexible Body Dynamics
   a. Equations of Motion of Some Distributed Parameter Systems
b. Approximation Methods
   c. Assumed Modes and Comparison Functions
6. Analysis of Dynamical Systems
   a. Eigenvalue Stability Analysis for Linear(ized) Systems
   b. Lyapunov Stability Analysis for Linear and Nonlinear Systems
   c. Gravity Gradient Stabilization
   d. Energy Sink Analysis for a Rigid Body
   e. Single and Dual Spin Stabilization
7. Introduction to Spacecraft Attitude Control
   a. Eigenstructure Assignment
   b. Sliding Mode Control, Path Planning and Tracking Control.

Laboratory: None
AERO 623-Optimal Spacecraft Attitude and Orbital Maneuvers

Catalog Data:  
**Optimal Spacecraft Attitude and Orbital Maneuvers**  
Credits: 3-0  
Application of optimization and optimal control techniques to spacecraft maneuver problems; computation of open loop and feedback controls for linear and nonlinear spacecraft dynamical systems; case studies.

Prerequisites:  
AERO 423 or equivalent

Goals:  
This course will emphasize the formulation and numerical solution of linear and nonlinear optimal control problems associated with dynamical systems. Some of the classic problems of interest are formation flying, the minimum-time climb of a supersonic aircraft and minimum time/control-effort maneuvers of flexible spacecraft. Control problems associated with robotics are also of interest and will be treated. Students will be introduced to a variety of numerical methods based on the calculus of variations, dynamic programming, parameter optimization methods, gradient methods, and shooting methods. Projects will be assigned individually and a term paper is expected at the end of the semester.

Prior knowledge of aircraft flight mechanics or spacecraft dynamics is not necessary.

Text:  
None

References:  
Optimal Control by Frank L. Lewis and Vassilis L. Syrmos  
Optimal Control Theory by Kirk  
Applied Optimal Control by Bryson and Ho  
Dynamic Optimization by A. E. Bryson, Jr.  
Optimal Spacecraft Rotational Maneuvers by Junkins and Turner  
A Unified Computational Approach to Optimal Control Problems by Teo, Goh, and Wong

Journal of the Astronautical Sciences  
Journal of Guidance, Control, and Dynamics

Grading:  
Homework 25%  
Quiz 25%  
Projects 25%  
Final Exam 25%

Topics:  
Static Optimization  
Equality and Inequality Constraints  
Kuhn-Tucker Conditions  
Determination of optimal initial conditions for dynamic systems  
Optimal Control of Continuous-time and Discrete-time Systems  
The Calculus of Variations, Terminal constraints  
Numerical Methods for Boundary-Value Problems  
LQ Problems  
Tracking and other Extensions  
Tracking, Accommodation of known disturbances  
Fixed final states, perturbation control  
Final-Time-Free and Constrained Input Control  
Pontryagin’s Principle, Minimum-Time and Minimum-Fuel Control  
The Hamilton-Jacobi-Bellman Equation  
Analytical Solutions, Dynamic Programming
Singular Optimal Control

Discretization and Approximate solutions using Nonlinear Programming

Applications
- Aircraft optimization problems
- Satellite rotational maneuvers
- Interplanetary Trajectories: low thrust and Impulsive transfers
- Formation Flying (Relative motion of spacecraft)
- Launch Trajectories
- Space Robotics

Laboratory: None
Catalog Data: AERO 624 – Celestial Mechanics
Credits: 3-0
Analytical and numerical methods for computing spacecraft orbits under the influence of gravitational, aerodynamic, thrust and other forces; Keplerian two-body problem, perturbation methods, orbit determination, navigation and guidance for aerospace vehicles.

Prerequisites: AERO 423 or equivalent.

Textbook:

Copies of portions of Reference 2 will be made available and additional class notes will be handed out in class. Reference 1 is available as the official required text in the bookstore.

Goals: To provide a rigorous foundation in orbital mechanics, perturbation methods and numerical methods that underlies modern applications of Guidance, Navigation, and Control of aerospace vehicles.

1) Students will gain an understanding of the classical gravitational two body problem that approximates orbits dominated by the gravity field of a near spherical body.
2) Students will come to understand the most important perturbation effects of the dominant inverse square gravity model, including the high order gravitational perturbations due to the Earth (or other body’s) departure from spherical symmetry, drag, thrust and attraction from other bodies in the Solar system.
3) Students will learn analytical and numerical methods for computing perturbed orbits.
4) Students will learn several classical regularizing transformations to remove certain geometric and dynamic singularities that occur due to classical coordinate choices.
5) Students will be required to develop their own MATLAB programs for solving initial value problems, two-point boundary value problems (orbit transfer), and for solving the inverse problems (orbit determination).

Grading: Grading Scale:
Mid-term Exam 30% 90-100 A
Homework 30% 80-89 B
Final Exam 40% 70-79 C
60-69 D
Below 60 F

Topics/Calendar:
INTRODUCTION
Kepler’s Laws: Geometrical/Empirical Genius
Newton’s Analytical Extensions and Generalizations

THE TWO BODY PROBLEM
Geometry of Conic Sections
Equations of Motion
The Classical Solution of The Elliptical Two Body Problem
Momentum, energy, and eccentricity integrals
Kepler’s Equation and Position/Time Transcendental Relationship
Solving the Classical Two-Body Problem Initial Value Problem
Analogous Parabolic and Hyperbolic Solutions
Singularities in the Classical Formulations
Avoiding Geometric and Dynamics Singularities of the Two-Body Problem
The F and G Formulations
Basic Motivation and Lagrange’s Time Series Approximations
Closed F&G Formulas for Elliptical, Parabolic and Hyperbolic Orbits
Change-in-Eccentric-Anomaly version of Kepler’s Equation
Universal Non-Singular Formulations of the two-Body Problem
Universal integration and universal transcendental functions
Universal computation of the universal functions ✅ Euler’s top-down method
The K-S Transformation and other regularizing coordinate transformations
Initial Condition Sensitivity and Neighboring Orbits: The State Transition Matrix
The Classical Formulation and Battin’s Formulation
Numerical Integration of Perturbed Motion

THE N BODY PROBLEM
Equations of Motion => Ten Exact Integrals
Alternative “Two Body Plus Perturbations” Forms
Sphere of Influence Concept => Patched Conic Approximations
The Three Body Problem
Lagrange’s Amazing Insights On Special Case Orbits
Straight Line and Equilateral Triangle Solutions
Restricted Three Body Problem
The Five Libration Points and Their Stability
The Zero Velocity Surfaces and Their Interpretation

INTRODUCTION TO PERTURBATION METHODS
Numerical Perturbation Methods => The methods of Cowell and Encke
Relative Motion => Hill’s Equations
Analytical Perturbation Methods
The method of variation of parameters => Lagrange Planetary Equations
Lagrange and Poission Brackets => Perturbative Differentiation
Special Problems
Modeling Gravity Perturbations & Drag Perturbations
Using the Lagrange Planetary Equations to Study the J2 Problem

INTRODUCTION TO ORBIT ESTIMATION

Laboratory: None
AERO 625-Digital Control of Aerospace Systems

Catalog Data: AERO 625-Digital Control of Aerospace Systems
Credits: 3-0
Analysis and design of discrete and sampled-data controllers unique to aircraft and spacecraft; modeling of aircraft and spacecraft, sources of uncertainties; requirements and specifications; direct digital design using SISO and MIMO optimal techniques; Z plane and w' plane analysis and design; sample rate selection, multi-rate controllers; robustness.

Prerequisites: AERO422 or equivalent

Goals: To provide engineering graduate students with the mathematical and conceptual tools necessary to synthesize and analyze digital controllers for aerospace systems. The course will particularly emphasize:

1. Modeling, dynamics, and dynamic modes unique to aircraft and spacecraft.
2. Operating environments and missions of aircraft and spacecraft, and how these translate into requirements and specifications for controller design.
3. Synthesis of sampled-data controllers which satisfy mission requirements using both discretization and direct design methods, using both classical and modern methods.
4. Implementation and simulation of digital and sampled-data control systems, including effects of roundoff error, truncation, and finite wordlength.
5. Nonlinearities, sensor requirements/limitations, and uncertainties unique to aircraft and spacecraft.


Supplementary Texts:

Grading:
Grading Scale:
Homework  25%  90-100  A
Project   10%  80-89  B
Midterm  30%  70-79  C
Final exam  35%  60-69  D
Below 60  F

Topics:
1 INTRODUCTION - The General Aerospace Control Problem (1 lecture)
2 MODELING OF AIRCRAFT (2 lectures)
3 AIRCRAFT FLIGHT CONTROL PROBLEM AND REQUIREMENTS (3 lectures)
4 TYPICAL AIRCRAFT FLIGHT CONTROL STRUCTURES (2 lectures)
5 MIMO CONTINUOUS LINEAR SYSTEMS ANALYSIS (3 lectures)
6 MATHEMATICAL MODELING OF DIGITAL COMPUTERS (3 lectures)
7 MATHEMATICS OF DISCRETE SYSTEMS (4 lectures)
8 APPROXIMATION TECHNIQUES (5 lectures)
9 SISO DIRECT DIGITAL DESIGN
10 MIMO DIRECT DIGITAL DESIGN
11 OUTPUT FEEDBACK DESIGN
12 ROBUSTNESS ANALYSIS

Laboratory: None
AERO 626-Estimation of Dynamic Systems

Credits: 3-0
This course provides the fundamental and recent aspects of estimation, with a particular emphasis on aerospace systems.

Prerequisites: AERO 310 or equivalent and Fundamentals Course in Statistics

Textbook:


Goals:
Learn about traditional concepts and recent advances in estimation, and to relate these concepts to modern dynamic systems found in aerospace disciplines. This course stresses modeling of physical problems into mathematical terms. Examples will be given from both spacecraft and aircraft systems.

