

# **Graduate Student Handbook**

## **Ph.D. Programs For Aerospace Engineering**

**(Revision 4/17/2018)**

---

**DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING**

The University of Texas at Arlington  
Box 19023  
Arlington, TX 76019-0031

Phone (817) 272-2500  
Fax (817) 272-2952

## **WELCOME!**

The faculty, staff and students in the Aerospace Engineering Program would like to welcome you to the doctoral program in Aerospace Engineering. This handbook is designed to help you get acquainted with the workings of our program. The information in this handbook will let you know what needs to be done, when it needs to be done, where you need to go to get information, and who can help you with problems that may occur. This handbook, the UTA Student Handbook, and the Graduate Catalog will serve as sources of information for you as you progress through our program. In case of any discrepancy between this document and the graduate catalog, the graduate catalog should prevail. In the case that there is a discrepancy between this document and the graduate catalog, the graduate catalog takes precedence over anything on this document.

### **NAMES YOU SHOULD KNOW**

#### **Graduate Advisor**

**Associate Professor Kamesh Subbarao**  
315G Woolf Hall  
817-272-7467  
[subbarao@uta.edu](mailto:subbarao@uta.edu)

Most of the decisions you make concerning your academic program will be made with the assistance of the graduate advisor. This includes curriculum, registration, adding and dropping courses, and completing the necessary paperwork as you pursue your degree. The graduate advisor is your first point of contact for all of these matters.

#### **Associate Chair for Aerospace Engineering**

**Professor Don Wilson**  
202 Woolf Hall  
817-272-2072  
[wilson@uta.edu](mailto:wilson@uta.edu)

The Associate Chair is responsible for all decisions concerning the operations of the program including the funding of all teaching and research assistantships as well as scholarships.

#### **Chairman, Committee on Graduate Studies**

**Professor Brian Dennis**  
316C Woolf Hall  
817-272-7379  
[dennisb@uta.edu](mailto:dennisb@uta.edu)

Many decisions concerning the requirements of the graduate program are made by the AE committee on Graduate Studies. This committee also handles student petitions and reviews the progress of all students in the program periodically.

#### **Graduate Advising Support**

**Wendy Ryan**  
204 Woolf Hall  
817-272-2500  
[wendy.ryan@uta.edu](mailto:wendy.ryan@uta.edu)

## GETTING STARTED IN THE PROGRAM

### Department Check-in

Upon arrival at the university, please come to the departmental office in Room 204 Woolf Hall. A staff assistant will assist you in getting started at UT Arlington.

### Orientation for International Students

All international students must attend a university orientation for foreign students, most often given a week or two before school starts. You will receive a letter directly from the International Office regarding this orientation. This orientation is required before you can be advised and register for classes.

### Students Requiring GESP

Those students who were admitted to the AE Program with an English deficiency must go to the GESP Office and be tested prior to meeting with the AE Graduate Advisor. The AE Graduate Advisor will not advise such students until the GESP Office has provided the results of the GESP tests.

### Meeting with the AE Graduate Advisor

All new graduate students must meet with the AE Graduate Advisor prior to registering for courses for their first semester. During this visit the program requirements for the Ph.D. degree program will be discussed and you will be advised on course selection for your first semester. Prior to meeting with the AE Graduate Advisor, please review this handbook, the semester AE course offerings, the AE section of the Graduate Catalog, and the MAE Department website, and have a plan for which courses you wish to take. The current semester's schedule of classes gives the exact days and times for registration and should be consulted each semester, not only for registration information, but for advising instructions, as well. The spring schedule is available in mid-October; the summer/fall schedule is available in mid-March. If you have graduate course work from another university, the graduate advisor (with the consent of the chair of the Committee on Graduate Studies) is empowered to waive course requirements if the student can show previous course work which is equivalent to that offered at UTA. This is handled on a case-by-case basis at the time of your initial advisement.

### Registration

Once you have met with the AE Graduate Advisor, you will be cleared for registration. In order to attend any given semester, a student must register and pay fees. ALL REGISTRATION at UTA is done on the UTA website, [www.uta.edu/mymav](http://www.uta.edu/mymav). New students register the week before classes begin. **All students must be advised by the Graduate Advisor prior to registration.**

### UTA Identification (ID) Card

You will be required to obtain a MAV EXPRESS card from the MavExpress Office, Main Level of the University Center. This card will allow you access to various campus events, the library, and the health center, as well as being a source of identification to verify that you are a UTA student.

## **Graduate Teaching and Research Assistants - Payment Procedures**

### **Criteria for Award of Assistantships**

Award of financial assistance is based solely on merit. A number of graduate teaching assistantships (GTA), graduate research assistantships (GRA), and fellowships are awarded each year. Applicants who demonstrate skills, experience or interests that meet the needs of the AE Graduate Program will be considered for fellowships or assistantships. A typical GTA requires that the assistant spend a up to 20 hours per week helping in undergraduate laboratories, grading undergraduate students' homework assignments, and other duties specified by the course instructor. A typical GRA requires that the assistant work on the research projects assigned by the professor who is providing the GRA support.

