Aerospace Engineering Sciences

GRADUATE STUDENT HANDBOOK

(AY 2013-2014)

Effective August 15, 2013

Note: This handbook is not a substitute for face-to-face advising. Students must meet with their faculty advisors at least once each semester to discuss their coursework and progress in the program.

Handbook Revisions

Foreword

The Department of Aerospace Engineering Sciences at the University of Colorado is one of the top aerospace engineering departments in the nation. Aerospace engineers work on Earth and in space not only to extend frontiers but also to understand more fully and to preserve our terrestrial environment. Few fields offer more exciting and diverse careers: becoming an astronaut (fifteen CU graduates to date have become astronauts), designing the next generation of aircraft and spacecraft, monitoring our global habitat via remote sensing from space, and helping to develop environmentally clean energy and transportation systems.

Teaching and research address both the challenges and the opportunities facing the aerospace engineering profession today. Graduate students, research staff and faculty work together on a wide range of research topics: aerodynamics and fluid mechanics; aerospace design and system engineering; astrodynamics and orbital mechanics; atmospheric, oceanic and space sciences; bioastronautics; computational and analytic methods; satellite-based global positioning/timing technology; remote sensing; structures, materials and structural dynamics; systems and control; and thermodynamics and propulsion.

Nearby government and industrial laboratories enhance the rich research environment of the University of Colorado. Local aerospace firms or their divisions include Ball Aerospace, Lockheed-Martin, Hughes, Raytheon, Loral, and TRW. Nearby government laboratories include the National Center for Atmospheric Research (NCAR), the Environmental Research Laboratories of the National Oceanic and Atmospheric Administration (NOAA), the National Renewable Energy Laboratory (NREL), and the National Institute of Standards and Technology (NIST).

In addition to the rules set forth in this Graduate Handbook, all students are also subject to the rules and provisions required by the University of Colorado Graduate School. The Graduate School Rules appear at:
http://www.colorado.edu/GraduateSchool/policies/_docs/GraduateSchoolRules.pdf

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Admission Requirements

An applicant may be admitted to the Graduate School as either a regular degree student or a provisional degree student. For acceptance into the Department of Aerospace Engineering Sciences, the following requirements must be met.

Aerospace Engineering Sciences at CU-Boulder has established minimum standards for graduate admission. Applicants must:

1. Have undergraduate courses in calculus, linear algebra, and differential equations.

2. Have two semesters of undergraduate calculus-based physics.

3. Have at least two semesters of upper-division undergraduate courses in engineering or physics.

4. Hold a baccalaureate degree in engineering, science, or mathematics from an institution accredited by an agency recognized by the U.S. Department of Education, or have the equivalent.

5. Have an undergraduate grade point average of at least 3.40.

6. Provide official GRE scores. The minimum desired GRE scores are 157 (560) verbal, 158 (740) quantitative and 4.5 written analytical.

International students must provide documentation that they have the financial resources to support themselves for at least the first year in the program.

Students with undergraduate degrees in all areas of engineering are encouraged to apply. Students with undergraduate degrees in mathematics, physics, chemistry and other physical sciences are also encouraged to apply.

Application Procedures

Graduate students are admitted into a specific focus area that provides research advising, financial support, and sets specialized admission and program requirements and recommendations for course work within and outside the department. The four focus areas are:

- Aerospace Engineering Systems
- Astrodynamics and Satellite Navigation Systems
- Bioastronautics
- Remote Sensing, Earth and Space Science

Each focus area has defined the required characteristics of its successful graduates at the MS and Ph.D. level, and defined the required and elective courses that support its educational program. See the focus area curricula charts appearing in this handbook for details.

An applicant for admission must present complete application materials that include:

1. The online graduate application (including focus area/subplan).

2. *Official* transcripts of <u>all</u> academic work completed to date, including study abroad and coursework for college credit completed in high school.

3. A $50 nonrefundable application fee. The foreign application fee is $70.

4. Four letters of recommendation.

5. *Official* test scores from the analytical, quantitative, and verbal sections of the Graduate Record Examination (GRE) taken within the past 5 years.

Applicants must submit the electronic application for admission available on the Colorado.edu website.

The application deadline is JANUARY 5 for FALL semester, and OCTOBER 1 for SPRING semester. International students must apply by December 1 for FALL and August 1 for SPRING

Academic Standards

A master's degree student is required to maintain at least a B (3.00) average in all work attempted while enrolled in the Graduate School. Admission to Ph.D. candidacy requires a 3.25 average. For both the master's degree and Ph.D., a course mark below B- is unsatisfactory and will not be counted toward fulfilling the minimum requirements for the degree.*

A student, who fails to maintain a 3.00 grade point average or to make adequate progress toward completing a degree, as assessed by the student's academic/research advisor, will be subject to suspension or dismissal from the Graduate School upon consultation with the major department. The final decision on suspension or dismissal will be made by the dean of the Graduate School.

See the Graduate School Rules, http://www.colorado.edu/GraduateSchool/policies/_docs/GraduateSchoolRules.pdf, for additional information.

*An incomplete (I) grade is given only when students, for documented reasons beyond their control, have been unable to complete course requirements in the semester enrolled. A substantial amount of work must have been satisfactorily completed before approval of such a grade is given. At the end of one year, and I grade given for a course that is not successfully completed or repeated is regarded as an F and shown as such on the student's transcript.

Students should refer to the version of the Graduate Handbook in effect at the time of their matriculation for degree plan requirements. Students who are readmitted or continue on from the MS to the Ph.D. program are subject to the handbook in effect at the time of their continuation start date.

Master of Science Degree

Program Requirements:

- A total of 30 semester hours (including courses, seminars and thesis hours), at least 24 semester hours of which must be completed at the 5000 level or above, with no more than 12 semester hours outside of ASEN.
- Up to 6 credits can be taken at the 4000 level in related engineering, math and science departments (ECEN, CVEN, MCEN, CHEN, CSCI, ATOC, ASTR, PHYS, MCDB, APPM, MATH, CHEM, IPHY, GEOL, ENVD). 4000 level ASEN courses are <u>not</u> counted toward the program.
- Two to four required courses (6-12 semester hours) as defined by the student's focus area must be taken in the student's primary focus/thrust area and one required course (3 semester hours) must be taken in a second focus/thrust area.
- One of the approved math courses (3 semester hours) listed on page 12.
- Seminar credits, even those earned in other disciplines, do not count toward the MS degree.
- Students must fulfill a graduate project requirement (6 credit hours) consisting of either: (1) MS thesis, (2) Graduate Projects I and II, or (3) required courses leading to an approved certificate
- Graduate Projects (ASEN 5018/6028) is a two-semester course sequence designed to expose MS and PhD students to project management and systems engineering disciplines while working a complex aerospace engineering project as part of a project team. The course is also open to students in other engineering departments with the approval of the project professor.
- Completion of all degree requirements within four years from the date of commencing coursework, normally completed in one to two years.
- Master's degree residence requirements can be met only by residence on the CU-Boulder campus for two semesters or three summer sessions, or a combination of at least one semester and two summer sessions. Residence in this context refers to a student's registration for CU-Boulder courses, and not physical residence.

- Pass all courses with a grade of B- or better, and maintain a cumulative GPA of 3.0 or better.

*Pre-approval of certificate programs offered outside the department is required.

Some required graduate level courses have prerequisites. Students are expected to complete prerequisite materials before enrolling in these courses. For any course to be counted toward the MS degree requirements, the student must earn a grade of **B- or higher**.

Students in the BS/MS program must also meet the above requirements.

The specific implementation of these requirements and additional requirements for the MS degree in the Department of Aerospace Engineering Sciences are described in the focus area curricula section appearing later in this handbook.