Grading:
Projects and Homework 100%

Topics:
- Review of Statistics - 3 lectures
  Random Variables, Gaussian Processes, Covariance and Correlation Function, Maximum Likelihood
- Least Squares Estimation - 5 lectures
  Linear Batch Estimation, Linear Sequential Estimation, Nonlinear Estimation
- Examples - 4 lectures
  Vehicle Attitude Determination, GPS Navigation
- State Estimation - 6 lectures
  Review of State-Space Systems, Response to Gaussian Inputs, Linear Kalman Filter, Neighboring-Optimal Linear Estimator, Extended Kalman Filter for Nonlinear Systems
- Examples - 5 lectures
  Position and Velocity Tracking Using an a-B Filter, Review of Attitude Dynamics, Attitude Estimation Using Dynamics, Gyros, Bias Estimation and Calibration
- Advanced Topics - 2 lectures
  Covariance Decompositions, Smoothing Algorithms
AERO 627 - Structural Dynamics

Catalog Data: AERO 627 - Structural Dynamics
Credits: 3-0
Examination of flexible structures through a review of single degree-of-freedom dynamical systems followed by an in-depth study of continuous and multiple degree-of-freedom systems; emphasis on discrete modeling of structures for vibration analysis and dynamic analysis, with minimal development of methods such as finite elements.

Prerequisites: Graduate classification in the College of Engineering.


Goals: We will examine the dynamics of structures through a review of single degree of freedom systems followed by an in-depth study of continuous and multiple degree of freedom systems. The course will emphasize modeling of structures for vibration analysis and dynamic analysis, but not the specific development of methods such as finite elements.

Topics:

<table>
<thead>
<tr>
<th>Topic</th>
<th>Lectures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction, background in dynamics</td>
<td>6</td>
</tr>
<tr>
<td>Free Response of Single Degree-of-Freedom (SDOF) Systems</td>
<td>5</td>
</tr>
<tr>
<td>Forced Response of SDOF Systems</td>
<td>3</td>
</tr>
<tr>
<td>Math Models of Continuous Systems</td>
<td>4</td>
</tr>
<tr>
<td>Free Vibration of Continuous Systems</td>
<td>4</td>
</tr>
<tr>
<td>Models of Multiple-Degree-of-Freedom (MDOF) Systems</td>
<td>4</td>
</tr>
<tr>
<td>Free Vibration of MDOF Systems</td>
<td>4</td>
</tr>
<tr>
<td>Vibration Analysis of MDOF Systems</td>
<td>3</td>
</tr>
<tr>
<td>Dynamic Response of MDOF Systems</td>
<td>3</td>
</tr>
<tr>
<td>Finite Element Modeling for Structural Dynamics</td>
<td>1</td>
</tr>
<tr>
<td>Further Considerations</td>
<td>3</td>
</tr>
<tr>
<td>Quizzes</td>
<td>2</td>
</tr>
</tbody>
</table>

Grading: I am an optimist - all of you start with A's! Here are opportunities to prove me right!

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homework weekly (low score dropped)</td>
<td>30 %</td>
</tr>
<tr>
<td>Tests</td>
<td>40 %</td>
</tr>
<tr>
<td>Final ( comprehensive )</td>
<td>30 %</td>
</tr>
<tr>
<td></td>
<td>100 %</td>
</tr>
</tbody>
</table>
Catalog Data: AERO 628 – Advanced Spacecraft Dynamics and Control
Credits: 3-0
Review of fundamental principles; introduction to alternate and advanced methods of dynamics and control for aerospace systems; alternate methods for generating and analyzing equations of motion; techniques for complex multibody systems; variable speed control moment gyros; method of quadratic modes; focus on modeling techniques for aerospace systems.

Prerequisites: Graduate classification and AERO 622.


Goals: This course is a follow-on course to AERO 622 to discuss the dynamics and control of some spacecraft models. The course begins with a brief review of fundamental dynamics principles, but the primary focus is on control principles and techniques for common spacecraft systems. The primary goals of this course introduce the student to traditional and advanced methods of spacecraft control.

1) Students receive detailed instruction on spacecraft control methods through lecture and example application.
2) Students gain an understanding and experience in developing and implementing control algorithms through numerical simulation. Approximately 8-10 projects are assigned.

Grading: Homework: 10%  
Projects and Presentations: 90%  
Grading Scale:

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<th>Grade</th>
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<tr>
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<td>D</td>
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Topics/Calendar:

<table>
<thead>
<tr>
<th>Topics</th>
<th>Class hours (2100 minutes)</th>
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<tbody>
<tr>
<td>1. Review of rigid body mechanics</td>
<td>150 minutes</td>
</tr>
<tr>
<td>2. Review of stability concepts and Lyapunov analysis</td>
<td>150 minutes</td>
</tr>
<tr>
<td>3. Lyapunov control methodology</td>
<td>150 minutes</td>
</tr>
<tr>
<td>4. Methods for rigid body regulation involving quaternions and other Euler-parameter types of attitude variables</td>
<td>150 minutes</td>
</tr>
<tr>
<td>5. Basics of reference motion tracking and reference motion trajectories for rotational motion</td>
<td>150 minutes</td>
</tr>
<tr>
<td>6. Reference motion tracking without rate information</td>
<td>150 minutes</td>
</tr>
<tr>
<td>7. Adaptive control for rigid body rotational motion</td>
<td>300 minutes</td>
</tr>
<tr>
<td>8. Gyrostat models, DC motor models, and control for nutation damping &amp; flat-spin recovery</td>
<td>150 minutes</td>
</tr>
<tr>
<td>9. Stability of near pure-spin states</td>
<td>150 minutes</td>
</tr>
<tr>
<td>10. Models for single-gimbal, variable-speed control moment gyros</td>
<td>300 minutes</td>
</tr>
<tr>
<td>11. Velocity- and acceleration-based steering laws</td>
<td>150 minutes</td>
</tr>
<tr>
<td>12. Feedback control singularities and null motion feedback control</td>
<td>150 minutes</td>
</tr>
<tr>
<td>13. Control of flexible-body systems; rigid bodies subject to constant or impulsive moments</td>
<td>(as time permits)</td>
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Laboratory: None

Total = 2100 minutes
**Catalog Data:**  
AERO 629 – Experimental Aerodynamics  
Credits: 3-0  
Review of fundamental principles in aerodynamics; basics of instrumentation, electronics, data-acquisition; experimental techniques in aerodynamics/fluid mechanics; pressure, skin friction, force and velocity measurement techniques in wind and water-tunnel testing; conventional and novel techniques in data-processing and systems modeling; smart systems in experimental aerodynamics.

**Prerequisites:**  
AERO 601.

**Textbook:**  
AERO 601.

**Goals:**  
To familiarize the students with modern experimental measurement and data modeling techniques in aerodynamics. Due to the typical multidisciplinary nature of modern engineering, they will also have exposure to related fields, to the degree that they tie to aerodynamics, such as active materials, structures and control. The students are expected to develop or improve their ability to attack a problem holistically, synthesizing different techniques/tools to solve it. The projects will be group projects; the students are expected to refine their ability to work efficiently in a team.

**Grading:**

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**Grading Scale:**

- A: 90-100
- B: 80-89
- C: 70-79
- D: 60-69
- F: Below 60

**Topics/Calendar:**

*Course Topic and Outline Based on 15 Week (45 class hours) Schedule:*

- Vector and Tensor Calculus and Notation 1
- Equations of Fluid Motion 1
- Data-Acquisition Fundamentals 2
  - Uncertainty Analysis 2
  - Elements of Analog and Digital Electronics 2
  - Data-Acquisition and the PC 1
  - Data-Acquisition Automation 1
- Measurement of Aerodynamic Loads 1
  - General Principles and Techniques 1
  - Internal and External Load Balances, their Calibration and Use 1
- Steady and Unsteady Pressure Measurement 2
  - General Principles and Techniques for Pressure Measurement 1
  - 5- and 7-Hole Probes, Calibration and Use 2
  - Omni-Directional 18-Hole Probes, Calibration and Use 1
  - Principles of Unsteady Fluid Mechanics and Unsteady Pressure Measurement Theory 2
  - Frequency Response of Pneumatic Systems 1
  - Fast-Response Pressure Probes 1
- Measurement of Skin Friction 1
<table>
<thead>
<tr>
<th>Topic</th>
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<tbody>
<tr>
<td>Hot-Wire Anemometry</td>
<td>2</td>
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<tr>
<td>Laser Doppler Velocimetry</td>
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</tr>
<tr>
<td>Particle Image Velocimetry</td>
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<tr>
<td>Doppler Global Velocimetry</td>
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<tr>
<td><strong>Data Processing and System Modeling</strong></td>
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<tr>
<td>Statistical Analysis</td>
<td>2</td>
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<tr>
<td>System Modeling from Experimental Data</td>
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<tr>
<td>Artificial Neural Networks</td>
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<tr>
<td>Fuzzy Logic</td>
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<tr>
<td>Multiresolution Analysis</td>
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<tr>
<td>Proper Orthogonal Decomposition</td>
<td>2</td>
</tr>
<tr>
<td><strong>Emphasis on Turbulence Measurements</strong></td>
<td>2</td>
</tr>
<tr>
<td><strong>Smart Systems in Aerodynamics</strong></td>
<td></td>
</tr>
<tr>
<td>Experimental Techniques in Fluid-Structure Interaction</td>
<td>2</td>
</tr>
<tr>
<td>Active Materials in Aerodynamics/Fluid Mechanics</td>
<td>2</td>
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<tr>
<td>Actuation Techniques</td>
<td>1</td>
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<td>Experimental Techniques in Flow Control</td>
<td>2</td>
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<td><strong>Final Exam</strong></td>
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</table>

**Laboratory:** None
AERO 630 – Introduction to Random Dynamical Systems

Credits: 3-0

Building on basic probability theory, course covers theory and applications of discrete and continuous random processes. Particular attention shall be paid to the response of dynamical systems (discrete, linear and non-linear), to random input processes and their application to Engineering Systems.

Prerequisites:
Graduate student status.