### **U.S. Students**

U.S. students must also attend an orientation session for all new employees. You will need to bring your social security card and your Texas driver's license or some other I.D. **THIS SESSION IS MANDATORY AND YOU WILL NOT GET PAID UNLESS YOU ATTEND.** The session takes about one and one half hours to complete.

### **International Students**

You will first need to go to the International Office with your visa to obtain an Identity and Employment Authorization letter. This letter certifies that you have a visa and that you are allowed to work in the U.S. You must take this letter to the Office of Human Resources (J.D. Wetsel Service Bldg. (corner of Mitchell & Davis Streets) along with your passport and social security card (if you have one) to set up an orientation session given to all new employees. This session is mandatory, and you will not get paid unless you attend. This session takes about one hour. If you do not have a social security card, you must return to personnel after you receive your card and show it to them. ALL students that will be paid in any way must have a social security number. Most international students will have to apply for a card and this should be done as soon as possible. Applications must be delivered in person to the Tarrant County Court House in Fort Worth (819 Taylor Street) or to the Arlington office of the Social Security Administration. At the international student orientation session held by the International Office, you can fill out an application for a social security number and that office may arrange to take students to Fort Worth to submit the form. If you are unable to go at that time, you can go any time on your own. It takes about 2 weeks to get your card, but you can call, after several days, and receive your number only; you **cannot** be paid until you get your social security number.

***English Proficiency.*** Before being appointed to an assistantship at UT Arlington, a student whose native language is not English must demonstrate acceptable skill with spoken English. An applicant who is a non-native speaker of English must submit a TOEFL iBT score of at least 23, or a score of at least 7 on the Speaking section of the IELTS, or take and pass the UTA Developmental English course to meet this requirement. Only official scores provided directly to UT Arlington by ETS or IELTS are acceptable. The English proficiency requirement will be waived for non-native speakers of English who possess a bachelor's degree from an accredited U.S. institution.

## UNIVERSITY FACILITIES

A campus map can be found in the University Catalog. Some of the more important facilities are listed below.

### **Office of Research and Graduate Studies ( Graduate School)**

The Graduate School is located in Davis Hall Room 333. The staff in that office can answer questions and supply the forms that you will need while you are enrolled here.

### **Libraries**

The University has three libraries, the Central Library, the Science and Technology Library, and the Architecture and Fine Arts Library. A full description of the library system is given in the graduate catalog. Library contact for Engineering is Martin Wallace, [martin.wallace@uta.edu](mailto:martin.wallace@uta.edu), 817-272-3924.

### **Computer Labs**

Computer Labs for student use can be found on campus in the following locations:

- Central Library (5th floor)
- Carlisle Hall (in the writing center-5th floor)
- Nedderman Hall (basement)
- Science Learning Center, Life Science Building
- MAE CADLAB, 320 Woolf Hall

### **Keys**

A Key Request Form should be obtained from Danette Stille in Room 204-Woolf Hall. The form should be signed by the person authorizing your key. The Department Chairman will approve the request. After all signatures are obtained, the form will be forwarded to the Key Control office.

### **Mailboxes**

AE graduate student (with GTA appointments) mailboxes are located in Room 204 Woolf Hall. Please check your mailbox **daily** since you will be notified of important happenings by notice in your mailbox.

### **Health Center**

A health center is available to meet your medical needs. A full description of the services offered by the health center can be found in the graduate catalog.

### **University Center**

The University Center has numerous facilities and offices of interest to all students. In it are private dining-meeting rooms, lounges, ballrooms, food service areas, bowling and billiards, a post office, general store, bank, gallery, and video room. The center is also home to campus student organizations, the Student Congress, and the Student Activities Board. The Housing Office is also located in the Center.

## **International Office**

The International Office is located in the Swift Center at 1022 UTA Blvd.

<http://www.uta.edu/oie/>

Hours of Operation: Monday - Friday from 8:00am - 5:00pm

Phone: 817-272-2355

Email: [international@uta.edu](mailto:international@uta.edu)

# REQUIREMENTS OF THE DOCTORAL PROGRAM

As in any doctoral program, you will be required to accomplish a number of tasks before being awarded your degree. In this section the entire process will be outlined step by step. PLEASE read this carefully and refer to it often: *The deadlines stipulated here are not to be taken lightly and the responsibility for adhering to them lies primarily with you.* The following describes the expected course of events for a typical full-time student.

## Core Areas in the Aerospace Engineering Program

The four core areas in the Aerospace Engineering program along with the recommended courses in each core area are listed below:

### 1. Fluid Mechanics, Aerodynamics and Propulsion

- AE 5313 Fluid Dynamics
- AE 5326 Air-Breathing Propulsion
- AE 5342 Gas Dynamics

### 2. Solid Mechanics and Structures

- AE 5310 Finite Element Methods
- AE 5311 Structural Dynamics
- AE 5339 Structural Aspects of Design

### 3. Flight Mechanics and Controls

- AE 5302 Advanced Flight Mechanics
- AE 5362 Guidance, Navigation and Control of Aerospace Vehicles

### 4. Flight Vehicle Design

- AE 5368 Flight Vehicle Synthesis and Systems Engineering

**All students must be advised by the Graduate Advisor prior to being cleared for registration.** First semester, all students must meet with the graduate advisor for this purpose. New students are also required to sign "the Milestone Agreement Form", which is to inform students about the academic milestones that they will be expected to reach in order to earn their Ph.D. degree as well as when they are expected to complete these milestones. In subsequent semesters, students who do not have a supervising professor still need to meet with the graduate advisor; for students who have a supervising professor, this may be accomplished by either scheduling an appointment for advising and discussion of any changes to your degree program, or in routine situations by filling out the Advising Form and giving it to Debi for approval by the advisor. Once the desired courses are approved, the advising hold will be removed.