Up to 9 credits from an incomplete MS program may be accepted for degree requirements; however, work already applied toward a graduate degree received from CU-Boulder or another institution cannot be accepted for transfer toward another graduate degree at the same level at CU-Boulder. For example, work already applied to meet requirements for a master's degree earned by a student cannot be used toward a second master's degree from CU. Also, undergraduate level credits cannot be transferred, including credits earned while in the BS program at CU and prior to matriculation into the masters or PhD programs. Transfer credit is any credit earned prior to matriculation into the graduate program. In addition, work completed for a doctoral degree may not be applied toward a subsequent master's degree. Extension work completed at another institution cannot be transferred; and correspondence work, except to make up deficiencies, is not recognized.

Up to 9 credits from the ACCESS and CAETE programs prior to matriculation will be accepted toward the MS degree. These credits do not have to be transferred, as they appear on the CU transcript. However, Continuing Education (non-degree) credits have to be transferred.

Guidelines for MS thesis:

The MS thesis must consist of original and independent research conducted by the graduate student under the supervision of the faculty advisor. The thesis topic must be related to the major field. The thesis must:

1. Represent the equivalent of 6 semester hours of course work.

2. Comply in mechanical features with the University of Colorado Graduate School Thesis and Dissertation Specifications.

3. Be filed with the Graduate School by posted deadlines for the semester for which the degree is to be conferred.

The examination committee for the MS thesis will consist of three graduate faculty members.

See the Graduate School Rules, http://www.colorado.edu/GraduateSchool/policies/_docs/GraduateSchoolRules.pdf, for additional information.

Courses Satisfying Math Requirement:

Math

ASEN 5227: Aerospace Math
ASEN 5307: Engineering Data Analysis Methods
ASEN 5417: Numerical Methods for Differential Equations
ASEN 5/6519: Uncertainty Quantification (Alireza Doostan)
EMEN 5005: Intro to Applied Statistical Methods
APPM 4000, 5000, 6000, 7000 level courses
MATH 4000, 5000, 6000, 7000 level courses
ECEN 5612: Noise and Random Processes
ECEN 5632: Theory and Application of Digital Filtering
ECEN 5642: Modern Methods of Spectral Estimation
ECEN 5652: Detection and Extraction of Signals from Noise

CU Certificate Programs*

(***Some certificates, noted below, require prior departmental approval to meet the graduate projects requirement**.)

In interdisciplinary certification programs, graduate students explore an interdisciplinary area while pursuing a master's or doctoral degree in a specific department. The students take classes outside their department and work with a faculty member affiliated with the program. Some programs also have research requirements. Professional certification programs allow professionals to pursue certification apart from degree completion. After completing the required work, students receive a certificate in the interdisciplinary field.

For detailed certificate information, See, http://www.colorado.edu/prospective/graduate/academics/certificates.html

Preapproved Certificates:

Interdisciplinary Certificates

Some of the most popular certificate programs include the following. Please see the departments for additional programs.

- Astrodynamics and Satellite Navigation
- Atmospheric & Oceanic Sciences
- Environment, Policy and Society
- Oceanography
- Remote Sensing (Modified for RSESS MS students)

Professional Certificates

Electrical and Computer Engineering

- Embedded Systems
- Energy Communication Networks
- Wireless Networks and Technologies

Engineering Management

- Engineering Entrepreneurship
- Engineering Management
- Leadership and Management
- Managing Applied Research
- Managing Research and Development
- Performance Excellence
- Project Management
- Quality Systems and Engineering
- Six Sigma Certification
- Technology Ventures & Product Management

Telecommunications

- Computer and Network Security
- Power Electronics
- Software Engineering

Certificates requiring pre-approval:

Interdisciplinary Certificates

- Behavioral Genetics
- Biotechnology
- Cognitive Science
- Development Studies
- Energy
- Geophysics and Hydrologic Sciences
- Neuroscience and Behavior
- Optical Science and Engineering
- Quantitative Biology
- Science and Technology Policy

Doctoral Degree

Prior to admission to the Ph.D. program, the student must have a graduate advisor (member of the Graduate Faculty) who has agreed to supervise the student's dissertation research. A student entering the Ph.D. program in Aerospace Engineering Sciences is not required to possess an MS degree; however, the student must have the proficiency required of a holder of the MS degree given in the Department of Aerospace Engineering Sciences at the University of Colorado to pass the preliminary examination. Until the comprehensive examination is passed, the student is considered a doctoral student. Once passed, the student is admitted to candidacy and officially becomes a Ph.D. candidate.

Program Requirements:

- Total of 36 course credits numbered 5000 or above with 12 of these taken at the 6000 level or above (9 credits at 6000 level or above for the remote sensing focus area), with a minimum cumulative GPA of 3.25, and at least 18 credits must be in ASEN. Up to 3 credit hours from ASEN seminars can be applied.
- Six credits of approved math courses (see list of approved math courses appearing earlier in this handbook; however, 4000 level courses cannot be applied to the PhD.).
- Up to 18 credits from an outside MS program can be applied, but not master's thesis credits. All credits earned from a MS program taken at the University of Colorado can be applied toward a Ph.D., except for master's thesis credit.
- Students are required to complete 30 PhD dissertation credits. (See Graduate School Rules for additional information.)
- Students must pass a departmental preliminary examination, or its equivalent, by no later than the end of the 3rd semester if the student already has a master's degree in aerospace engineering; or the 5th semester if the student does not already have a master's degree in aerospace engineering.
- Students must pass a comprehensive examination by no later than the end of the 5th semester if the student already has an aerospace master's degree; or the 7th semester if the student does not already have an aerospace master's degree. Note: students must have completed the 36 required course credits by this semester or the remaining coursework must be pending in the semester in which the comprehensive exam is taken. Students cannot be admitted

into candidacy until the necessary coursework is complete. In addition, students need to plan their program such that they meet the requirements of the Graduate School Rules regarding the accumulation of PhD dissertation credits, and within the maximum 6 year program length to complete the PhD. See, Graduate School Rules, http://www.colorado.edu/GraduateSchool/policies/_docs/GraduateSchoolRules.pdf, for additional information. Students must complete a Ph.D. dissertation and successfully defend the dissertation in a final examination.

- All degree requirements must be satisfied in a period of 6 years from the commencement of coursework for the Ph.D.
- Course curriculum is defined by the chosen focus area and approved by the faculty advisor. See, focus area curricula charts appearing later in this handbook.
- The minimum residence requirement for a Ph.D. is six semesters beyond the attainment of an acceptable bachelor's degree (2 semesters from another institution may be counted towards this requirement). ”Residence” in this context refers to a student’s registration for CU-Boulder courses, and not physical residence.
- Continuous registration. A student must register for a minimum of five dissertation hours in the fall and spring semesters of each year, beginning with the semester following the passing of the comprehensive exam and extending through the semester in which the dissertation is successfully defended (final examination).
- For the Ph.D., a course mark **below B- is unsatisfactory** and will not be counted toward fulfilling the minimum requirements for the degree.
- A student who fails to maintain a 3.25 grade point average or to make adequate progress toward completing a degree, as assessed by the student’s advisor, will be subject to suspension from the Graduate School upon consultation with the major department. The final decision on suspension will be made by the dean of the Graduate School.

Teaching Practicum:

All Ph.D. students are expected to gain teaching experience through a Teaching Practicum. The teaching practicum reflects one semester of documented teaching experience (equivalent to a 50% appointment) for each Ph.D. student. It may be fulfilled in a number of ways to allow flexibility to the student and their advisor based on interests, skills, and departmental needs. While some teaching activities might be paid assignments from the department (for example, a teaching

assistantship or hourly course assistantship), there is no requirement for the teaching practicum to be a paid appointment.