Textbook:
Lecture Notes and recommended reading:

Goals:
1) Understand fundamentals of random variables and processes
2) Apply the theory of random processes to the modeling and analysis of stochastic engineering systems
3) Understand the fundamentals of the response of dynamical systems to stochastic perturbations, in particular, the stability of such systems
4) Apply the knowledge gained to a real-world (Aerospace) engineering problem in the form of an extended class project

Grading:

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<tr>
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<tr>
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Grading Scale:

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Topics/Calendar:

<table>
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<tr>
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<th>Hours</th>
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<tr>
<td>Basic Probability Theory</td>
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<td>Random Variables and Functions</td>
<td>4</td>
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<tr>
<td>Random Processes and their applications</td>
<td>12</td>
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<tr>
<td>Linear Dynamical Systems with application to Engineering</td>
<td>8</td>
</tr>
<tr>
<td>Nonlinear Dynamical Systems with application to Engineering</td>
<td>12</td>
</tr>
<tr>
<td>Exams</td>
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<tr>
<td>Total</td>
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Laboratory: None
Catalog Data: AERO 631- Advanced Trajectory Optimization for Aerospace Systems
Credits: 3-0
This course will cover numerical solution of optimal control problems (OCP) as a nonlinear
programming problem (NLP) with applications including control of a nonlinear missile,
trajectory generation for differentially flat UAVs, motion planning with simple obstacles,
atmospheric entry problems for crew return vehicles. The nonlinear programming problem
will be solved using the student version of SNOPT. Students will be introduced to elements
of approximation theory, numerical analysis, stochastic optimal control theory, dynamical
systems and stability theory and advanced parameter optimization methods. Projects will be
assigned individually and a term paper is expected at the end of the semester.

Prerequisites: Graduate classification

Goals:
1. Understand and derive numerical solution techniques to solve linear and nonlinear optimal
control problems.
2. Learn advanced techniques to approximate nonlinear systems using differential flatness to
reduce computational complexity.
3. Understand elements of approximation theory to transcribe optimal control problems to
nonlinear programming problems including direct collocation, pseudo-spectral methods,
Spline approximations, meshless FEM approaches.
4. Solve stochastic optimal control problems using polynomial chaos theory.
5. Learn to apply receding horizon control techniques to engineering problems.

Textbook: N/A.

Supplementary Texts:
1. Practical Guide to Splines, Carl de Boor.
2. Orthogonal Polynomials, G. Szego.
3. Parallel and Distributed Computation: Dimitri P. Bertsekas and John N. Tsitsiklis
4. Applied Optimal Control by A.E. Bryson and Y.-C. Ho
5. Dynamic Optimization by A. E. Bryson, Jr.
6. IEEE Transactions in Automatic Control
7. Automatica, A Journal of IFAC, the International Federation of Automatic Control
8. Journal of Guidance, Control, and Dynamics

Grading:
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<tr>
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<td>60-69</td>
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<td>Below 60</td>
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</table>

Topics/Calendar:
1. Introduction (3 hours)
2. Elements of Nonlinear Dynamical Systems (6 hours)
3. Numerical Approximation Theory (12 hours)
4. Transcription of Optimal Control to Nonlinear Programming (9 hours)
5. Stochastic Optimal Control (6 hours)
6. Applications (6 hours)

Laboratory: None
Catalog Data: AERO 640-Turbulance Processes
Credits: 3-0
Fundamentals of conservation, Lagrangian, transformation and variance properties; flow features:
laminar, transition and turbulence regimes, characteristics, spectrum; statistical (filter/average)
description: scales, Reynolds, arbitrary averaging, realizability; elementary turbulence processes:
viscous, advective/inertial process, role of pressure; models of elementary processes: RDT, viscous
RDT, RDT for velocity gradients, equipartition of energy, restricted Euler equations; isotropic and
homogeneous turbulence

Prerequisites: None

Goals: At the end of this course, the students will be able to:

1. To understand the physics underlying various turbulence processes: production, slow and rapid pressure
   strain correlation and dissipation.
2. To be able to perform linear analysis with Rapid Distortion Theory
3. To be able to perform non-linear studies with Homogenized Euler Equation.
4. To perform direct numerical simulations of isotropic and anisotropic turbulence to examine various
   features of turbulent cascade, energy transfer and scales of motion.
5. To comprehend closure modeling issues

Textbook: None

Supplementary Texts:
‘Turbulent Flows’ by S. B. Pope

Grading:
Assignments and projects (3X30%) 90%
Final Exam 10%
Grading Scale:
90-100 A
80-89 B
70-79 C
60-69 D
Below 60 F

Topics/Calendar:

1. Fundamentals
   a) On the nature of turbulence
   b) Governing equations
   c) Lagrangian description
   d) Transformation and invariance properties
   4 Hrs

2. Flow features
   a) Laminar, transition and turbulence regimes
   b) Turbulence characteristics
   c) Turbulence spectrum
   d) Scales of turbulence
   4 Hrs

3. Statistical description
   a) Need for statistical description
   b) Reynolds and generalized central moment averaging
   c) Generalized statistics equations
   d) Realizability and other kinematic constraints
   4 Hrs

4. Elementary turbulence processes
   a) Advective/inertial process – production and transport
   b) Viscous process – dissipation and transport
   c) Role of pressure – redistribution and transport
   10 Hrs
5. Models of elementary processes
   a) Inviscid RDT – linear model of advection and pressure effects
   b) Viscous RDT: RDT + viscous effect
   c) Homogenized Euler equations:
       Model for non-linear advection and pressure effects
6. Isotropic and homogeneous turbulence

Total Hours: 42

Laboratory: None
AERO 642- Laser Diagnostics for Combustion and Propulsion

Catalog Data:  AERO 642- Laser Diagnostics for Combustion and Propulsion
Credits: 3-0

Laser diagnostics as applied to combustion and propulsion; brief exposition of fundamental electromagnetic theory; practice of basic experimental laser techniques used to measure thermochemistry; basic implementation of Raman and Rayleigh scatterings; Laser–Induced Fluorescence (LIF); detection methods, optical systems, noise contributions, and signal enhancement techniques will be discussed.

Prerequisites:  Graduate classification.

Goals:  Knowledge of fundamentals of electromagnetic wave propagation, dispersion and scattering, basics of vibrational, rotational and electronic molecular excitations, theory and practice of elastic (Rayleigh) and inelastic (Raman) scattering and photon absorption/emission (LIF) as applied to the measurement of aerothermochemistry, setting-up of experiments and quantifying of signal and noise in practical systems.


Supplementary Texts:  None

Grading:  Grading Scale:

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Grading: Exams 60%, Project 40%

Grading Scale: 90-100 A, 80-89 B, 70-79 C, 60-69 D, Below 60 F

Topics/Calendar:

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<th>Week</th>
<th>Topic</th>
<th>Hours</th>
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<tr>
<td>1.</td>
<td>Electromagnetism, wave propagation, diffraction</td>
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<tr>
<td>2.</td>
<td>Raman scattering</td>
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<td>3.</td>
<td>Rayleigh scattering</td>
<td>6</td>
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<tr>
<td>4.</td>
<td>Laser-Induced Fluorescence (LIF)</td>
<td>6</td>
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<tr>
<td>5.</td>
<td>Coherent Anti-Stokes Raman Spectroscopy (CARS)</td>
<td>6</td>
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<tr>
<td>6.</td>
<td>Wave-mixing, Doppler-shift techniques</td>
<td>6</td>
</tr>
<tr>
<td>7.</td>
<td>Detectors, optical systems</td>
<td>6</td>
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TOTAL: 42 hours
Catalog Data:  AERO 650 – Spacecraft Attitude Determination
Credits: 3-0
Spacecraft attitude determination systems; attitude and parameterizations, attitude sensors, data processing and calibration; introduction to single- and three-axis attitude determination and to optimal attitude and error estimation; ECI motion and time definitions.

Prerequisites:  AERO 423 or equivalent.


Goals:  At the end of this course, using MATLAB, the students will be able to:

1. Transform among the attitude parameterizations, and quantify the attitude error,
2. Know how most of the existing attitude sensors work,
3. Perform the data processing and calibration for the existing attitude sensors,
4. Learn the definitions of the time and the inertial reference update,
5. Estimate a given direction or three-axis attitude from vector observations,
6. Estimate the attitude error, and perform speed and accuracy tests comparisons.

Mathematical background (Linear algebra, best-fitting, spherical trigonometry); Attitude and Error Representation; Attitude Sensors; Data Processing; Time definitions and ECI motion; Sun, Earth, and Star direction evaluation, Single-and-three axis attitude determination, Wahba’s problem; Optimal attitude algorithms; Speed and accuracy comparison tests.

Grading:  

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<tr>
<td>Homework &amp; Quizzes</td>
<td>40%</td>
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Grading Scale:  A: 90-100, B: 80-89, C: 70-79, D: 60-69, F: Below 60

Topics/Calendar:  

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<tr>
<td>1. Mathematical background.</td>
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<td>2. Attitude parameterizations,</td>
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<td>3. Attitude error,</td>
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<tr>
<td>4. Attitude sensors description.</td>
<td>6</td>
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<tr>
<td>5. Sensor data processing</td>
<td>8</td>
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<tr>
<td>6. Sensors calibration</td>
<td>3</td>
</tr>
<tr>
<td>7. Inertial reference motion (Precession and nutation), and time definitions</td>
<td>4</td>
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<tr>
<td>8. Single-axis determination</td>
<td>2</td>
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<td>9. Three-axis optimal attitude determination</td>
<td>6</td>
</tr>
<tr>
<td>10. Attitude error estimation</td>
<td>2</td>
</tr>
<tr>
<td>11. Speed and accuracy tests comparisons</td>
<td>2</td>
</tr>
<tr>
<td>Total Hours</td>
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</table>

Laboratory:  None
AERO 660-NONLINEAR FLIGHT DYNAMICS

Credits: 3-0
Nonlinear equations of motion for coupled aircraft motions; coupled aerodynamic phenomena; application of the direct method of Lyapunov to nonlinear aircraft motions; elastic airplane equations of motion.

Prerequisites:
AERO 421 or approval of instructor

Textbook:

Supplemental References:

Goals:
To provide Aerospace Engineering graduate students with the mathematical and conceptual tools necessary to analyze nonlinear problems in flight dynamics of aerospace vehicles and to provide practice in realistically applying these tools.

Grading:
Homework 30%
Project 10%
Midterm 30%
Final exam 30%

Topics:
Definitions and Concepts
Phase Plane Analysis
Lyapunov Functions and Methods
Bifurcation and Catastrophe Analysis
Describing Functions
Extended Kalman Filtering
Note that one or more of these may be abbreviated to fit the available time

Laboratory:
None
AERO 674- Hypersonic Flow

Catalog Data: AERO 674- Hypersonic Flow
Credits: 3-0
Theoretical formulation of inviscid hypersonic flow theory; techniques for hypersonic flowfield analysis; high temperature effects, including both equilibrium and nonequilibrium flows; classical and modern computational methods.