Your first year will be devoted primarily to course work. Full-time students will enroll in a minimum of 9 hours of course work/research per semester in the fall and spring semesters, and 6 hours of course work/research in the summer semester. The courses must be approved by the graduate advisor prior to registration. *Students are strongly encouraged to discuss the selection of courses with their supervising professor.* The details of the course offerings are listed in the Graduate Catalog, and the requirements that pertain to you are those listed in the catalog current

at the time you enter the Graduate School. The Graduate Catalog is accessible on-line at <http://grad.uta.edu/catalog/>. Unless you have deficiencies to be made up, you will normally take AE courses in the first semester. The Graduate Studies Office requires that you maintain a 3.0 GPA (on a 4 point scale) in all course work taken as a graduate student.

During the first year you are encouraged to select a research advisor. You are recommended to talk to a large number of faculty members about potential research projects. Faculty profiles are provided on the MAE web site <http://www.uta.edu/mae/>.

**BS-PhD Track Students.** Special provisions apply to BS-PhD Track students. A BS-PhD student will be required to enroll in at least three hours of research each semester during the student's first two years, receiving a pass/fail grade (no R grade) in these hours. A BS-PhD student must have a faculty research (dissertation) advisor prior to the start of the student's second full semester.

## **Degree Requirements**

- The Ph.D. degree requires a minimum of 24 hours of graduate-level course work beyond the Master's degree, and will include a scholarly dissertation that provides a significant original contribution to Aerospace Engineering.
- Students who did not satisfy the specific course requirements of Master of Science in Aerospace Engineering (see graduate catalog and Graduate Student Handbook - Masters Program for Aerospace Engineering) are expected to do so during their PhD program.
- All entering students must be proficient in mathematics, engineering analysis, and computer programming. (*Students not meeting these requirements may be admitted on a probationary basis and given a plan of remedial undergraduate coursework*).
- No graduate credit will be granted for courses that are required in the undergraduate Aerospace Engineering curriculum.
- The doctoral candidates in Aerospace Engineering shall enroll in the Graduate Seminar (AE 5101) a minimum of three times (see course description).
- All candidates are required to select a Supervising Professor and obtain an approved program of work in the second full semester or after 12 hours are completed.
- The Ph.D. degree course requirement can be tailored to satisfy the individual student's aspirations in choice of the area of specialization. However, to meet the educational goals of a broad-based technical background in Aerospace Engineering, it is expected that each student will take sufficient course work to obtain in-depth knowledge in at least two core areas of Aerospace Engineering. Students must take one course each from at least two core areas.



- A summary of the course requirements for students who met AE Master of Science requirements is given below.

<b>Master of Science Degree (Thesis)</b>		
<b>Description</b>	<b># of courses</b>	<b># of credits</b>
<b>Core courses</b>	2	6
<b>Math/Engineering analysis courses</b>	1	9
<b>Electives</b>	4	12
<b>AE5698-Theiss in Graduating Semester</b>	1	6
	<b>Credit Total</b>	<b>30</b>

- A summary of the course requirements for students who met AE Master of Engineering requirements is given below.

<b>Master of Engineering (Non-Thesis)</b>		
<b>Description</b>	<b># of courses</b>	<b># of credits</b>
<b>Core courses</b>	3	9
<b>Math/Engineering analysis courses</b>	2	6
<b>Electives</b>	5	15
	<b>Credit Total</b>	<b>30</b>

- Qualifying Exam: see below
- Comprehensive Exam: see below
- Dissertation Defense: see below

### **B.S. to Ph.D. Track**

- In addition to the requirements listed above for the Ph.D. degree, a B.S.-Ph.D. Track student will be *required to enroll in at least three hours of research each long semester during the student's first two years, receiving a pass/fail grade (no R grade) in these hours.* A student may be exempted from enrolling in research hours in the student's initial semester.
- A B.S.-Ph.D. Track student must have a faculty research (dissertation) advisor prior to the start of the student's second full semester.
- A summary of the course requirements for students who are in the BS-PhD track is given below.

(BS-PhD Track)		
Description	# of courses	# of credits
Core courses	2	6
Math/engineering analysis Courses	2	6
AE-related elective courses	10	30
	sub total	42
Seminar Course (AE5101)	3	3
AE6999 (Dissertation)	1	9
	sub total	54
AE6397 (Research) Every long semester for first 2 years	4	12
	total credit	66

Final course requirements are determined by the student's supervising committee. In addition, a student must pass three examinations before being awarded the Ph.D. degree: the Qualifying Exam, the Comprehensive Exam, and the Final Exam (or Dissertation Examination).