Examples of 1 semester teaching practicum activities:

- Teaching assistant (50% appointment)
- Course Assistant (hourly)
- Team-teaching a course with advisor
- Instructor of record or GPTI
- Mentor responsible for UROP, Discovery Learning Apprentice, SURE or SMART student or high school student, for full summer or semester
- Coordinator for focus area seminar

The advisor is responsible for specifying the teaching activities required and providing guidance and assistance to the student in this work. For teaching as a research mentor the advisor should set clear expectations for the role of the graduate student mentor and ensure that both the graduate mentor and the undergraduate student(s) they are working with understand the responsibilities and roles of each. Students must complete the teaching practicum tracking sheet available in the back of this handbook, or in the graduate advising office, prior to or in the semester of their final defense.

Ph.D. Program Timeline and Examinations:

YEARS 1-2 – Preparation for the Preliminary Exam

During the first two years of the Ph.D. program students will take coursework needed for academic preparation, begin conducting research with their advisor, and possibly initiate their teaching practicum.

Preliminary Exam

The **Preliminary Exam** (prelim) evaluates students' academic qualifications and competency in relevant subject areas for entrance into the PhD program. The goal is to ensure that all students continuing in the program have the technical and communications skills required for successful completion of the doctorate. The prelim must be completed by the end of the third semester if the student already has an aerospace master's degree upon entry to the program, or the fifth semester if the student does not have an aerospace master's degree, as a PhD student. After passing the prelim a student is considered a PhD pre-candidate. (Students become PhD candidates after passing the comprehensive exam, described below.)

Subject Matter
The prelim examining committee consists of three ASEN faculty members selected by the student. It is headed by the PhD advisor and includes a second faculty member from the student's focus area and a third faculty member from a different focus area (or focus sub-area thrust for students within the aerospace engineering systems focus area). The committee members determine the topical coverage of the exam for each student. In general, it will include MS level coursework and undergraduate prerequisite material relevant to the student's and committee members' focus areas. The exam questions may also address relevant research topics, background material, and integration of material from several courses. Students are expected to discuss expectations for the exam with each of the faculty members they select for their committee.

Logistics
The exam comprises a written and oral component, both administered by the student's prelim committee. Each faculty member will ask one or more questions on both the written and oral exams. The written exam is typically given each year on the **second Monday in September**. Unless otherwise noted, the exam is open book and has duration of 6 hours.

a) Students return the Preliminary Exam form to the graduate advisor by the posted deadline with the names of the three faculty members they have asked to sit on the committee.

b) The student's faculty advisor should be the committee chair.

c) The oral exam is scheduled by the student within 1-2 weeks after the written exam.

d) The oral exam has duration of 1-2 hours.

Students are NOT allowed to discuss the preliminary examination with other students until after ALL preliminary examinations are completed – written and oral. Failure to abide by this rule is an Honor Code violation.

Grading

The committee will provide an overall recommendation on the student's progress, and determine one of the following outcomes:

- Preliminary examination is passed unconditionally
- Preliminary examination has conditions placed. Conditions must be completed within one month of the next exam offering.
- Preliminary examination was unsatisfactory. Students who fail the exam may retest at the next exam offering. Students who fail to pass the exam after the second attempt will be dismissed from the Ph.D. program.

Committee members will evaluate the examinee based on the following parameters:

1) Written exams – Each member will grade the written exam on a 0-100% scale before holding the oral examination. The lead committee member takes the written scores and records the cumulative level of competency (satisfactory/marginal/unsatisfactory) on the prelim form in the written exam line. All members will hold on to the graded exams as they may want to revisit questions during the oral exam.
2) Oral exams – Each member participates in the oral exam. Upon completion of the exam, committee members record a cumulative level of competency satisfactory/marginal/unsatisfactory) on the prelim form in the oral exam line.
3) Pass / Conditional Pass / Fail – After the oral examinations are completed, the committee will make its final decision on whether the student passes unconditionally, with conditions, or fails. The lead committee member will notify the student of the outcome.

In marginal cases, the preliminary examination committee may factor in a student's research and/or teaching abilities into its final decision.

YEARS 2-3 – Preparation for the Comprehensive Exam and Admission to Candidacy

<u>After completing the requisite course work</u> a doctoral student is eligible to apply for candidacy for the Ph.D. degree by submitting the form "Application for Admission to Candidacy for an Advanced Degree" to the Graduate School. Before admission into candidacy, the student must pass a comprehensive examination. An "Exam Request Form" must be submitted to the Graduate School at least two weeks in advance of the exam.

In the second and third years of the program, Ph.D. students who have successfully passed the Preliminary Exam work on advancing their specialized technical expertise and in collaboration with their advisor, and they begin the process of defining their specific doctoral research topic. By no later than their fifth or seventh semester, they must select a thesis committee of at least 5 members comprised of 3 ASEN faculty members and, 1 regular CU faculty member from another CU department, and pass the comprehensive examination. The members of this committee must be approved by the Graduate School. This committee will serve as the examining board for the Comprehensive Examination and Final Examination.

The Comprehensive Exam tests mastery of a broad field of knowledge, not merely formal course work. It will include a written and an oral element, which together test the student's depth of understanding of their technical area. The written element will consist of a research proposal (~15-20 pages) that demonstrates the student's capacity for scholarly work in their chosen topic, including a timeline for the proposed tasks. The oral exam will include a presentation by the student defending their written proposal and addressing questions from the thesis committee and other faculty who may attend. The oral presentation should be about 45 minutes and address the following questions:

1. Why is the proposed research of interest, how does it compare to prior work?
2. Is the proposed research challenging enough to be worthy of a Ph.D. dissertation?
3. Is the student qualified and knowledgeable enough to perform the proposed work?
4. Are the timeline and the scope of the proposed work reasonable?

The outcome of the Comprehensive Exam is determined by Graduate School procedures. Students who successfully pass this exam then are considered Ph.D. Candidates. A successful candidate must receive the affirmative votes of a majority of the members of the examining board. The student is automatically dismissed by the Graduate School after a second failure. Details on the Comprehensive Examination format can be found on the Graduate School web site.

Successful completion of the comprehensive examination is required before a student is admitted into Ph.D. candidacy. The following guidelines for the comprehensive examination are given:

1. A student shall have earned at least four semesters of residence, have a GPA of 3.25 for all graduate ASEN or CU coursework, and shall have passed the Comprehensive Examination before admission to candidacy is approved by the Graduate School. The Comprehensive Examination must be taken at least one semester before the Final Exam.

2. The Exam is conducted by a group of at least 5 graduate faculty members who comprise the thesis committee.

3. At least two weeks before the comprehensive exam, the candidate must complete the Candidacy Application for Advanced Degree form and the Doctoral Exam Report and submit those documents to the graduate advisor in the aerospace offices for approval by the Graduate School. On the day of, or the day before, the exam the candidate must pick up the approved Doctoral Exam Report from the graduate advisor and take it into the comprehensive exam.

4. At least one week before the Exam, the candidate must provide each member of the thesis committee with a written document consisting of a detailed written proposal for the thesis research.

5. The Examination typically requires a time period of about 2 hours. The candidate makes an oral presentation on the research proposal, typically of duration of about 40 minutes. The remainder of the Exam consists of questions directed to the candidate by the committee members. The questions typically pertain to the subject matter and content of the proposal, but may also be asked on topics outside this area, at the committee's discretion.

6. A successful candidate must receive the affirmative votes of a majority of the members of the examining board. In case of failure, the examination may be attempted once more after a period of time determined by the thesis committee. The student is automatically suspended after a second failure.

A successful written research proposal and examination convinces the thesis committee that the candidate has:

- a thorough understanding of the research literature in the chosen field
- articulated an original and significant research program
- familiarity with the tools and methods of the proposed research
- identified a project that is of the appropriate scope for a Ph.D. thesis
- a reasonable plan to complete the research in the time period allowed for the Ph.D. requirements.