Prerequisites: AERO 303 or equivalent.

Textbook: Anderson, J., Hypersonic and High Temperature Gas Dynamics, AIAA.

Goals: At the end of this course, students will be able to explain the fundamental principles of inviscid and viscous hypersonic flow, compute flow properties with and without high temperature effects using classical and modern computational methods, compute gas temperature/chemically reacting gas composition given the spectroscopic descriptions of the species, compute the flow properties for frozen, equilibrium and non-equilibrium flows, and be exposed to experimental methods (e.g., shock tunnels).

Grading: Midterm Exam: 30%, Projects: 35%, Final Exam: 30%. Practice problems are assigned but not graded.

Topics:

<table>
<thead>
<tr>
<th>Topic</th>
<th>Text</th>
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<tbody>
<tr>
<td>1. Introduction</td>
<td>Ch. 1</td>
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<tr>
<td>2. Inviscid Hypersonic Flow</td>
<td>Ch. 2 – 515</td>
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<tr>
<td>3. Hypersonic Viscous Flow</td>
<td>Ch. 6 – 815</td>
<td></td>
</tr>
<tr>
<td>4. Overview of High-Temperature Flows</td>
<td>Ch. 9/Notes</td>
<td>3</td>
</tr>
<tr>
<td>5. Experimental Methods</td>
<td>Notes</td>
<td>3</td>
</tr>
<tr>
<td>6. Advanced Topics</td>
<td>Notes</td>
<td>3</td>
</tr>
<tr>
<td>TOTAL</td>
<td>Notes</td>
<td>3</td>
</tr>
</tbody>
</table>

Laboratory: None
Catalog Data: AERO 676- Aerothermochemistry
Credits: 3-0

Fundamentals of kinetic theory, chemical thermodynamics and statistical mechanics; applications to high temperature chemically reacting equilibrium and nonequilibrium aerodynamic flows.

Prerequisites: AERO 303 or equivalent.

Textbook: Anderson, J., Hypersonic and High Temperature Gas Dynamics, AIAA.

Goals: At the end of this course, students will be able to explain the fundamental principles of aerothermochemistry, compute gas temperature/chemically reacting gas composition given the spectroscopic descriptions of the species, compute the flow properties for frozen, equilibrium and non-equilibrium flows, and be exposed to advanced laser diagnostic techniques.

Grading: Midterm Exam: 30%, Projects: 35%, Final Exam: 30%. Practice problems are assigned but not graded.

Topics:

<table>
<thead>
<tr>
<th>Text</th>
<th>Hours</th>
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<tbody>
<tr>
<td>7. Introduction</td>
<td>Ch. 9</td>
</tr>
<tr>
<td>8. Classical Thermodynamics/Equilibrium Combustion Chemistry</td>
<td>Ch. 10/Notes</td>
</tr>
<tr>
<td>9. Molecular Description of Diatomic Molecules</td>
<td>Notes</td>
</tr>
<tr>
<td>10. Molecular Thermodynamics</td>
<td>Ch. 11</td>
</tr>
<tr>
<td>11. Gas dynamics of non-perfect gases</td>
<td>Ch. 14/Notes</td>
</tr>
<tr>
<td>12. Nonequilibrium gas dynamics</td>
<td>Ch. 12/13/15</td>
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<tr>
<td>7. Laser Diagnostics</td>
<td>TOTAL</td>
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Laboratory: None.
Catalog Data: MEMA-601 Theory of Elasticity
Credits: 3-0
Analysis of stress and strain in two and three dimensions, equilibrium and compatibility equations, strain energy methods; torsion of noncircular sections; flexure; axially symmetric problems.

Prerequisites: MATH 601 or registration therein


Goals: The aim of the course is to provide the student with a thorough grounding in the concepts of the linearized theory of elasticity and its application to a variety of problems of engineering interest. In particular, the course will highlight the efficacy and limitations of the theory and will teach the use of a variety of formulations and solution techniques (including approximate solutions and estimation).

Outcomes: The student will demonstrate his/her understanding of and proficiency in the subject by being able to:
Make a judicious evaluation as to whether the linearized theory is applicable to a particular problem
Make the necessary idealizations in the geometry and applied loading
Decompose the problem into a suitable number of parts for solution
Get a physically reasonable, rough estimate of the solution using suitable approximation techniques.
Obtain accurate solutions where needed by a suitable combination of analytical and numerical techniques
Use some design rules and guidelines to avoid costly detailed evaluations.

Grading: Homeworks and quizzes etc. 20 %
Exam 1 25 %
Exam 2 25 %
Final Exam 30 %

Prerequisites by Topic: Undergraduate courses in mechanics of materials, differential equations, Linear Algebra and numerical methods.

Topics: INTRO TO CONTINUUM MECHANICS: Representing bodies as continua.
Kinematics of continuaa- Local measures of deformation-Intro to tensors and indicial notation. Different strain measures -Linearization-Compatibility
CONSTITUTIVE THEORY: Green and Cauchy Elasticity- Restrictions on the Constitutive Assumptions-Material Symmetry-Stiffness And Compliance Tensors for a number of anisotropic Media, Fiber Reinforced Media.
SOME EXACT SOLUTION SOLUTIONS: Homogenous Deformations- Plane strain-antiplane strain- plane stress and plane stress - Complex Variable techniques-Axisymmetric solutions-Anisotropic Media-Superposition

Laboratory: None
MEMA-602/AERO 603-Continuum Mechanics

Catalog Data: MEMA-602 Continuum Mechanics
Credits: 3-0
Development of field equations for analysis of continua (solids as well as fluids); conservation laws; kinematics, constitutive behavior of solids and fluids; applications to aerospace engineering problems involving solids and fluids.

Prerequisite: Graduate Classification. Cross-listed with AERO 603.


Goals: Present a comprehensive treatment of the Mechanics of Continuous Media (solids and fluids). Introduce the algebra for Tensors and the calculus for Tensor fields. Introduce the concepts of deformation and motion of a continuum as well as deformation gradient, strain, traction and stress. Develop the basic conservation principles in local and global form for continuous media, develop the fundamental linear and nonlinear constitutive theories for solids and fluids and formulate well posed Boundary Value Problems (BVP) for modeling solid and fluid systems.

Grading: Homework: 40%
Midterm exam: 30%
Final exam: 30%

Prerequisites by Topic: Understanding of advanced calculus, linear algebra, matrix theory, dynamics and strength of materials

Topics: 1. Introduction, 1.5 lecture hour
2. Tensors, 6 hours
3. Kinematics of a Continuum, 6 hours
4. Stress, 6 hours
5. The Elastic Solid, 7.5 hours
6. Newtonian Viscous Fluid, 7.5 hours
7. Integral Formulations of General Principles, 3 hours
8. Non-Newtonian Fluids, 3 hours

Laboratory: None
AERO 608-Nanomechanics

Credits: 3-0

Application of mechanics concepts to nano-scale behavior of materials. Review of continuum mechanics; Extensions to generalized continua; Nonlocal elasticity; Nano-scale plasticity. Focus on multi-scale modeling: Dislocation Dynamics; Quasi-Continuum method; Molecular dynamics with introductions to quantum mechanics and statistical mechanics. Cross-listed with MEMA/MSEN 608.

Prerequisite: AERO 603 or MEMA 601.
Prerequisites: AERO 603 or MEMA 601.

Goals:

Textbook: Notes and handouts will be provided.

Grading Scale:

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<thead>
<tr>
<th>Component</th>
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<tr>
<td>Homework, Quizzes</td>
<td>35%</td>
<td>A</td>
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<tr>
<td>Project</td>
<td>30%</td>
<td>B</td>
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<tr>
<td>Paper Review</td>
<td>15%</td>
<td>C</td>
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<td>Final Exam</td>
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<tr>
<td>Continuum Mechanics</td>
<td>22</td>
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<tr>
<td>a. Elasticity and diffusion equations</td>
<td>3</td>
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<tr>
<td>b. Basic results from elasticity (point forces, crystal defects)</td>
<td>3</td>
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<tr>
<td>c. Theory of nanoindentation*</td>
<td>3</td>
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<tr>
<td>d. Theories of patterning and self-organization</td>
<td>3</td>
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<tr>
<td>e. Nonlocal elasticity: connections to physics</td>
<td>3</td>
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<tr>
<td>f. Nanomechanics of defects in nanorods and nanotubes</td>
<td>4</td>
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<tr>
<td>g. Microstructure evolution</td>
<td>3</td>
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<tr>
<td>Discrete Methods in Nanomechanics</td>
<td>20</td>
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<tr>
<td>a. Discrete dislocation plasticity**</td>
<td>8</td>
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<tr>
<td>b. Elements of quantum mechanics</td>
<td>3</td>
</tr>
<tr>
<td>c. Introduction to molecular dynamics simulations*</td>
<td>6</td>
</tr>
<tr>
<td>d. Coupled atomistic/continuum methods</td>
<td>3</td>
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Total 42

*includes 30-50% of laboratory instruction and constitutes basic material for some projects.

** includes one session at the Immersive Visualization Center (IVC: http://ivc.tamu.edu) and constitutes basic material for some projects.

Laboratory: None
MEMA 611-Fundamentals of Engineering Fracture Mechanics

Catalog Data: MEMA 611-Fundamentals of Engineering Fracture Mechanics
Credit: 3-0
Understanding of the failure of structures containing cracks with emphasis on mechanics; linear elastic fracture mechanics, complex potentials of Muskhelishvili. I and Westergaard, J-integral, energy release rate, R-curve analysis, crack opening displacement, plain strain fracture toughness testing, fatigue crack propagation, fracture criteria, fracture of composite materials.

Prerequisites: MEMA 601 or approval of instructor.


Goals: The main objective of this course is to expose graduate-level engineering students to the fundamental aspects of the mechanics of fracture, starting from the fundamentals of solid mechanics, and continuing through the basics of the fields surrounding defects in materials that exhibit either linear or non-linear, elastic or inelastic behavior.