#### **M.S. to Ph.D. Track**

- 8 courses in AE or other relevant programs
  - If MS course requirements were not met
    - At least 2 should be from two different core areas
    - At least 2 should be from math/engineering analysis (AE5331, AE5332)
    - 3 graduate seminars (AE5101 three times)
    - Complete Course work within 2 years
- Qualifying Exam
  - at the end of the 1<sup>st</sup> semester
- Comprehensive Exam
  - 1<sup>st</sup> semester of the 3<sup>rd</sup> year
- Dissertation
  - 9 credit hours (AE6699, AE6999, AE7399)
  - Dissertation defense at the end of the 3<sup>rd</sup> year
- M.S.to Ph.D. Track students must have a faculty research (dissertation) advisor prior to the start of the student's second full semester.

- A summary of the course requirements for students who are in the MS-PhD track is given below.

MS course requirement met		
Description	# of courses	# of credits
AE-related courses	8	24
AE 6999 (Dissertation)	1	9
	Credit Total	33

MS course requirement NOT met		
Description	# of courses	# of credits
Core courses	2	6
Math/Engineering analysis courses	2	6
AE-related courses	4	12
	Subtotal	24
Seminar Course	3	3
AE6999 (Dissertation)	1	9
	Credit Total	36

## Research

Research for the Ph.D. program will begin usually by the end of the first year of course work, and will continue until your research advisor and dissertation committee think that you are ready to defend your work. In or before your last semester, you must file the *Application for Candidacy and Final Program of Work*, downloadable from

<http://grad.uta.edu/students/forms/doctoral/>.

- **Qualifying Exam:** All students entering the Ph.D. program are required to take the Ph.D. Qualifying Exam. Students admitted into AE Ph.D. program with MS degree in Aerospace Engineering or equivalent **must take the qualifying exam at the end of the 1st semester**. Students admitted into AE B.S.-Ph.D. program **must take the qualifying exam within the first year**. This exam is offered twice per year, during the week preceding the start of classes for the fall and spring semesters. Possible outcomes of this evaluation are: 1) continuation in the doctoral program, 2) approval to continue with certain specified remedial work, 3) failure with approval to retake, 4) termination in the program.

**Dissertation Committee:** Prior to the comprehensive exam, the student with consultation with his/her research advisor should set up his/her dissertation committee. The dissertation committee must be composed of at least five members but not more than six, of whom four must be faculty members of the Mechanical and Aerospace Engineering (MAE) Department. The chair of the committee must be a member of the Aerospace Engineering (AE) Faculty and is usually the research advisor of the student. As such, the chair of the committee is a full-time faculty member of the MAE Department, including tenure-track, tenured and Professors in Practice, who participate substantially in the aerospace engineering program. At least one member of the committee must be non-MAE. Should there be an External or Special Member, that person will be the sixth member of the committee and should have prior approval from AECAP (Aerospace Engineering Committee on Academic Programs).

- **Comprehensive Exam:** Students are eligible to take the comprehensive examination after satisfying all requirements stipulated by the Qualifying Exam Committee and giving evidence to their doctoral committee of adequate academic achievement by having completed all or most coursework requirements. The comprehensive examination is used to determine if the student has the necessary background and specialization required for the dissertation research and if the student can organize and conduct the research. *An applicant must pass this examination to be admitted to candidacy for the Ph.D. degree.*

### **Dissertation Defense**

The final requirement for the Ph.D. degree is the submission and oral defense of a dissertation which describes the results of your work. The dissertation committee should have the same members who served in your comprehensive exam. You should refer to the Graduate Studies Thesis and Dissertation Forms (<http://grad.pci.uta.edu/students/forms/thesis/>) when writing your dissertation to insure that an acceptable format is used. A copy of the dissertation must be given to each committee member two weeks in advance of the exam. This copy should be in a form so that it could be turned in as the final version. It should not be left for the committee to make major corrections and revisions in spelling, syntax, organization, or content of the dissertation. A dissertation in need of major rewriting will result in automatic failure at the first oral defense. At the oral defense you will give a brief presentation of your research and answer questions from the committee and the audience. After the public part of the exam, there will be a final question-and-answer session that involves only the student and the committee. Following the oral defense, the **Dissertation Defense Report must be submitted to the graduate school.** You must see that any conditions placed on passing are met in the time allowed and to the satisfaction of the committee members. Failure of the defense will result in the scheduling of a second defense within three months. Failure of that defense will result in dismissal from the program.

### **Graduating Semester**

In the semester that you plan to graduate, there are several important deadlines that you must meet and fees that are to be paid. You should check the Graduate School's website (<http://grad.uta.edu/CurrentStudents/VirtualGraduateSchoolAdvisor.asp>) for these deadlines and fees. A **graduation checklist** is provided at this website. The **Application for Graduation** and **Thesis and Dissertation Data Sheet** are additional forms that are filed during the graduating semester.