Typically, a successful candidate will have conducted some preliminary research on the thesis topic prior to the examination, and these preliminary results should be included in the research proposal.

Exam forms can be obtained from the Graduate Advisor.

YEARS 3 and beyond – Dissertation Research, Professional Training, & Teaching

In the subsequent years of the program, the Ph.D. candidate will work with the faculty to conduct research which includes writing and presenting technical papers at conferences and in journals, reviewing technical papers, writing research proposals, and mentoring undergraduate, MS, or new doctoral students. They will also take advanced coursework and complete their teaching practicum. Both the advisor and student are responsible for ensuring that the work is adequately progressing. The student will meet with each of the members of their thesis committee at least once per semester to assess progress and to obtain feedback.

Ph.D. Dissertation

A dissertation based upon original investigation and showing mature scholarship and critical judgment, as well as familiarity with the tools and methods of the research, must be written upon a subject approved by the student's committee chair. Each dissertation presented in partial fulfillment of the doctoral degree must:

1. Comply in mechanical features with the University of Colorado Graduate School Thesis and Dissertation Specifications.

2. Be filed with the Graduate School by the posted deadline for the semester in which the degree is to be conferred.

Final Examination

After the dissertation has been accepted by the student's committee a final examination of the dissertation and related topics will be conducted. The following rules must be observed:

1. A student must be registered as a regular degree student on the Boulder Campus for a minimum of five, and no more than ten, dissertation hours the semester in which the final examination is scheduled.
2. The examination will be oral and open to anyone who wishes to attend
3. The examination will be conducted by the thesis committee
4. More than one dissenting vote will disqualify the candidate. In case of failure, the examination may be attempted only one more time. A second failure will result in automatic suspension by the Graduate School. Signatures from all committee members are required.
5. Arrangements for the final examination must be made in the Graduate School at least two weeks in advance of the scheduled date of the examination (this is arranged through the ASEN Graduate Advisor).

See the Graduate School Rules for additional information, http://www.colorado.edu/GraduateSchool/policies/_docs/GraduateSchoolRules.pdf

Focus Areas

The MS and Ph.D. programs in Aerospace Engineering Sciences are organized into four focus areas listed below. Graduate students are admitted into a specific focus area which provides research advising and financial support, and sets specialized admission and program requirements and recommendations for course work within and outside the department.

- Aerospace Engineering Systems (AESys)
- Astrodynamics and Satellite Navigation Systems (ASN)
- Bioastronautics (Bio)
- Remote Sensing, Earth and Space Science (RSESS)

Many of our faculty members have interests in two or more of these areas and, in fact, some students may end up doing research that spans multiple focus areas. The purpose of defining these areas is to allow for specialization of the academic program in a sustainable way, aligned with primary research interests of the faculty. Furthermore, by bringing students directly into one of these groups we seek to facilitate and strengthen their connection with a primary advisor and with other like-minded students in the department.

Each focus area will define the required characteristics of their successful graduates at the MS and Ph.D. level and will define a set of required and elective courses to be offered on a regular basis that support their educational program. Each focus area is encouraged to look for synergy with other areas and other departments to avoid duplication and to enhance multidisciplinary education.

Focus Area Curricula Charts

The following pages provide charts listing the courses offered by each of the focus areas and their area specific requirements for the MS and Ph.D. Courses shown in bold are MS Core courses. All others are considered MS or Ph.D. electives.

Aerospace Engineering Systems (AESys)

AESys Specific MS Requirements

- 2 Core Classes in one thrust area (Fluid Dynamics and Propulsion, Automatic Control, or Structures and Materials); 1 core course in a second thrust area within AESys.
- 2 electives from the student's core thrust area.

Note: for AESys focus area ONLY, MS requirement of outside core is waived; however, CAETE students in the structures thrust area must take an outside core course to fulfill the second thrust area requirement since no fluids or control courses are currently offered through CAETE.

AESys Specific Ph.D. Requirements

- Satisfaction of the AESys Specific MS Requirements.
- 2 of the AESys 6000 level electives in one thrust area (these may be the same courses used to satisfy the MS Requirements).

Thrust Area: Automatic Control
Core MS Courses in Thrust Area:

Course Number (current)	Title	Offering (F - Fall, S – Spring, A – annually, B – biennially)
ASEN 5114	Automatic Control Systems	F
ASEN 5014	Linear Systems Theory	F
ASEN 5010	Attitude Dynamics and Control (cannot count as outside core for ASN focus)	S

Elective Courses offered by Thrust Area:

Course Number (current)	Title	Offering (F - Fall, S – Spring, A – annually, B – biennially)
ASEN 5024	Nonlinear Systems	B, S
5148	Spacecraft Design	S, A
ASEN 6519	Cooperative Control of Multi-Vehicle Systems	B, S
ASEN 6xxx	System Identification for Control	B, S

Additional Elective Courses accepted by Thrust Area:

Course Number (current)	Title	Offering (F - Fall, S – Spring, A – annually, B – biennially)
ASEN 5070	Statistical Orbit Determination I	F, A
ASEN 6080	Statistical Orbit Determination II	S, A
ASEN 6XXX	Trajectory Optimization	B

Thrust Area: Fluids and Propulsion
Core MS Courses in Thrust Area:

Course Number (current)	Title	Offering (F - Fall, S – Spring, A – annually, B – biennially)
ASEN 5051	Intro to Fluid Mechanics	F
ASEN 5327 or 5519	Computational Fluid Dynamics-Structured Grid or Computational Fluid Dynamics-Unstructured Grid	S
ASEN 5151	High Speed Aerodynamics	S

Elective Courses offered by Thrust Area:

Course Number (current)	Title	Offering (F - Fall, S – Spring, A – annually, B – biennially)
ASEN 5427	Computational Gas Dynamics	B
ASEN 5053	Rocket Propulsion	F
ASEN 5063	Gas Turbine Propulsion	F
ASEN 6519	High Performance Computing	B
ASEN 6013	High Speed Propulsion	
ASEN 6xxx	Microfluidics	B
ASEN 6427	Advanced CFD	B
ASEN 6037	Turbulence	B,S
ASEN 6xxx	Molecular Gas Dynamics and Direct Monte Carlo Simulation	B
ASEN 6xxx	Multi-phase Flows	B
ASEN 6xxx	Reacting Flows	B
ASEN 6xxx	Wind Energy	S
ASEN 6xxx	Multi-Scale Multi-Physics Modeling	S
ASEN 6xxx	Experimental Fluid Mechanics	
ASEN 6021	Viscous Flow	B

Thrust Area: Structures and Materials
Core MS Courses in Thrust Area:

Course Number	Title	Offering (F - Fall, S – Spring, A – annually, B – biennially)
5012	Mechanics of Aerospace Structures	F, A
5022	Introduction to Dynamics of Aerospace Structures	S, A
5007	Introduction to Finite Elements	F, A

Elective Courses offered by Thrust Area:

Course Number (current)	Title	Offering (F - Fall, S – Spring, A – annually, B – biennially)
5111	Aeroelasticity	S, B
5148	Spacecraft Design	S, A
5519	Design Optimization in Aerospace Systems	S, B
5519	Vibrations in Mechanics and Physics	S, B
6107	Nonlinear Finite Elements	S, B
6337	Advanced Finite Elements for Plates & Shells	S, B
6519	Engineering Nonlinear Dynamics	S, B
6519	Uncertainty Quantification	S, B

Courses currently 5000-level which should automatically count as 6000-level courses until course number has officially changed:

Course Number Current	Course Number New
ASEN 5024	ASEN 6024
ASEN 5519	Cooperative Control of Multi-Vehicle Systems
ASEN 6xxx	System Identification for Control

Core Faculty:

Brian Argrow
Sedat Biringen
Alireza Doostan
Carlos Felippa
Eric Frew
Jean Koster
Dale Lawrence
Kurt Maute
K.C. Park
Ryan Starkey
Mahmoud Hussein
Ken Jansen

Astrodynamics and Satellite Navigation Systems (ASN)

ASN Specific MS Requirements
3 ASN Core Classes
Required MS Course outside focus area: ASEN 5051, ASEN 5327, ASEN 5151, ASEN 5114, ASEN 5014, ASEN 5012, ASEN 5022, ASEN 5007, ASEN 5016, ASEN 5148, ASEN 5158, ASEN 5307, ASEN 5337, ASEN 5168, ASEN 5245, ASEN 5215, ASEN 5335, ASEN 5235

Required MS Courses in Focus Area:

Course Number (current)	Title (faculty who teach)	Offering (F - Fall, S – Spring, A – annually, B – biennially)
ASEN 5010	Attitude Dynamics and Control (Schaub)	S, A
ASEN 5050	Space Flight Dynamics (Nerem)	F, A
ASEN 5090	Introduction to GNSS (Axelrad, Larson, Akos)	F, A
ASEN 5070	Statistical Orbit Determination (Born)	F, A

Elective Courses offered by Focus Area:

Course Number (current)	Title	Offering (F - Fall, S – Spring, A – annually, B – biennially)
ASEN 6070	Satellite Geodesy (Nerem)	F/B
ASEN 6080	Statistical Orbit Determination 2 (Born)	S/B
ASEN 6519	Astro Applications of Dynamical Systems Theory	F/B
ASEN 6008	Interplanetary Mission Design (Born)	?/B
ASEN 6020	Trajectory Optimization (Scheeres)	?/B
ASEN 6010	Advanced Spacecraft Dynamics and Control (Schaub)	F/B
ASEN 6014	Spacecraft Formation Flying (Schaub)	F/B

ASEN 6519	Advanced Celestial Mechanics (Scheeres)	F/B
ASEN 6090	Advanced GNSS Software (Larson)	S/B
ASEN 6519	Satellite Navigation Receiver Architecture (Akos)	S/B
ASEN 6519	ASN Seminar	FS/A

Core Faculty:

Dennis Akos
Penny Axelrad
George Born
Brandon Jones
Kristine Larson
Dale Lawrence
Jay McMahon
Steve Nerem
Scott Palo
Jeffrey Parker
Hanspeter Schaub
Dan Scheeres

Bioastronautics

Bio Specific MS Requirements
ASEN 5016 Space Life Sciences
ASEN 5158 Space Habitat Design
ASEN 5335 Aerospace Environment (RSESS)*
ASEN 5050 Space Flight Dynamics (ASN)*
ASEN 5053 Rocket Propulsion (VS)*
**any 2 of 3*

Bio Specific PhD Requirements
This specialized field of study addressing human spaceflight is typically augmented with coursework tailored to meet the student's specific career interests, and may include related topics in spacecraft engineering design, life sciences or other areas relevant to the needs of the research.

ASEN 5016 Space Life Sciences
ASEN 5158 Space Habitat Design

Required MS Courses in Focus Area:

Course Number (current)	Title	Offering (F - Fall, S – Spring, A – annually, B – biennially)
ASEN 5016	Space Life Sciences	S, A
ASEN 5158	Space Habitat Design	F, A

Required MS Courses outside Focus Area (*any 2 of 3*)**:**

Course Number (current)	Title	Offering (F - Fall, S – Spring, A – annually, B – biennially)
ASEN 5335	Aerospace Environment	S, A
ASEN 5050	Space Flight Dynamics	F, A
ASEN 5053	Rocket Propulsion	F

Elective Courses offered by Focus Area:

Course Number (current)	Title	Offering (F - Fall, S – Spring, A – annually, B – biennially)
ASEN 5849	MS Independent Study	on request
ASEN 6849	Independent Study (for PhD 'pre/non-thesis' topic)	on request
ASEN 5018 ASEN 6028	Human Spacecraft Design Project I Human Spacecraft Design Project II	S-A, F-A (two semester course)

Courses currently 5000-level which should automatically count as 6000-level courses until course number has officially changed*:*

Course Number Current	Course Number New
ASEN 5016	
ASEN 5158	

Core Faculty:

David Klaus
Virginia Ferguson (Mechanical Engineering)
Louis Stodieck
Joe Tanner
James Voss

Remote Sensing, Earth and Space Science (RSESS)

Remote Sensing, Earth and Space Sciences focus area is a field that embodies a broad multidisciplinary approach. The expected competency at the graduating masters level in the RSESS focus area is to have completed course work in four primary topics of study (1) Data or Numerical Analysis Methods, (2) Instrumentation Fundamentals, (3) Physical Sciences of Earth and Space and (4) Astrodynamics or Aerospace Engineering Systems.

The below requirements are applicable to both MS and PhD candidates in the RSESS focus area.

The expected competency at the PhD level is to further advance the four primary topics within RSESS by complementary theory and analysis obtained through course work offered at the 6000 level and above, and by research activities in developing the PhD thesis.

Required courses needed to specialize in the RSESS focus area are:

1. One course in data or numerical analysis
2. One course in instrumentation
3. One course in physical science
4. One course in astrodynamics or aerospace engineering systems
5. PhD students are strongly encouraged to enroll for the remote sensing seminar and present their research.

MS students interested in using the Remote Sensing Certificate for their degree requirements in lieu of an MS thesis or two semester graduate project are required to take an additional course from groups #1, 2 or 3 (above). The course taken to meet requirement #4 cannot be used to meet the additional course requirement.

Below is a list of core RSESS courses, offered regularly by the AES faculty, that satisfy the four primary topics. These are listed as core courses as their content satisfies a primary topic in our focus area. Students can design a course schedule with their graduate faculty advisor to insure their course selections satisfy the RSESS focus area. It is possible to petition courses outside of these core courses to fulfill the required course work as long as they meet the four topics of study outlined above and that the general guidelines of the AES graduate program are met.

RSESS Data or Numerical Analysis Courses (1):

Course Number (current)	Title	Offering (F - Fall, S – Spring, A – annually, B – biennially)
ASEN 5307	Engineering Data Analysis	S-A
ASEN 5337	Remote Sensing Data Analysis	F-A
APPM 5540	Introduction to Time Series	S-A
APPM 5580	Statistical Methods for Data Analysis	S-A
APPM 5520	Introduction to Mathematical Statistics	
APPM 5570/EMEN 5005	Statistical Methods	
APPM 5350	Methods in Applied Mathematics: Fourier Series and Boundary Value Problems	
ECEN 5612	Noise and Random Processes	F-A
ECEN 5632	Theory and Application of Digital Filtering	F-A
ECEN 5642	Modern Methods of Spectral Estimation	S-A
ECEN 5652	Detection and Extraction of Signals from Noise	S-A

RSESS Instrumentation Courses (2):

Course Number (current)	Title	Offering (F - Fall, S – Spring, A – annually, B – biennially)
ASEN 5168	Remote Sensing Instrumentation	S-A
ASEN 5245	Radar and Remote Sensing	S-A
ASEN 5519	Fundamentals of Spectroscopy for Optical Remote Sensing	F-A
ASEN 5519	Microcontroller Fundamentals with Aero Applications	F-A
ASEN 5090	Global Navigation Satellite Systems	F-A

RSESS Physical Sciences Courses (3):