Grading: Exam 1 20%
Exam 2 20%
Final Examination 30%
Homework 30%

Prerequisites by Topic: Graduate standing in engineering; mechanics of solids.

Topics: Elements of solid mechanics
Stress fields around discontinuities
The stationary crack under static loading
Small-scale yielding, plastic-zone corrections
Energy approaches
Crack initiation
Crack growth
Non-Linear fracture mechanics
Fracture toughness testing
Subcritical crack growth
Dynamic crack growth
Experimental methods

Laboratory: Demonstrations of standard fracture toughness tests.
MEMA 612 / AERO 612 - WAVE PROPAGATION IN ISOTROPIC AND ANISOTROPIC SOLIDS

Catalog Data: MEMA 612 / AERO 612 - WAVE PROPAGATION IN ISOTROPIC AND ANISOTROPIC SOLIDS
Credits: 3-0
Mathematical and experimental methods of studying stress waves with emphasis on anisotropic solids, e.g., fiber-reinforced composite materials; waves in an unbounded medium, in a half-space, in rods; waves in a general anisotropic medium; wave surface, slowness surface, velocity surface, energy velocity and group velocity. Materials with periodic structures: Brillouin zones, cut-off frequency and dispersion.

Prerequisites: AERO 603 or MEMA 601

Goals: To provide engineering graduate students with the mathematical and conceptual tools necessary to synthesize and analyze digital controllers for aerospace systems. The course will particularly emphasize:

1. Modeling, dynamics, and dynamic modes unique to aircraft and spacecraft.
2. Operating environments and missions of aircraft and spacecraft, and how these translate into requirements and specifications for controller design.
3. Synthesis of sampled-data controllers which satisfy mission requirements using both discretization and direct design methods, using both classical and modern methods.
4. Implementation and simulation of digital and sampled-data control systems, including effects of round off error, truncation, and finite word length.
5. Nonlinearities, sensor requirements/limitations, and uncertainties unique to aircraft and spacecraft.

Textbook:
5. Additional references and journals as appropriate.

Grading: Weekly abstracts of current journal publications 10% 90-100 A
Mid-term Examination 20% 80-89 B
Final Examination 25% 70-79 C
Homework 20% 60-69 D
Term Paper, including presentation to the class 25% Below 60 F

Grading Scale:

Topics/Calendar:

I. Introduction
   Why should we study wave propagation? 1

II. Isotropic Solids
   A. Unbounded Media
      Plane Waves 1
      Cylindrical Waves 2
      Spherical Waves 2
   B. Half-Space
      Reflection and Reflection at an interface 3
   C. Waveguides
      SH waves in a plate 2
      Lamb waves 2
      Waves in a circular rod 2
      (i) Torsional Waves 1
      (ii) Longitudinal Waves 2
(iii) Flexural Waves

III. Anisotropic Solids
   A. Method of characteristics 3
   B. Huygen's principle; wave surface, velocity surface and slowness surface; energy and group velocity 5
   C. Materials with transverse isotropy (unidirectional fiber-reinforced composite materials). 5
   D. Reflection and refraction at an isotropic/anisotropic interface 3
   E. Wave propagation in a medium with a periodic structure: Brillouin zones, cut-off frequency, dispersion, energy velocity 6

IV. Experimental Methods (3 Hours)
   Shear Pendulum and Hopkinson Bar 1
   Kolsky Bar 1
   Ultrasonics 1
   **Total** 42
MEMA 613 – Principles of Composite Materials

Catalog Data: MEMA 613 – Principles of Composite Materials
Credits: 3-0
Classification and characteristics of composite materials; micromechanical and macromechanical behavior of composite laminae; macromechanical behavior of laminates using classical laminate theory; interlaminar stresses and failure modes; structural design concepts, testing and manufacturing techniques.

Prerequisite: Graduate Classification
MEMA 601 or 602 (Continuum Mechanics or Elasticity)

Textbook: Jones, Mechanics of Composite Material Mechanics (optional)
Notes at copy center or handed out in class

Goals: To use mechanics to describe the response of composite materials to mechanical, thermal, and hygroscopic loads.

Grading: Mid-term: 40%
Final: 40%
Homework: 20%

Topics: Introduction
Basic equations of anisotropic elasticity
Transformations: vectors, stress, strain, stiffness matrix, compliance matrix
Material symmetries
2D elasticity
Micromechanics for stiffness prediction
Lamina strength prediction (tension, compression, notched strength)
Laminated beam theory
Classical laminated plate theory
Benchmark plate solutions
Solution of simple plate problems using virtual work
Special topics

Laboratory: None
MEMA 614 - Physical Phenomena in Materials

Catalog Data: MEMA 614-Physical Phenomena in Materials
Credits: 3-0

Physical principles governing behavior on materials; emphasis on crystalline materials, particularly in metals; includes crystal structures, vacancies, solid diagrams, diffusion and transformations.

Prerequisites: MEEN 340 or equivalent

Textbook:

Goals:

Grading:

Topics/Calendar:

Laboratory:
MEMA 616 / AERO 616-Damage & Failure in Composite Materials

Catalog Data: MEMA 616-Damage & Failure in Composite Materials
Credits: 3-0

Mechanisms and models related to damage and failure in composite materials subjected to mechanical loads.

Prerequisite: Courses in composite materials, elasticity. Cross-listed with AERO 616.

Prerequisites: Courses in composite materials, elasticity.

Goals: To provide understanding of the physical mechanisms of damage and failure in composite materials and to give an in-depth treatment of the methods of analysis of damage, its evolution, and the ensuing failure.

Textbook: Selected papers and handout notes.

Grading: Project 1 30% 90-100 A
         Project 2 35% 80-89  B
         Project 3 35% 70-79  C
         60-69  D
         Below 60  F

Grading Scale:

Topics/Calendar:
1. Observations of damage and measurements of materials response (stress-strain behavior) caused by damage. General definition of damage. (Lecture 1-2)
2. Single vs. multiple cracking. The Aveston-Cooper-Kelly (ACK) analysis. (Lecture 3-4)
3. Variational analysis of transverse cracking in laminates. (Lecture 5-7)
4. Micromechanics applied to damage in composites. (Lecture 8-9)
5. Continuum damage mechanics: damage characterization, thermodynamics based theories, experimental characterization. (Lecture 10-16)
6. Evolution of damage in static and cyclic loading. (Lecture 17-20)
7. Fracture mechanics based analysis of damage evolution. (Lecture 21-22)
8. Mechanisms based analysis of damage evolution. (Lecture 23-24)
10. Guided self-study, as needed.

Laboratory: None
MEMA 619-Materials Modeling of Phase Transformation and Microstructural Evolution

Catalog Data: MEMA 619-Modeling of Phase Transformation and Microstructural Evolution
Credits: 3-0
Computer modeling and simulation of microstructural evolution during various phase transformation processes in solid materials, including spinodal decomposition, ordering, martensitic transformation, ferroelectric and ferromagnetic domain evolution, dislocation dynamics, and crack propagation.

Prerequisites: Graduate Status and approval of instructor of course name. Cross-listed with AERO 619 and MSEN 619

Goals: 1 - Understand various phase transformations in crystalline solids
2 - Understand thermodynamics and kinetics of microstructure evolution
3 - Understand mathematical approach to description of various microstructure processes
4 - Practice basic programming skills
5 - Perform simulations and analyze the results
6 - Exposure to state-of-the-art research in the relevant fields

Textbook: None. Recommended references will be provided.

Grading: Homework 50% Project 50%
Grading Scale:

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<tr>
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<td>D</td>
<td>60-69</td>
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Topics:

<table>
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<tr>
<th>Lecture</th>
<th>Topic</th>
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<tbody>
<tr>
<td>1-3</td>
<td>Mathematical Methods</td>
</tr>
<tr>
<td></td>
<td>Tensor Algebra, Variational Calculus, Numerical Methods</td>
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<tr>
<td>4</td>
<td>Crystallography</td>
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<td></td>
<td>Crystal Lattice, Lattice Rearrangement, Coherent Interface</td>
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<td>5-6</td>
<td>Density Field and Microstructure</td>
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<td></td>
<td>Concentration, Polarization, Magnetization, Long-Range Order Parameter, Conserved Field, Non-Conserved Field, Microstructures</td>
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<td>7-8</td>
<td>Thermodynamic Potential</td>
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<td>Bulk Free Energy, Landau-Type Polynomial Potential, Non-Convexity of Thermodynamic Potential, Stability (Metastability, Instability), Phase Transitions</td>
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<td>9</td>
<td>Interface and Gradient Thermodynamics</td>
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<td>Phase Boundary, Domain Wall, Twin Boundary, Grain Boundary, Free Surface, Interfacial Energy</td>
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<td>10-15</td>
<td>Long-Range Interaction Energy</td>
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<td>Microelasticity, Electrostatics, Magnetostatics, Configuration-Dependent Energy, Domain Self-Assembling</td>
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<td>16-18</td>
<td>Kinetic Equation</td>
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<td>19-20</td>
<td>Decomposition</td>
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<td>21</td>
<td>Ordering</td>
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<tr>
<td>22-23</td>
<td>Martensitic Transformation</td>
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<tr>
<td>24-25</td>
<td>Ferroelectric and Ferromagnetic Domain Evolution</td>
</tr>
<tr>
<td>26-28</td>
<td>Crystal Defects: Dislocations and Cracks</td>
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<tr>
<td>28</td>
<td>Multi-Physics and Multi-Scale Modeling</td>
</tr>
<tr>
<td></td>
<td>Linking Microstructure Evolution to Continuum Constitutive Model and Atomistic Computation</td>
</tr>
</tbody>
</table>

Laboratory: None
MEMA 625- Micromechanics

Catalog Data: MEMA 625- Micromechanics
Credits: 3-0
Eigenstrains; inclusions, and inhomogeneities; Eshelby’s solution for an ellipsoidal inclusion; Eshelby’s equivalent inclusion method. Effective elastic properties of composites; composite spheres and cylinders models; bounds on effective moduli; Hashin-Shtrikman bounds; applications to fiber, whisker and particulate reinforced composites; introduction to micromechanics of inelastic composites and solids with damage.

Prerequisite:
MEMA 601 or AERO 603/MEMA 602.