## **Forms**

The Graduate School maintains a complete list of downloadable forms at the following website:

<http://grad.uta.edu/students/forms/doctoral/>.

## **Miscellaneous**

### **Academic Probation**

A graduate student whose cumulative grade point average falls below a 3.00 in all graduate courses, be they graduate or undergraduate level, taken while enrolled as a UT Arlington graduate student will be placed on academic probation. The student must attain a grade point average of at least 3.00 in the next semester he or she is enrolled or be subject to dismissal. Undergraduate courses or graduate courses graded P, R, I or W or courses that do not provide graduate credit (see Courses Not Providing Graduate Credit) cannot be used to remove the condition of academic probation.

### **Dismissal**

Students have the initial responsibility to recognize when they are having academic difficulties and are expected to initiate steps to resolve the problem. When a student is in academic difficulty, and dependent upon the severity of the problem, the student may receive an oral warning and/or written statement of the problem and required corrective actions from his or her program. Failure to take these corrective actions can result in termination from the degree program.

A student who has been dismissed from the Graduate School for failure to remove the condition of academic probation by meeting the 3.0 grade-point average requirement may be readmitted for further graduate study in the same or in a different program only if a Petition to the Graduate Faculty has been approved by the appropriate Committee on Graduate Studies and the Dean of Graduate Studies.

A student can be dismissed from a degree program not only for failure to maintain an adequate grade point average, but also for such reasons as unsatisfactory progress toward a degree as defined by the department or program, inability to pass a comprehensive examination, failure to prepare or to defend a thesis or dissertation in a satisfactory manner or complete thesis or dissertation work in an acceptable amount of time. Termination due to inadequate academic progress is a decision made by the program's or department's Graduate Advisor and Graduate Studies Committee. A student's thesis/dissertation committee may recommend termination for failure to prepare a thesis/dissertation proposal, prospectus or final draft in a satisfactory manner or failure to complete work in an acceptable amount of time to the program's Graduate Advisor and Graduate Studies Committee. Such decisions to terminate a student must be communicated to the Dean of Graduate Studies by the Chairman of the Graduate Studies Committee with required

justification. The Graduate Dean will review the case make the final decision. The student may continue enrollment until the Dean finalizes the termination decision.

Students failing to pass a comprehensive examination or thesis/dissertation defense may be terminated upon the recommendation of the examining committee. Such decisions are indicated on the Comprehensive Examination Report or Final Defense Report which are returned to the Dean of Graduate Studies. The Graduate Dean will notify the student formally of the program's or department's decision.

## **APPENDICES**

**A. AE PhD Qualifying Exam Guidelines**

**B. AE Comprehensive Exam Guidelines**

## APPENDIX A

### AE PhD Qualifying Exam Guidelines

The Qualifying Exam is a written test of the student's capability to successfully pursue the Ph.D. degree program and aids in developing a program of study appropriate for the student. Students are examined in *two* of the following *four* core areas:

- 1) Aerodynamics/Propulsion
- 2) Structures and Materials
- 3) Flight Dynamics and Controls
- 4) Flight Vehicle Design

#### Procedure

- 1) The Ph.D. Qualifying Exam in Aerospace Engineering will be held during the week before start of classes for the Fall and Spring Semesters.
- 2) Candidates for the Qualifying Exam must notify the Graduate Advisor by completing AE PhD qualifying exam registration form no later than one month prior to the scheduled examination week of their intent to take the exam and identify the two subject areas in which to be examined. *The selection of the areas must have approval of the student's supervising professor.*
- 3) Each exam will be between two & three hours in duration and will be closed book. A list of important equations will be provided.
- 4) The examination schedule will be posted one week prior to the exam.

#### Qualifying Examination Report

The qualifying examination report must be filed in the Graduate School by the AE qualifying examination committee after the qualifying exam. Results of the qualifying examination may be:

- 1) Approval to continue in the doctoral program;
- 2) Approval to continue with specified remedial work;
- 3) Failure, but with permission for reevaluation after a specified period; or
- 4) Failure and dismissal from the program.

#### Suggested Materials

Suggested reference materials and a list of topics for each exam are provided below.



## PhD Qualifying Exam – Aerodynamics and Propulsion

### Reference Material

- 1) John D. Anderson, *Fundamentals of Aerodynamics*, 4<sup>th</sup> Edition, McGraw-Hill, 2007
- 2) John D. Anderson, *Modern Compressible Flow*, 3<sup>rd</sup> Edition, McGraw-Hill, 2002
- 3) Frank M. White, *Fluid Mechanics*, 5<sup>th</sup> Edition, McGraw-Hill, 2003
- 4) J. D. Mattingly, *Elements of Gas Turbine Propulsion*, AIAA