Course Number (current)	Title	Offering (F - Fall, S – Spring, A – annually, B – biennially)
ASEN 5215	Oceanography	S-A
ASEN 5519	Ocean Modeling	F-B
ASEN 5335	Aerospace Environment	F-A
ATOC 5050	Introduction to Atmospheric Dynamics	F-A
ASEN 5235	Introduction to Atmospheric Radiation Transfer and Remote Sensing	S-A
ATOC 5060	Dynamics of the Atmosphere	S-A
ATOC 5051	Introduction to Physical Oceanography	F-A
ATOC 5050	Introduction to Atmospheric Dynamics	
ATOC 5060	Dynamics of the Atmosphere	
ATOC 5051	Introduction to Physical Oceanography	
ASTR 5140	Astrophysical and Space Plasmas (same as PHYS 5141)	
ASTR 5150	Introduction to Plasma Physics (same as PHYS 5150)	
ASTR 5300	Introduction to Magnetospheres	

RSESS ASN or AESys Courses (4):

Course Number (current)	Title	Offering (F - Fall, S – Spring, A – annually, B – biennially)
ASEN 5014	Linear Systems Theory	F-A
ASEN 5050	Space Flight Dynamics	F-A
ASEN 5051	Fluid Mechanics	F-A
ASEN 5061	Intro to Real Gas Dynamics	F-A
ASEN 5070	Statistical Orbit Determination 1	F-A
ASEN 5148	Spacecraft Design	S-A
ASEN 6060	Satellite Geodesy	S-B
ASEN 6080	Statistical Orbit Determination	S-B

RSESS 6000 level courses:

Course Number (current)	Title	Offering (F - Fall, S – Spring, A – annually, B – biennially)
ASEN 6519	Special Topics in Aerospace Environment: Upper Atmospheres	S-B
ASEN 6519	Lidar Remote Sensing	S-B

Other Courses of interest to RSESS students:

Course Number (current)	Title	Offering (F - Fall, S – Spring, A – annually, B – biennially)
ASEN 5227	Aerospace Math	F-A
ASEN 5327	Computational Fluid Mechanics	S-A
ASEN 5417	Numerical Methods for Differential Equations	S-A
ECEN 5134	Electromagnetic Radiation and Antennas	F-A
ECEN 5254	Radar Remote Sensing	S-B
PHYS 7310	Electromagnetic Theory I	F-A

Core Faculty:

Xinzhao Chu
Bill Emery
Jeff Forbes
Lakshmi Kantha
Zoltan Sternovsky
Scott Palo
Jeff Thayer
Kristine Larson
Xinlin Li
R. Steven Nerem

Certificates

The University of Colorado recognizes that interdisciplinary study at the graduate level may involve coursework and formal requirements that exceed those of established degree programs. To recognize this additional work by graduate students, interdisciplinary faculty may establish a certificate program within the Graduate School. In addition to earning a Certificate while pursuing a graduate degree, the Graduate School has extended the Certificate program to students who have received a B.A. or B.S. degree and are continuing to take courses but are not enrolled in a graduate degree program and meet the course prerequisites.

Students in the Department of Aerospace Engineering Sciences may want to consider obtaining a Certificate in Remote Sensing, or a Certificate in Astrodynamics and Satellite Navigation Systems.

Certificate in Remote Sensing

Remote sensing (satellite and ground-based) is increasingly being used as a technique to probe the Earth's atmosphere, ocean and land surfaces. Probing of other planets is accomplished largely by satellite remote sensing. Given national priorities in such areas as climate and global change, the interest in remote sensing will only increase with time.

Remote sensing is a relatively new academic subject, with few universities having any sort of an organized curriculum. The purpose of formalizing the CU remote sensing curriculum is to coordinate curricula across campus so that a coherent curriculum in remote sensing can be provided to complement and supplement the students' regular degree program. An additional purpose is to encourage multi-disciplinary education of the students in the area of remote sensing.

Graduate students, research staff, and faculty work on a wide variety of topics, ranging from the theory of remote sensing, to its application. These applications include: use of satellite remote sensing to determine ocean surface temperature and heat fluxes; use of surface radar to improve the determination of clouds and precipitation from satellite; determination of surface biological characteristics and productivity from satellite; mapping of land use from satellite; mapping of surface landform and topographical features; searching for locations of buried artifacts; use of surface radar to determine upper atmosphere wind motions; and aircraft remote sensing to assess the validity of satellite retrieval algorithms of surface and atmospheric characteristics.

A Certificate in Remote Sensing will be awarded based on a written request by the student to the Remote Sensing Graduate Chairman, provided that the following requirements have been met:

All students must take at least three Remote Sensing courses ***from the list below*** (passed with grade B or better) and complete at least one semester of the Remote Sensing Seminar, ATOC 7500 or ASEN 5210. This class is offered once each year. Most remote sensing courses are offered once each year.

The Remote Sensing graduate courses are:

ATOC 7500/ASEN 5210: Remote Sensing Seminar (*required)

ASEN/ATOC 5235: Radiative Transfer of the Earth's Atmosphere

ASEN 5337: Remote Sensing Data Analysis

ASEN 5168: Remote Sensing Instrumentation

ASEN 5245/ECEN 5254: Radar and Remote Sensing

ECEN 5274: Radar Science and Techniques

GEOL/GEOG 5093: Remote Sensing of the Environment

GEOL5440/GEOG 6443-2: Remote Sensing Field Methods

GEOL 6340: Remote Sensing of Planetary Surfaces

Letters to the Remote Sensing Graduate Committee should be sent to:

University of Colorado
Aerospace Engineering Sciences
Graduate Advisor/RSS certificate committee
429 UCB
Boulder, Colorado 80309-0429
aerograd@colorado.edu

*Upon completion of your courses, email aerograd@colorado.edu and ask for the certificate request form.

Certificate in Astrodynamics and Satellite Navigation Systems (ASN)

The certificate recognizes student accomplishments at the graduate level in successfully completing a specialized program of study in Astrodynamics and Satellite Navigation (ASN). It is essentially a specialization of the Aerospace Engineering Sciences Master of Science (MS) degree in the ASN focus area with additional requirements for breadth and depth in the ASN area.

The certificate will make students more desirable to future employers looking for the astrodynamics and satellite navigation specialists.

1.Certificate Requirements

Complete all four core area subjects in ASN, plus two advanced ASN courses of the student's choosing.

Core Requirements:
ASEN 5010 - Spacecraft Attitude Dynamics and Control

ASEN 5050 - Astrodynamics (This requirement can be satisfied by taking an additional 6000 level course which has ASEN 5050 as a pre-requisite.)

ASEN 5070 - Statistical Orbit Determination

ASEN 5090 - Introduction to Global Navigation Satellite Systems

Advanced Requirements - Select ANY two 6000 level courses in ASN including (but not limited to):
ASEN 6090 GNSS Software and Applications (course number assignment pending)

ASEN 6091 Satellite Navigation Receiver and Architectures (course number assignment pending)

ASEN 6080 Advanced Statistical Orbit Determination

ASEN 6519 Advanced Spacecraft Attitude and Control

ASEN 6519 Spacecraft Formation Flying

ASEN 6519 Optimal Trajectories

ASEN 6519 Advanced Astrodynamics and Celestial Mechanics

2. Admission Requirements

Requirements for a Graduate Certificate in Astrodynamics and Satellite Navigation Systems:

- Approval of your ASN course selections.
- Completion, with a grade of B or better, of all required courses.
- Upon completion of your courses, email aerograd@colorado.edu and ask for the certificate request form.