Textbook:

Goals:
The course will present an in-depth analysis of the effective thermomechanical response of heterogeneous media. The main objective is to develop a methodology for calculating the constitutive response at the macroscale of composite materials in terms of microscale parameters, e.g., shape and volume fraction of inhomogeneities, as well their own constitutive properties. Applications will be presented for continuous fiber and particulate composites, composites with microcracks, for both random and periodic microstructures. Comparison of the different averaging schemes and elements of homogenization methods for periodic composites will be presented.

Grading:
Homework 25%
Midterm 25%
Project 25%
Final 25%

Prerequisites by Topic:
1. Advanced and vector calculus, linear algebra, matrix theory
3. Basic knowledge of elasticity, continuum mechanics, conservation laws, Kinematics and constitutive equations

Topics:
2. Elastic fields due to eigenstrains. Eshelby’s inclusion problem.
5. Composite cylinders and composite spheres models.
7. Mori-Tanaka averaging scheme.
8. Generalized self-consistent scheme; Comparison of different approaches.
11. Composite laminates with periodic cracks.
12. Effective mechanical properties of solids with periodic microstructure (homogenization).
13. Effective thermal properties.

Laboratory:
None
MEMA 626 / AERO 618-Mechanics of Active Materials

Catalog Data: MEMA 626 / AERO 618-Mechanics of Active Materials
Credits: 3-0
Introduction to coupled field theories; constitutive response of materials with electromagnetic coupling; microstructural changes due to phase transformations; shape memory alloys; active polymers and ionic solutions; electrodiffusion; multifunctional nanocomposites.

Prerequisites: MEMA 601 (Theory of Elasticity) or MEMA 602 (Continuum Mechanics)

Goals: The course will particularly emphasize:

(1) Introduction; notation; review of kinematics, momentum, linear elasticity
(2) Coupled electro-mechanical field equations; piezoelectricity;
   Gauss law; boundary conditions; material symmetries.
(3) Piezoelectric structures and devices; transducers; vibration control
(4) Shape memory alloys; martensitic phase transformations
(5) Electroactive multifunctional nanocomposites
(6) Actuation, energy storage, and electrical power from polymer electrolyte/carbon electrode supercapacitors.

Textbook: Non-Equilibrium Thermodynamics, deGroot and Mazuer

Grading: Grading Scale:

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<tr>
<th></th>
<th>Homework</th>
<th>Project</th>
<th>Midterm</th>
<th>Final exam</th>
<th>Hours</th>
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<tr>
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Topics/Calendar:

Outline

1. Introduction. Notation. 2
3. Fundamental definitions for electricity and magnetism. 3
4. Maxwell’s equations with emphasis on low frequency conditions. 6
5. Balance of linear and angular momentum. 2
6. Conservation of energy. 2
7. Second law of thermodynamics. Thermodynamic potentials. Entropy production. 4
8. Thermodynamically reversible active materials:
   A. Thermoelasticity 1
   B. Piezoelectricity 5
9. Thermodynamically irreversible active materials:
   A. Shape memory alloys 8
   B. Ionic diffusion materials:
      1. Ionomeric polymer metal composites 5
      2. Double-layer capacitors 2

Total 42

Laboratory: None
MEMA 635-Structural Analysis of Composites

Catalog Data: MEMA 635-Structural Analysis of Composites
Credits: 3-0

Formulation and analysis structural response of laminated composite components; bending, vibration and stability of laminated composite plates; interlaminar stresses, effect of shear deformation on structural response; numerical modeling of laminated plates.

Prerequisites: MEMA 613

Textbook:

Goals:

Topics:

Laboratory:
### MEMA 641 Plasticity Theory

**Catalog Data:**
MEMA 641 Plasticity Theory  
*Credits:* 3-0  
Theory of plastic yield and flow of two and three-dimensional bodies; classical plasticity theories, unified viscoplastic theories, numerical considerations; applications and comparisons of theory to experiment.

**Prerequisites:**
MATH 601 or registration therein

**Textbook:**

**Goals:**

**Topics:**

**Laboratory:**
MEMA 646 – Introduction to Finite Elements

Credits: 3-0

Weak or variational formulation of differential equations governing one- and two-dimensional problems of engineering; finite element model development and analysis of standard problems of solid mechanics (bars, beams and plane elasticity), heat transfer and fluid mechanics; time-dependent problems; computer implementation and use of simple finite element codes in solving engineering problems.

Prerequisite:
Graduate Classifications
MATH 308

Textbook:
Notes at copy center

Goals:
Obtain understanding of:
Basic theory of finite element formulations
  Elasticity
  Heat transfer
  Fluids
Architecture of a simple finite element program

Grading:
Homework/Project: 20%
Midterm: 40%
Final: 40%

Topics:
Introduction
Classical solution of weak form
Finite element approximation: introduction
Writing a finite element program
Derivation of interpolation functions
Timoshenko beam element
Transformation of FE matrices and load vectors
Multi-point constraints
Trusses
Introduction to 2D finite element analysis
Working with normalized coordinates
Potential fluid flow
Plane elasticity
2D incompressible fluid flow
Optional topics: Plate analysis, Torsion

Laboratory:
None
Catalog Data: MEMA 648-Nonlinear Finite Element Methods in Structural Mechanics
Credits: 3-0
Tensor definitions of stress and strain, finite strain, geometric and material nonlinearity; development of nonlinear finite element equations from virtual work; total and updated Lagrangian formulations; solution methods for nonlinear equations; computational considerations; applications using existing computer programs.

Prerequisites: MEMA 646, MEMA 647, or equivalent.


Goals: The primary objective of this advanced course on the finite element method is to study advanced concepts in finite-element analysis and the application of these concepts to advanced topics, including nonlinear finite element formulations of problems in engineering. The course provides both formulative and computational background necessary to solve linear and nonlinear problems of heat transfer, fluid mechanics, and solid mechanics. The background gained should allow formulation and analysis of other field problems. Computer implementation of various finite element formulations forms an essential part of the course.

Grading:
- Exam #1 20%
- Exam #2 20%
- Final Exam 25%
- Homework 35%

Prerequisites by Topic: Graduate courses in elasticity, continuum mechanics, partial differential equations, and numerical methods.

Topics:
Finite element analysis of nonlinear second-order equations in one dimension
Iterative methods of solution of nonlinear algebraic equations
Computer implementation
Nonlinear bending of Euler-Beroulli and Timoshenko beams
Membrane and shear locking
Finite element analysis of nonlinear second-order equations in two dimensions, with applications to problems of heat transfer, fluid flow, and solid mechanics; time-dependent problems
Finite element analysis of nonlinear plate bending and Navier-Stokes equations
Finite element analysis of continuum problems using total and updated Lagrangian descriptions, with applications to 2D elasticity
Computer implementation of finite element models of plate bending, 2D Navier-Stokes equations, and continuum problems
Materially nonlinear finite element formulations of solid mechanics and fluid flow problems

Laboratory: None
MEMA 651-Viscoelasticity of Solids and Structures I

Catalog Data: MEMA 651-Viscoelasticity of Solids and Structures I
Credits: 3-0

Linear, Viscoelastic mechanical property characterization methods, time-temperature equivalence, multiaxial stress-strain equations; Viscoelastic stress analysis: the correspondence principle, approximate methods of analysis and Laplace transform inversion, special methods; static and dynamic engineering applications; nonlinear behavior.

Prerequisites: Approval of Instructor.

Textbook:

Goals:

Topics:

Laboratory:
Following statements included in all courses:

Other Pertinent Course Information

Students are expected to attend class. For additional information visit the student rules website on attendance: [http://student-rules.tamu.edu/rule07](http://student-rules.tamu.edu/rule07).

Americans with Disabilities Act (ADA)

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact Disability Services, in Cain Hall, Room B118, or call 845-1637. For additional information visit [http://disability.tamu.edu](http://disability.tamu.edu).

Academic Integrity

For additional information please visit: [http://www.tamu.edu/aggiehonor](http://www.tamu.edu/aggiehonor)

“An Aggie does not lie, cheat, or steal, or tolerate those who do.”
G. Maps of Aerospace Space

The Aerospace Engineering physical space is as follows. The main office, faculty offices and most classrooms are in the Harvey (Bum) Bright Bldg (HRBB). Graduate offices and research laboratories are in the following additional buildings Reed-McDonald Bldg (RDMC), Richardson Bldg. (RICH), Wisenbaker Bldg. (WERC), Easterwood Research Complex (ERC), Munnerlyn Bldg. (MUNN), Riverside Campus (RC), and University Services Building (USB). Maps for all but the USB building are given below.

G.1 Wide View of Aerospace Engineering Space

Aerospace Engineering Space is highlighted in Red
G.2 Close View of Aerospace Engineering Main Campus Space
Aerospace Engineering Space is highlighted in Red

G.3 Aerial View of Aerospace Engineering Easterwood Complex
H. Aerospace PhD and MS Graduate Student Graduations