### Topics - Aerodynamics

- Characteristics of Aerodynamics
  - Classification, practical objectives, fundamental variables
  - Forces, moments, center of pressure, dimensional analysis, flow similarity, buoyancy force, types of flow
- Fundamental Principles and Equations
  - Vector and tensor relations
  - Models of the fluid: control volumes and fluid elements
  - Lagrangian and Eulerian Descriptions (substantial derivative and Reynolds transport theorem)
  - Integral and Differential forms for conservation of mass, momentum, and energy
  - Control volume analysis
  - Bernoulli Equation
  - Pathlines, streamlines, streaklines
  - Angular velocity, vorticity, strain
- Irrotational Incompressible Flow
  - Circulation, stream function, velocity potential
  - Fundamental potential flows and the superposition principle
  - Incompressible flow over airfoils
  - Incompressible flow over finite wings
  - Three-dimensional incompressible flow
- Inviscid Compressible Flow
  - Fundamental principles and differential equations of inviscid flow
  - One-dimensional flow (Normal shock waves, Hugoniot equation, etc.)
  - Oblique shock and expansion waves
  - Quasi-One Dimensional flows (nozzles, diffusers, and wind tunnels)
  - Subsonic compressible flow over airfoils: linear theory
  - Linearized supersonic flow
  - Elements of transonic and hypersonic flow
- Viscous Flow
  - Fundamental principles and differential equations of viscous flow
  - Basic Navier-Stokes solutions (Flows of Couette, Poiseuille, etc.)
  - Laminar and turbulent boundary layers

## Topics - Propulsion

- Jet Engine Thrust /Efficiency Relations
- Parametric Cycle Analysis of Ideal Engines
  - Basic concepts
    - Ramjet
    - Turbojet
    - Turbofan (separate exhaust)
    - Turbofan (mixed exhaust)
  - Component Performance – Engineering Approach to Cycle Analysis
- Parametric Cycle Analysis of Real Engines
  - Basic concepts
  - Ramjet
  - Turbojet
  - Turbofan (separate exhaust)
  - Turbofan (mixed exhaust)
- Off-design Performance
- Inlet Design/Performance Analysis
  - Subsonic external compression inlets
  - Supersonic external compression inlets
- Nozzle Design/Performance Analysis
  - Convergent nozzles
  - Convergent-divergent nozzles
- Turbomachinery
  - Basic concepts
  - Axial flow compressor (mean radius analysis)
  - Axial flow compressor ( radial variations)
  - Axial flow turbine

## PhD Qualifying Exam – Structures and Materials

### Reference Material

- 1) C.T. Sun, *Mechanics of Aircraft Structures*, John Wiley & Sons, 1998.
- 2) Roy R. Craig, Jr., *Structural Dynamics*, John Wiley & Sons, 1981

### Topics - Structural Statics

- Characteristics of Aircraft Structures and Materials
  - Stress & strain in basic structural elements;
  - Wing & fuselage; aircraft materials
- Introduction to Elasticity
  - Basic concepts of stress/strain; principal stresses and their planes
  - Maximum shears and their planes; stress transformation
  - Linear stress/strain relationship; elastic strain energy
  - Plane stress/plane strain; equation of equilibrium; Airy stress function
- Torsion
  - Torsion of uniform bars with circular cross-sections;
  - Torsion of uniform bars with rectangular cross-section;
  - Torsional rigidity
  - Transformation matrices; elastic constants transformation
- Bending and Flexural Shear
  - Bernoulli-Euler Beam Equation
  - Bi-directional bending
  - Transverse shear
- Flexural Shear Flow in Thin-Walled Sections
  - Open thin-walled sections
  - Shear center
  - Closed thin-walled sections
  - Multi-cell closed sections
- Fatigue and Fracture Mechanics Analysis
  - Strength failure criteria
  - Fracture mechanics
  - Fatigue analysis and crack growth
- Elastic buckling
  - Euler buckling analysis;
  - Long column vs. short column
  - Initial Imperfection
  - Unsymmetrical Section

## **Topics - Structural Dynamics**

- Free Vibration of Single degree Of Freedom Systems (SDOF)
- Harmonic Response SDOF
- Transient Response SDOF
- Numerical Methods for Transient Response of SDOF
- Continuous Systems
  - Rods and beams
  - Natural frequencies
  - Various boundary conditions
- 2-Degree of Freedom Systems - Natural Frequencies
- Multidegree of Freedom Systems - Natural Frequencies
- Modal Methods - Response of Multi-DOF
- Finite Element Modeling - Fundamentals

## PhD Qualifying Exam – Flight Dynamics and Control

### Reference Material

- 1) Bandu N. Pamadi, *Performance, Stability, Dynamics, and Control of Airplane*, 2<sup>nd</sup> Edition, AIAA Education Series
- 2) Arthur E. Bryson, Jr., *Control of Spacecraft and Aircraft*, Princeton University Press.
- 3) Katsuhiko Ogata, *Modern Control Engineering*, 4<sup>th</sup> Edition, Prentice-Hall, Inc.
- 4) *Orbital Mechanics for Engineering Students* by Howard D. Curtis, Elsevier Aerospace Engineering Series