Contact Persons

Annie Brookover (first point of contact)
Graduate Advisor
429 UCB
University of Colorado
Boulder, CO 80309-0429
ann.brookover@colorado.edu

Professor Daniel Scheeres
Associate Chair for Graduate Studies
429 UCB
University of Colorado
Boulder, CO 80309-0429
daniel.scheeres@colorado.edu

Professor Penina Axelrad
Chair, Aerospace Engineering Sciences
429 UCB
University of Colorado
Boulder, CO 80309-0429
penina.axelrad@colorado.edu

Expectations for Students Working on Appointment

Student Expectations: When you are supported as a Research, Teaching or General Assistant (RA/TA/GA), there are certain expectations the department has and certain requirements that you must meet.

We expect you to want to learn. We expect to see enthusiasm, energy, and 100% effort. Mediocrity will not be tolerated in the environment in which you will be eventually employed and will not be tolerated here. Writing should be clean and neat. Notes should be well-organized. Assignments should be completed on time and presented as a neat well-finished package. A lab book of activities and results should be well maintained. Attention now will pay dividends later.

All engineers and scientists of quality spend more than 40 hours per week engaging in scholarly activities. As a graduate student your scholarly activities are defined as working in the laboratory, learning through discussions, going to seminars, taking courses, working at your desk, reading literature in the library, writing publications and theses, and participating in university activities. Your professor is engaged in all these activities and additionally in similar activities outside the university as research, advising, and committee work demand. Students should also strive to meet this "culture of excellence." Don't solely rely on your professors to tell you what you should be doing. Be proactive with your research and work and look for research areas to explore and expand.

Your presence at your desk, in the laboratory, and at seminars and meetings is a direct measure of your involvement in engineering and science. It is a privilege to be here. Make sure that you deserve the privilege.

Your attendance at department seminars, colloquia, and other presentations is an important part of your training as an engineer and scientist. This is an essential activity of all our scholars and we expect you to attend and participate in functions, especially those related to your area of research interest. You are also encouraged to present your research at seminars as opportunities arise.

We expect a cordial atmosphere at all times and places. Respect and be courteous to other students, staff, and faculty. Maintain a quiet work atmosphere; excessive noise distracts others. Assist your advisor and fellow graduate students. This is an important part of your training for the future. You will often be working in a group environment, so be a responsible team member. When you are required to share equipment with others, transfer data/codes/etc., do so in a professional manner. We expect that students follow the highest standards of ethics in their research and publications. Plagiarism, data manipulations, etc. are examples of unethical behavior and are not tolerated. Your adviser can help you and/or refer you to the proper channels if the ethical line is not clear.

Faculty expectations: Likewise, there are things that you should expect of your professors. It is the professor's responsibility to clarify the ground rules regarding time off, work hours, publication authorship, funding, etc. early on; it is your responsibility to make sure he/she does so. Your professors will guide you in your research, teaching, and professional development, and assist you with post-graduation job placement. They will provide you with opportunities for industry or laboratory internships and encourage your attendance at professional conferences. Your professor will provide you with an annual evaluation of your progress in meeting your degree requirements and in your research, and if you have a RA appointment, financial support is guaranteed so long as you make reasonable progress and there are available funds.

Disagreements between a student and faculty member: If after discussions with your advisor an irreconcilable disagreement occurs, consult the Associate Chair for Graduate Affairs.

Appointment percentage: The majority of department RA/TA/GAs have a 50% AY appointment (20 hrs/wk). Some may have summer appointments (40 hrs/wk) but this is determined by the supervisor. A RA/TA/GA can hold no less than a 15% appointment to receive tuition remission. Any appointment in addition to a 50% appointment needs approval by the Graduate School.

Tuition: Tuition remission covers tuition and $1,100 of the Gold Comprehensive Insurance Plan provided that you work at least 12 weeks of the semester. It is your responsibility to pay the remainder of the insurance and all mandatory fees. Some fellowships do allow for the payment of fees but department appointments do not.

Leave Time: The appointment follows the University holiday schedule and not the class schedule. http://hr.colorado.edu/Pages/Holiday_Schedule.aspx Please note that these dates do not follow the same dates as the academic year.

Fall - September 1 through December 31
Spring - January 1 through May 31
Summer - June 1 through August 31

For example, the University is closed on the Friday of spring break, not for the entire spring break week, so unless you make arrangements with your advisor you are expected to work during the week of spring break even though there are no classes this week.

Students on appointment do not accumulate sick or vacation time through their appointment. There is not a policy within the department as to what happens if a student wants to take sick or vacation days; this policy is set directly by your supervisor.

It is up to you to discuss taking time off with your supervisor *before* making travel arrangements or arranging for time off. If you will be away from your position for an extended period of time, your supervisor does have the option to put the position on a short work break, without pay. This doesn't happen often, but it is an option.

Appendix A – Worksheets/Forms

AES PhD Student Teaching Practicum Worksheet

Name: Advisor:

Current Date: Matriculation Date: Expected Graduation Date:

PhD Preliminary Exam Date: PhD Comprehensive Exam Date:

Teaching Activities:

AY & Semester	Type of Activity Circle one	Course Name & # or Project Title	Faculty Supervisor	Primary Responsibilities	Status
	Instructor of Record/GPTI Teaching Fellow/Team Teach Teaching /Course Assistant Research Mentor Seminar Coordinator (1yr) Other:_____				Planned Current Completed
	Instructor of Record/GPTI Team-Teaching Teaching/Course Assistant Research Mentor Seminar Coordinator (1yr) Other:_____				Planned Current Completed

Faculty Advisor Signature: _____

Date:_____

MS degree planning form – AESys Focus

_____
Advisor Approval

<u>Coursework</u>:

Focus area: (Aerospace Engineering Systems)

- Primary technical thrust:(Fluid Dynamics, Automatic Control, Structures & Materials)
- Second technical thrust **core**: _____
  (outside core for CAETE structures students – i.e. core in ASN, Bio, RSESS focus areas)

- 30 or more semester hours total (courses, seminars, thesis)
  - 24 must be 5000 or above
  - 18 credits of ASEN
  - up to 6 credits can be 4000 level in ECEN, CVEN, MCEN, CHEN, CSCI,ATOC, ASTR, PHYS, MCDB, APPM, MATH, CHEM, IPHY, GEOL, ENVD

- 6-12 semester hours as defined by the student's focus area must be taken in the student's primary focus area and one required course (3 semester hours) must be taken in a second focus area.
  - AESys focus requirement: 2 Core classes in primary thrust of focus area

_____ _____
(AESys Thrust1) **(AESys Thrust1)**

  - AESys focus area requirement: 1 Core class in second thrust:

_____
(**AESys Thrust2**)

- 6 elective credits in primary thrust _____ _____

- 3 semester hours of approved math coursework _____
(Math)

Circle One:

1. MS Thesis, or
2. Graduate Projects (can be inside or outside the focus area), or
3. An approved certificate program

Thesis:

- Represent the equivalent of 6 semester hours of course work.
- Comply in mechanical features with the University of Colorado Graduate School Thesis and Dissertation Specifications.
- Be filed with the Graduate School by posted deadlines for the semester for which the degree is to be conferred.