<table>
<thead>
<tr>
<th>Year</th>
<th>Degree</th>
<th>Area</th>
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<th>Student</th>
<th>Thesis/Dissertation Title</th>
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<td>MS</td>
<td>A&amp;P</td>
<td>Girimaji</td>
<td>Amarnath Sambasivam</td>
<td>Realizability of Reynolds Stress and Rapid Pressure-Strain Models in Turbulence</td>
<td>Software firm in Virginia</td>
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<td>2003A</td>
<td>MS</td>
<td>D&amp;C</td>
<td>Hurtado</td>
<td>Elizabeth Louise Savage</td>
<td>Cooperative Control of Autonomous Underwater Vehicles</td>
<td>Returned to England; employer unknown</td>
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<td>2003A</td>
<td>MS</td>
<td>D&amp;C</td>
<td>Hurtado</td>
<td>Juan Carlos Juan Carlos Zarco Cruz</td>
<td>Vibrational Characteristics of a Long and Very Flexible Rotating Fixed-Free Beam</td>
<td>Continued to Ph.D. w/Mortari; leave of absence after 1 semester</td>
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<td>Ph.D.</td>
<td>D&amp;C</td>
<td>Strganac</td>
<td>George Platanitis</td>
<td>Nonlinear Adaptive Control of Aeroelastic Systems</td>
<td>Post Doc (research assistant professor) at Univ. of Arizona</td>
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<td>2003B</td>
<td>MS</td>
<td>D&amp;C</td>
<td>Pollock</td>
<td>Hector Camerino Garcia Gonzalez</td>
<td>Optimization of Composite Tubes for Athermal Optical Lens Housing Design</td>
<td>Returned to Mexico; employed by Univ. of Mexico City</td>
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<td>MS</td>
<td>A&amp;P</td>
<td>Rediniotis</td>
<td>Ashwin Balasubramanian</td>
<td>Modeling of D/C Jet Driven Synthetic Actuators for Flow Separation Control</td>
<td>Continuing to Ph.D. at TAMU in MEEN</td>
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<td>2003B</td>
<td>MS</td>
<td>M&amp;S</td>
<td>Whitcomb</td>
<td>Deepak Goyal</td>
<td>Analysis of 2x2 Braided Composites</td>
<td>Continuing to Ph.D. at TAMU in AERO</td>
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<td>2003C</td>
<td>MS</td>
<td>A&amp;P</td>
<td>Cizmas</td>
<td>Tao Yuan</td>
<td>Reduced Order Modeling for Transport Phenomena Based on Proper Orthogonal Decomposition</td>
<td>Works in TN, employer unknown</td>
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<td>2003C</td>
<td>MS</td>
<td>D&amp;C</td>
<td>Alfriend</td>
<td>Prasenjit Sengupta</td>
<td>Satellite Relative Motion Propagation and Control in the Presence of J2 Perturbations</td>
<td>Continuing Ph.D. at TAMU in AERO</td>
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<td>Julian Varghese</td>
<td>Hierarchical Strategy for Rapid Finite Element Analysis</td>
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<td>D&amp;C</td>
<td>Junkins</td>
<td>Hee Eun Lee</td>
<td>Hierarchical Modeling of Multi-Scale Dynamical Systems Using Adaptive Radial Basis Function Neural Networks: Application to Synthetic Jet Actuator Wing</td>
<td>Samsung Electronics, Korea</td>
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<td>MS</td>
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<td>Rediniotis</td>
<td>Vijay Ramakrishnan</td>
<td>Calibration and Algorithms for Non-conventional Multi-Hole Pressure Probes</td>
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<td>M&amp;S</td>
<td>Boyd</td>
<td>Gyongil Cho</td>
<td>Fast-response Variable Focusing Micromirror Array Lens</td>
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<td>Strganac</td>
<td>Kiun Kim</td>
<td>Nonlinear Dynamic Behavior in Aeroscatic Systems</td>
<td>KIAST (Korea)</td>
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<td>A&amp;P</td>
<td>Girimaji</td>
<td>Aditya Murthi</td>
<td>Effect of Turbulent Transport Models and Grid Spacing on Pans Calculations of a Lid-Driven Cavity</td>
<td>Continued to Ph.D. in CHEN</td>
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<td>A&amp;P</td>
<td>Girimaji</td>
<td>Rajagopal Pachalla Seshadri</td>
<td>Analysis of Oscillating Flow-Cooled SMA Actuator</td>
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<td>Troy Allen Henderson</td>
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<td>Valasck</td>
<td>Rafael Eduardo Caicedo</td>
<td>Vehicle Formation Flying Control Using a Structural Analogy</td>
<td>Sandia National Laboratories</td>
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<td>M&amp;S</td>
<td>Lagoudas</td>
<td>Chad Randall Scary</td>
<td>A multiscale model for predicting damage evolution in heterogeneous viscoelastic media</td>
<td>Stress Engineering Services, Inc.</td>
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<td>D&amp;C</td>
<td>Mortari</td>
<td>Keun Joo Park</td>
<td>GPS Receiver Self Survey and Attitude Determination Using Pseudolite Signals</td>
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**Fall 2004 (A=Spring, B=Summer, C=Fall terms)**

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<td>Cizmas</td>
<td>Jason Antonio Guarnieri</td>
<td>Thermal Signature Reduction Through Liquid Nitrogen and Water Injection</td>
<td>Jackson &amp; Tull, AFRL Kirtland AFB</td>
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<td>MS</td>
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<td>Steven Bradley Chambers</td>
<td>Investigation of Combustive Flows and Dynamic Meshing in Computational Fluid Dynamics</td>
<td>Aerovironment, CA, Engineer</td>
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<td>MS</td>
<td>A&amp;P</td>
<td>Girimaji</td>
<td>Joshua Robert O'Neill</td>
<td>Linear Analysis of Rotating Shear Flow</td>
<td>Bell Helicopter</td>
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<td>Girimaji</td>
<td>Sunil Lakshmipathy</td>
<td>Pans Method of Turbulence: Simulation of High and Low Reynolds Number Flows Past a Circular Cylinder</td>
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<td>Kinra</td>
<td>Atul Shridatta Ganpatye</td>
<td>Ultrasonic Ply-By-Ply Detection of Matrix Cracks in Laminated Composites</td>
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<td>MS</td>
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<td>Naga Venkata Satya Peddiraju</td>
<td>Prediction of Cryogen Leakage through Cryogenic Composite Laminates</td>
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<td>Redinotiis</td>
<td>Adam Cole Miller</td>
<td>Flow Control Via Synthetic Jet Actuation</td>
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<td>Hurtado</td>
<td>Jonathan Hebert</td>
<td>The Effect of Irregular Fiber Distribution and Error in Assumed Transverse Fiber CTE on Thermally Induced Fiber/Mattir Interfacial Stresses</td>
<td>Employed by Neptec, Houston</td>
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<td>D&amp;C</td>
<td>Whitecomb</td>
<td>Seung-Don Zu</td>
<td>Non-Thesis Option - NTO</td>
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<td>Ph.D.</td>
<td>D&amp;C</td>
<td>Alfrend</td>
<td>Deok-Jin Lee</td>
<td>Nonlinear Bayesian Filtering with Applications to Estimation and Navigation</td>
<td>Returned to Korea, employer unknown</td>
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<td>Celerino Rosas</td>
<td>Numerical Simulation of Flow Separation Control by Oscillatory Fluid Injection</td>
<td>National Polytechnic Institute, Mexico City, Mexico</td>
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<td>D&amp;C</td>
<td>Junkins</td>
<td>Andrew James Sinclair</td>
<td>Generalization of Rotational Mechanics and Application to Aerospace Systems</td>
<td>Tenure track faculty position at Auburn University</td>
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<td>M&amp;S</td>
<td>Lagoudas</td>
<td>Petar Angelov Popov</td>
<td>Constitutive Modeling of Shape Memory Alloys and Upscaling of Deformable Porous Media</td>
<td>Employed as Post-Doc with VPR/TiMS</td>
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<td>MS</td>
<td>A&amp;P</td>
<td>Bowersox</td>
<td>Justin Walter McLellan</td>
<td>The Effects of Diamond Injector Angles on Flow Structures at Various Mach Numbers</td>
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<td>Girimaji</td>
<td>Ravi Kiran Bikkani</td>
<td>Characterization of Inertial and Pressure Effects in Homogeneous Turbulence</td>
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<td>Tapan Ramchandra Kulkami</td>
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<td>Yusuke Kawatsugi</td>
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<td>Parikshith Krishna Kumar</td>
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<td>M&amp;S</td>
<td>Slattery</td>
<td>Kaibin Fu</td>
<td>Applications of a New Theory Extending continuum Mechanics to the Nanoscale</td>
<td>Continuing to 2nd Ph.D. at TAMU in MATH</td>
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<td>M&amp;S</td>
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<td>Xiuhua Si</td>
<td>Applications of the Thermodynamics of Elastic, Crystalline Materials</td>
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<td>Phuong Thach Doan</td>
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<td>Marilee Ruth Myres</td>
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<td>Ossama Abdelkhalik</td>
<td>Asst. Prof., Embry-Riddle, Daytona Beach, FL</td>
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<td>Ravichandra Srinivasan</td>
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<td>Puneet Singla</td>
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<td>Chakravorty</td>
<td>Jaime Luis Ramirez Riberos</td>
<td>Design of Fuel Optimal Maneuvers for Multi-Spacecraft Interferometric Imaging Systems</td>
<td>Continuing to Ph.D. at MIT</td>
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<td>A&amp;P</td>
<td>Saric</td>
<td>Christopher William McKnight</td>
<td>Design and Safety Analysis of an In-Flight Test Airfoil</td>
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<td>Dynamics and Real-Time Optimal Control of Satellite Attitude and Satellite Formation Systems</td>
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<td>Cooperative Optimal path Planning for Herding Problems</td>
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<td>Sujay Deshmukh</td>
<td>Effect of Single Walled Carbon Nanotubes (SWNTs) on the Electro-Mechanical Properties of Polyamide Nanocomposites</td>
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<td>A Phenomenological Constitutive Model for Magnetic Shape Memory Alloys</td>
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**Fall 2007 (A=Spring, B=Summer, C=Fall terms)**

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Fall 2008 (A=Spring, B=Summer, C=Fall terms)

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I. Aerospace Vision Committee Report

Aerospace Engineering Vision Committee Final Report
May 25, 2011

Five Cross-Disciplinary Research Groups for the Aerospace Engineering Department

By
Amine Benzerfa, Rodney Bowersox (Chair), Suman Chakravorty, John Junkins, Adonios Karpetis, William Saric

Executive Summary

The Department Head (Dr. D. Lagoudas) established the Aerospace Engineering Vision Committee (AVC) on Oct. 25, 2010 to consider a new administration structure to help achieve and maintain the departmental goal of being the top ranked Aerospace Engineering Department within the United States. The primary focus was to investigate the merits of a new matrix organization. The matrix would maintain the three departmental disciplines (Aerodynamics and Propulsion, Dynamics and Control and Materials and Structures) as the core foundation (or rows in the matrix terminology). In addition, the department would identify five research thrust areas to increase national visibility. The first step in the committee charter was to assess the department and the reputation thereof via the NRC rankings and informal peer surveys. This analysis suggested that our peers undervalue the department, which has an adverse implication in our placement within the rankings. In addition, the NRC data suggested that departments that are identified by research/application areas received higher perceptions than the their quantitative output would merit, and visa versa. Based on this input, the committee worked with the department to identify research thrusts with the goal of increasing visibility. Thus, as the second step, the committee recommended the following five thrust areas: (1) Autonomous Aerospace Vehicle Systems, (2) Aerospace Propulsion and Energy Systems, (3) Hypersonic Vehicle Systems, (4) Space Exploration and Sensing Systems, and (5) Controlled Intelligent Materials and Structures. The final step is implementation, which is under the purview of the Department Head.
1. Aerospace Vision Committee Objective and Approach

The Aerospace Engineering Department established the vision of achieving the status of top ranked public university in the United States during the 2009 Faculty Retreat. The Aerospace Engineering Vision Committee (A VC) was founded with the objective of developing a strategy to achieve and maintain the departmental goal of being the top ranked public Aerospace Engineering Department in the United States.