### Topics in Atmospheric Flight Dynamics, Orbital Mechanics and Control Systems

- Axes Systems
  - Inertial frame
  - Body frames
  - Wind frame
- Directional Cosine Matrices
  - Elementary rotations
  - Sequence of elementary rotations (Euler Theorem)
  - Covariance of vector representations
  - Small angles
  - Moving Axes Theorem
  - Velocity and acceleration
- Equations of Motion
  - Translational
  - Angular momentum
  - Central angular momentum – rigid
  - Equations of motion – rotational
  - Kinematics equations – translational
  - Kinematics equations – rotational
- Trimmed Flight Conditions
  - Equilibrium or steady-state conditions
  - Nonlinear algebraic equations
- Small Disturbance Theory
  - Kinematics and dynamics
  - Constitutive equations
  - Typical longitudinal flight dynamics
  - Typical lateral flight dynamics
  - Stability derivatives
  - State-space equations
- The Two-Body Problem
  - Equations of Motion in an Inertial Frame
  - Equations of Relative Motion
  - Angular Momentum and Orbit Formulae
  - The Energy Law
  - 2-Body Orbits and Trajectories
  - Orbit position as a function of time

- Rigid-Body Dynamics
  - Euler Equations for Rigid Body Rotational Dynamics
  - Torque Free Motion
  - Gyroscopic Attitude Control
  - Gravity-Gradient Stabilization
- Linear System Theory
  - Basics
  - Performance specs
- Laplace Transforms
  - Definition
  - Properties
  - Inversion
- Transfer Functions
  - Definition
  - Computation
  - Examples
  - Pole-zero diagrams
  - State-space models
  - Natural flight
  - Stick-fixed longitudinal flight
  - Stick-fixed lateral flight
- Block Diagram Algebra
  - Series
  - Parallel
  - Feedback
- Time Domain Performance
  - 1st-order systems (1<sup>st</sup> order longitudinal and lateral flight modes)
  - 2nd-order systems (2<sup>nd</sup> order longitudinal and lateral flight modes)
- Control System Components
  - System, Input, Output
  - Block Diagram
  - Plant, Actuator, Sensor, Controller
  - Main Control Objectives
- Transfer Function of Systems
  - Definition & Construction
  - Poles & Zeros
  - System Behavior based on Poles
  - System Decomposition based on Poles
- System Response Analysis
  - Types of Input Signals
  - Transient & Steady-state Response
  - Impulse Response of Systems
  - Effect of Poles on the Response
  - Effect of Zeros on the Response
  - Dominant Poles and Zeros
  - Effect of Real Pole on Second Order System
  - System Type

- Control System Design
  - Open Loop versus Feedback Control
  - Stability of Linear Feedback Control System
  - Routh-Hurwitz Stability Criterion
  - Root-Locus Method
  - PI, PD, PID Controllers
  - Frequency Response Analysis
  - Gain and Phase Margins
  - Bandwidth
  - Bode Plot

## **PhD Qualifying Exam – Flight Vehicle Design**

### **Reference Material**

- 1) Nicolai, L.M. and Carichner, G.E., “Fundamentals of Aircraft and Airship Design – Volume I: Aircraft Design,” First Edition, AIAA Education Series, 2010
- 2) Chudoba, B., MAE 4350-4351 Class Notes, 2013-2014

### **Topics**

- Introduction
- Review of Practical Aerodynamics
- Aircraft Performance Methods
- Aircraft Operating Envelope
- Preliminary Estimate of Takeoff Weight
- Estimating the Takeoff Wing Loading
- Selecting the Planform and Airfoil Section
- Preliminary Fuselage Sizing and Design
- High-Lift Devices
- Takeoff and Landing Analysis
- Preliminary Sizing of the Vertical and Horizontal Tails
- Designing for Survivability (Stealth)
- Estimating Wing-Body Aerodynamics
- Propulsion System Fundamentals
- Turbine Engine Inlet Design
- Corrections for Turbine Engine Installation
- Propeller Propulsion Systems
- Propulsion System Thrust Sizing
- Structures and Materials
- Refined Weight Estimate
- Static Stability and Control
- Trim Drag and Maneuvering Flight
- Control Surface Sizing Criteria
- Life Cycle Cost
- Trade Studies and Sizing



## **APPENDIX B**

### **AE PhD Comprehensive Exam Guidelines**

The Office of Graduate Studies of the University of Texas at Arlington requires all doctoral students to pass a Comprehensive Exam. In the Aerospace Engineering Program, this exam consists of both a written document and an oral presentation of the student's proposed dissertation research. Students are eligible to take the Comprehensive Examination after giving evidence to their doctoral committee of adequate academic achievement by having satisfied all requirements imposed by the Qualifying Evaluation and completed all or most coursework requirements. The comprehensive examination is used to determine if the student has the necessary background and specialization required for the dissertation research and if the student can organize and conduct the research.. An applicant must pass this examination to be admitted to candidacy for the Ph.D. degree.

The comprehensive examination usually marks the end of formal coursework and the beginning of concentrated work on dissertation research and preparation. The student must be enrolled in the Graduate School in the semester in which he/she takes the exam. For most students the Comprehensive Exam ordinarily will be taken during the student's second year of doctoral studies. At this point a doctoral student should have commenced concentrated work on dissertation research under a faculty advisor and established a Comprehensive Exam Committee in accordance with the requirements set in section "Dissertation Committee". Once the committee is established, the student should file with the Office of Graduate Studies "Request for the Comprehensive Examination" form.