Courses of interest that Satisfy Math Requirement

_____

_____

Electives (balance of courses up to 30 required total MS hours):

_____

_____

_____

_____

Potential Courses of Interest/Semester Offered:

_____ / _____

_____ / _____

_____ / _____

_____ / _____

_____ / _____

MS degree planning form – ASN Focus

_____
Advisor Approval

Coursework:
Focus area: (Astrodynamics and Satellite Navigation)

- Three focus area core
- Outside focus area **core**: _____

Required MS Course outside focus area: ASEN 5051, ASEN 5327, ASEN 5151, ASEN 5114, ASEN 5014, ASEN 5012, ASEN 5022, ASEN 5007, ASEN 5016, ASEN 5148, ASEN 5158, ASEN 5307, ASEN 5337, ASEN 5168, ASEN 5245, ASEN 5215, ASEN 5335, ASEN 5235

- 30 or more semester hours total (courses, seminars, thesis)
  - 24 must be 5000 or above
  - 18 credits of ASEN
  - up to 6 credits can be 4000 level in ECEN, CVEN, MCEN, CHEN, CSCI,ATOC, ASTR, PHYS, MCDB, APPM, MATH, CHEM, IPHY, GEOL, ENVD

- 6-12 semester hours as defined by the student's focus area must be taken in the student's primary focus area and one required course (3 semester hours) must be taken in a second focus area.
  - ASN focus area requirement: 3 Core Classes

_____ _____ _____
(ASN Core1) **(ASN Core 2)** **(ASN Core 3)**

- Outside Core: _____ **(Outside core)**

  - 3 semester hours of approved math coursework _____ (Math)

Circle One:

1. MS Thesis, or
2. Graduate Projects (can be inside or outside the focus area), or
3. An approved certificate program

Thesis:

- Represent the equivalent of 6 semester hours of course work.
- Comply in mechanical features with the University of Colorado Graduate School Thesis and Dissertation Specifications.
- Be filed with the Graduate School by posted deadlines for the semester for which the degree is to be conferred.

Courses of interest that Satisfy Math Requirement

_____

_____

Electives (balance of courses up to 30 required total MS hours):

_____

_____

_____

_____

Potential Courses of Interest/Semester Offered:

_____ / _____

_____ / _____

_____ / _____

_____ / _____

_____ / _____

_____ / _____

MS degree planning form – Bio Focus

_____
Advisor Approval

Coursework:

Focus area: (Bioastronautics)

- two focus area core courses
- two of three specified second focus area **core**: ASEN 5335 (RSESS), ASEN 5050 (ASN) or ASEN 5053 (AESys) are required; however, students with non-aerospace BS degrees are encouraged to take all three

- 30 or more semester hours total (courses, seminars, thesis)
  - 24 must be 5000 or above
  - 18 credits of ASEN
  - up to 6 credits can be 4000 level in ECEN, CVEN, MCEN, CHEN, CSCI,ATOC, ASTR, PHYS, MCDB, APPM, MATH, CHEM, IPHY, GEOL, ENVD

- 6 semester hours must be taken in the Bio focus area and two required courses (6 semester hours) must be taken in a second focus area as defined above.
  - Bio focus area requirement: 2 Core Classes

_____ _____
(Bio Core1) **(Bio Core 2)**

  - Two of 3 required outside Core: _____ _____
(**Outside Core1**) (**Outside Core 2**)

- 3 semester hours of approved math coursework.

_____
(Math)

Circle One:

1. MS Thesis, or
2. Graduate Projects (can be inside or outside the focus area), or
3. An approved certificate program

Thesis:

- Represent the equivalent of 6 semester hours of course work.
- Comply in mechanical features with the University of Colorado Graduate School Thesis and Dissertation Specifications.
- Be filed with the Graduate School by posted deadlines for the semester for which the degree is to be conferred.

Courses of interest that Satisfy Math Requirement

_____

_____

Electives (balance of courses up to 30 required total MS hours):

_____

_____

_____

_____

Potential Courses of Interest/Semester Offered:

_____ / _____

_____ / _____

_____ / _____

_____ / _____

_____ / _____

_____ / _____

MS degree planning form – Remote Sensing Focus

_____
Advisor Approval

<u>Coursework</u>:
Focus area: (Remote Sensing)

- four focus area core, one in each primary topic area
- second focus area **core (may also count as primary topic core)**

- 30 or more semester hours total (courses, seminars, thesis)
  - 24 must be 5000 or above
  - 18 credits of ASEN
  - up to 6 credits can be 4000 level in ECEN, CVEN, MCEN, CHEN, CSCI,ATOC, ASTR, PHYS, MCDB, APPM, MATH, CHEM, IPHY, GEOL, ENVD

- 6-12 semester hours as defined by the student's focus area must be taken in the student's primary focus area and one required course (3 semester hours) must be taken in a second focus area.
  - RSESS focus area requirement: 4 Core Classes, 1 in each primary topic area.

_____ _____ _____ _____
(RSESS Topic 1) (RSESS Topic 2) (RSESS Topic 3) (RSESS Topic 4)

- Outside Core (may also fulfill a topic req't): _____ **(outside core)**
- Remote Sensing Seminar: _____ **(seminar)**

- 3 semester hours of approved math coursework _____ **(Math)**

Circle One:

1. MS Thesis, or
2. Graduate Projects (can be inside or outside the focus area), or
3. An approved certificate program

Thesis:

- Represent the equivalent of 6 semester hours of course work.
- Comply in mechanical features with the University of Colorado Graduate School Thesis and Dissertation Specifications.
- Be filed with the Graduate School by posted deadlines for the semester for which the degree is to be conferred.

Courses of interest that Satisfy Math Requirement

_____

_____

Electives (balance of courses up to 30 required total MS hours):

_____

_____

_____

_____

Potential Courses of Interest/Semester Offered:

_____ / _____

_____ / _____

_____ / _____

_____ / _____

_____ / _____

_____ / _____

PhD degree planning worksheet: All focus Areas

_____
Advisor Approval

Coursework/dissertation requirements:

- 36 or more semester hours course credit (5000 or above)
  - 12 above 6000 (9 credits for RSESS focus)
  - 18 must be in ASEN
  - 6 credits of math from approved list

- 30 hours dissertation credit
- Teaching Practicum
- Prelim exam (by third or fifth semester) _____
- Comps (after course work completed by fifth or seventh semester/before semester of final defense) _____
- Written Dissertation
- Defense/Final Examination
  - Up to 10 PhD dissertation credits pre-comprehensive exam
  - Up to 10 PhD dissertation credits in semester in which comprehensive exam is passed
  - Remaining PhD dissertation credits post-comprehensive exam, but students must register *for a minimum of 5 PhD dissertation credits* in each semester following the comprehensive exam through the semester in which final dissertation is successfully defended.

Courses:

18 credits of **ASEN** coursework (not other department coursework)

_____	_____	_____	_____
(**ASEN 1**)	(**ASEN 2**)	(**ASEN 3**)	(**ASEN 4**)

_____	_____
(**ASEN 5**)	(**ASEN 6**)

- 12 credits of 6000 level or above (9 credits for RSESS focus).

_____	_____	_____	_____
(6000 level 1)	**(6000 level 2)**	**(6000 level 3)**	**(6000 level 4)**

- 6 semester hours of approved math coursework

_____	_____
(Math)	(Math)

Courses of interest that Satisfy Math Requirement

_____

_____

Potential Courses of Interest/Semester Offered:

_____ / _____

_____ / _____

_____ / _____

_____ / _____

_____ / _____

_____ / _____

_____ / _____

Petition to the Associate Chair for Graduate Studies

Name: _____

Email:_____

Advisor: _____

Degree Seeking: MS or PhD (circle one)

Students who wish to waive a curriculum requirement or substitute a course should write a letter of petition addressed to the Associate Chair for Graduate Studies and **attach it to this form**. Your letter should contain the reason(s) for your petition, i.e. what action you are requesting the Associate Chair take, and include detailed information about why the request should be approved. Supplementary materials such as course descriptions or syllabi may also be included.

Is this your first petition? Yes _____ No _____

If this is not your first petition, how many petitions have you filed? _____

Briefly describe your previous petitions and whether they were approved or declined.

_____

_____

_____

_____

_____

Your Signature: _____ Date: _____

Advisor's Signature: _____ Date: _____

Focus Lead's Signature: _____ Date: _____
(2013-2014: Bio, Klaus; RSESS, Chu; AESys, Felippa; ASN, Larson)

Associate Chair's Signature _____ Date: _____

DECISION

Approved _____ Declined _____ Date _____ Initials _____