The committee was comprised of (1) the two departmental distinguished professors, Drs. Junkins and Saric, to provide experienced leadership, (2) three junior professors, Drs. Benzerla, Chakravorty, and Karpetis to provide a long term vested interest, and (3) the associate department chair, Dr. Bowersox to provide an administrative perspective.

A three-step approach was employed to meet the objective. Peer judgment is a key factor determining the overall rank of departments. Hence, the first task was to assess the current views of TAMU Aerospace Engineering department. The committee examined the 2009 NRC Rankings and performed informal surveys from faculty at peer institutions. The second step was to develop education/research roadmap for the next 5-10 years. The department head, based on the 2010 faculty retreat input suggested a matrix organization, with the fundamental core areas forming the basis (rows) and a newly identified list of five research thrust areas forming the columns. The basic premise was that the research thrust areas would bolster the visibility and reputation of the department. The research thrusts were aligned with current success and projected National, State, and University programs and Strategic Plans. The third, and final, step was to suggest an implementation plan to change the overarching structure of the department. Specifically, the committee identified the thrust areas and made suggestions for area leads to the department head.

2. Assessment Results

Professor Karpetis performed an in-depth analysis of the 2009 NRC Survey (R- and S-Ranking) results, which were based on 2006-07 data. In summary, the data showed that the TAMU Aerospace Engineering Department’s measured (quantitative S-ranking) rankings significantly exceeded the corresponding reputation (R-ranking). Upon further examination, it was noted that departments that project research thrusts/aerospace applications tended to outperform departments that emphasized core disciplines in R-rankings (see Fig. 1). Informal surveys of faculty at Caltech, Ga Tech and Stanford confirmed the NRC conclusions, where it was noted by our peers that TAMU provides solid students for industry, and the our programs are not tailored to academia.
3. New Matrix Organization

The assessment results suggested that a corrective measure was warranted to improve the department perception, and thus provided the incentive to consider the matrix organization, suggested by the Department Head, to better emphasize the research strengths of the department. The resulting research roadmap defined five departmental thrust areas that aligned our departmental strengths (success) with COE, University and National strategic plans.

The matrix organization maintains the three departmental core disciplines as the departmental foundations (or rows in the matrix terminology):

- Aerodynamics and Propulsion
- Dynamics and Control
- Materials and Structures

In terms of administration, the core discipline group leaders form an Academic Advisory Committee to provide guidance to the department head on issues such as the health of the academic programs, hiring needs, laboratory and classroom needs, etc.

After considerable deliberation and consultation with the core discipline groups, the following five research thrust areas were defined:

- Aerospace Propulsion and Energy Systems (APES)
- Autonomous Aerospace Vehicle Systems (AAVS)
- Controlled Intelligent Materials and Structures (CIMS)
- Hypersonic Vehicle Systems (HyVS)
- Space Exploration and Sensing Systems (SESS)

In terms of administration, the research thrust leaders will form a Research Advisory Committee to provide guidance to the department head on health of the research thrust, hiring needs, laboratory needs, etc.
The resulting matrix organization is given in Table 1. The faculty members are listed in the first column grouped by discipline. The faculty in the Aerodynamics and Propulsion discipline are listed in the first group of rows (blue); the Dynamics and Control faculty are listed in the second grouping (gray), and Materials and Structures faculty are listed in the last group (blue). The group leaders are indicated in bold and underlined. The five thrust areas are denoted columns two through five. The thrust area faculty and area leaders, as indicated by bold type, are listed in the rows. A brief explanation of each thrust area is given in the next section.

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4. Research Thrust Areas

Three criteria formed the basis of the five thrust areas. The first criterion was future importance to the nation as this defined future placement for graduates. The second was departmental strength, existing or planned, as this defines the credibility of the department to compete for major research initiatives. The last criterion was funding potential as this determines the ability to support nationally renowned programs.

4.1 Aerospace Propulsion and Energy Systems (APES)

Future Importance: Efficient propulsion is required for access-to-space, commercial transport and space exploration. Many technologies are also applicable to the energy crisis (e.g. power generation, alternate fuels, renewables and wind energy). In addition, Aerospace Propulsion and Energy systems are rich with scientifically challenging problems that cut across many disciplines. This topic is aligned with National requirements, University and College Strategic plans in energy and national defense. It is expected that this field will require a highly educated work force to advance the necessary science and technologies.

Departmental Strength: This thrust area builds on existing nationally prominent faculty (listed in Table 1) and the following laboratories

- Laser Diagnostics and Combustion Laboratory
- Low-Speed Wind Tunnel
- Materials and Testing Laboratory
- National Aerothermochemistry Laboratory
- Propulsion Laboratory

Funding Potential: Current and projected funding sources include the DoD, DoE, NASA, Sandia National Laboratory, and private industry (e.g., Vestas). The department currently has numerous major projects with AFOSR, VESTAS, AFRL etc.
4.2 Autonomous Aerospace Vehicles Systems (AAVS)

**Future Importance:** Unmanned Systems, in particular, UAVs, are a long term goal of the US for military and Space Exploration. Such systems require both autonomy (intelligence) as well as new vehicle design concepts (synergy between control, fluids and structures). This field is naturally interdisciplinary including AE, CSE, EE, and ME. This topic is aligned with National requirements, University and College Strategic plans in national defense. It is expected that this field will require a highly educated work force to advance the necessary science and technologies.

**Departmental Strength:** The Aerospace department has in-place nationally renowned faculty (listed in Table 1) and prominent centers/laboratories including:

- Centers
  - Consortium for Autonomous Space Systems
- Laboratories
  - LASR Laboratory
  - Flight Mechanics Laboratory
  - Emergency Robotics Laboratory
  - Vehicle Systems and Control Laboratory

**Funding Potential:** Current and projected funding sources include the DoD, NASA, NSF, and private industry. The department currently has numerous major projects with AFOSR, NSF, NRO, Boeing, NASA and DARPA.

![Fig. 3 AAVS Application and LASR Lab](image)

4.3 Controlled Intelligent Materials and Structures (CIMS)

**Future Importance:** Controlled materials are required for many future aerospace and industrial systems. Challenges include extreme environments, multi-functionality, shaping and morphing, etc. This topic is aligned with National requirements, University
and College Strategic plans in national defense. It is expected that this field will require a highly educated work force to advance the necessary science and technologies.

**Departmental Strength:** The Aerospace department has in-place nationally renowned faculty (listed in Table 1) and prominent centers/laboratories including:

- Centers/ Multimillion Dollar Programs
  - Functionally Graded Multifunctional Hybrid Composites for Extreme Environments (MURI)
  - International Institute of Multifunctional Materials for Energy Conversion
  - SMA-RT Vehicles Concepts Center

- Laboratories
  - Materials Testing Laboratory

- **Funding Potential:** Current and projected funding sources include the DoD, NASA, NSF, and private industry. The department currently has numerous major projects with DoD, NSF, and NASA.

![CIMS Applications](image)

**4.4 Hypersonic Vehicles Systems (HyVS)**

**Future Importance:** Hypersonic flight offers the promise of important space (economic) and national defense advantages for the United States. This field is rich with scientifically challenging problems that cut across many disciplines. This topic is aligned with National requirements, University and College Strategic plans in national defense. It is expected that this field will require a highly educated work force to advance the necessary science and technologies.
Departmental Strength: The Aerospace department has in-place nationally renowned faculty (listed in Table 1) and prominent centers/laboratories including:

- Centers and major projects
  - National Center for Hypersonic Transition
  - Functionally Graded Hybrid Composites for Extreme Environments
- Laboratories
  - Laser Diagnostics and Combustion Laboratory
  - Materials and Testing Laboratory
  - NASA LaRC/TAMU Mach 6.0 Quiet Tunnel
  - National Aerothermochemistry Laboratory

Funding Potential: Current and projected funding sources include the DoD, NASA, NSF, and private industry. The department currently has numerous major projects with DoD and NASA (~$25M in external research funding for 2004 – 2014).

Fig. 5 HyVS Applications

4.5 Space Exploration and Sensing Systems (SESS)

Future Importance: Space exploration and sensing has many cross-cutting applications including Climate Monitoring, National Security, Orbit Debris Mitigation, Near Earth Asteroids/Planetary Defense, Space Situational Awareness, Enhanced Mapping and Reconnaissance. This field requires sophisticated modeling, sensing, guidance, navigation and control, and space system design. This topic is aligned with National requirements, University and College Strategic plans in national defense. It is
expected that this field will require a highly educated work force to advance the necessary science and technologies.

**Departmental Strength:** The Aerospace department has in-place nationally renowned faculty (listed in Table 1) and prominent laboratories including:

- Hyland’s Telescopes and ICI Setup
- Junkin’s Land, Air and Space Robotics (LASR) Laboratory

**Funding Potential:** Current and projected funding sources include the DoD, NASA NRO, AFOSR, AFRL, Industrial Partners. The department currently has numerous major projects AFOSR, AFRL, NSF, NRO and industry.

![Fig. 6 SESS Applications](image)

5. Conclusions

The goal of the AVC was to establish a plan to achieve and sustain the status as the top ranked public aerospace engineering program in the United States. The approach was to: (1) perform a systematic study of the departmental strengths and weaknesses, where it was determined that the TAMU Aerospace Engineering Department appears to be undervalued in the National Rankings and peer assessments, where visibility was identified as a key issue; (2) Introduce a new matrix organization to highlight visible thrust areas, where future potential (national needs and funding opportunities) and significant critical mass within the department (people and facilities) were the major determining factors, and (3) propose a reorganization of the departmental administration to promote sustainment of highly visible interdisciplinary research and education programs.