The Comprehensive Examination may result in: (1) unconditional pass and recommendation to proceed to the next phase of the program; (2) approval to remain in the program but a requirement to meet certain specified additional criteria; (3) failure, but with permission to retake the examination after a period specified by the examining committee; or (4) failure with recommendation not to continue in the program.

The student must set the exam date with the agreement of the committee members and file the "Request for the Comprehensive Examination" form with the Office of Graduate Studies at least 14 days prior to the exam date. The exam specifically involves evaluation of the student's dissertation research proposal. A written proposal document is to be provided to all committee members at least 7 days prior to the exam date. On the day of the exam, the student is to provide the committee members copies of the presentation material that is to be covered. This document details guidelines for students in preparing the written proposal.

#### **Written Proposal Format**

The dissertation research proposal needs to be presented in a succinct manner. Pages should be standard letter size with margins of 1 inch at the top, bottom, and on each side. The type font size must be no smaller than 12, and the line spacing must be double-spaced. Students are encouraged to adopt, as appropriate, format and styles required by the Office of Graduate Studies for dissertations. (<http://grad.pci.uta.edu/students/forms/thesis/>).

The proposal should typically contain the following sections with suggested contents:

- **Title Page**
  - The proposed research title should be brief, clear, and unambiguous.
  - Use words that clearly reflect the focus of your proposal.
  - Remove words from the title that are unnecessary.
  - Include your name, your advisor's name (Committee Chairman), the names of the other members of the Comprehensive Exam Committee, and the date.
- **Project Summary**
  - The Project Summary provides the reader with a "picture" of your proposal.
  - It must be concise and lay the framework of your proposal.
  - This section should be prepared last, after you have written the rest of the proposal and you have a clear understanding of what follows in the document.
  - Make sure that the reader sees:
    - objectives of the research and expected significance
    - reasons for the research
    - the uniqueness of the work
    - a clear rationale
    - focused ideas
    - a summary of work done thus far
    - a summary of work that remains to be done
- **Table of Contents**
  - The Table of Contents lists all main sections and subheadings contained in the document, with appropriate page numbers.
- **Project Description**
  - The purpose of the Project Description is to provide the *what*, *why*, and *how* of the proposal.
  - The Project Description contains all elements that are condensed in the Project Summary.
  - It should contain discussion of:
    - objectives of the research and expected significance
    - reasons for the research
    - the uniqueness of the work
    - what you intend to do and why it is worth doing
    - what you have done to establish the feasibility of what you are proposing
    - how the research will be accomplished
    - relation of your proposed research to the present state of knowledge in the field; cite appropriate references
    - identification of required resources
    - a projected sequence and schedule
    - potential difficulties and limitations and how these will be overcome or mitigated
    - expected results and alternative approaches if unexpected results are found
    - discussion of what work has been done thus far, including experimental procedures, analysis methods, and results
    - contributions: what your work adds to the field of knowledge
    - References

- The proposal should cite essential references pertinent to the subject being addressed.
- Every reference cited in the proposal must be listed in this section.
- Citations must be complete. Include full listing of authors, the title of the article, name of the journal or book, publisher (if a book), volume number, page numbers, and date.
- Use a consistent bibliographic style.
- **Appendices**
  - Appendices contain materials too lengthy for inclusion in the text, or not directly relevant.
  - Appendices may be useful for providing raw data, background materials, supplemental tables, figures, derivations, analysis, etc.
  - All material in Appendices must be referred to in the text so readers know why they are there.
  - Each Appendix should have a title.

### **Common Shortcomings**

- The following list details common deficiencies in research proposals:
  - It is not clear what hypothesis is being addressed by the proposal.
  - It is not clear that the proposed hypothesis is worth addressing.
  - The case for innovative research (i.e., the contribution) is not made.
  - The proposed research is just a routine application of known techniques.
  - The proposer seems unaware of what others have done in this field.
  - There is no evidence that the proposer will succeed where others have failed.
  - The proposer is attempting too much.
  - The approach lacks clear thinking and logical development.
  - The resources are not adequate for the proposed research.

### **Resources for Writing Proposals and Dissertations**

There are many resources available via the internet for writing proposals and dissertations. In particular, many universities have excellent information via their Office of Sponsored Projects or Graduate School sites. The following is a list of some helpful web sites:

S. Joseph Levine, Ph.D., Michigan State University – “Guide for Writing a Funding Proposal”  
<http://learnerassociates.net/proposal/>

S. Joseph Levine, Ph.D., Michigan State University – “Guide for Writing and Presenting Your Thesis or Dissertation”  
<http://www.learnerassociates.net/dissthes/>

Foundation Center – “Proposal Writing Short Course”  
[http://foundationcenter.org/getstarted/tutorials/shortcourse/prop1\\_print](http://foundationcenter.org/getstarted/tutorials/shortcourse/prop1_print)

National Science Foundation (NSF) – “A Guide to Proposal Writing”  
<http://www.nsf.gov/pubs/2004/nsf04016/start.htm>