

GUIDE FOR BUILDING SYSTEMS PROGRAM GRADUATE STUDENTS

Academic Year 2008-2009

Welcome to the Building Systems Program! This document contains an outline of things you need to know about the program. It is by no means exhaustive, but should get you started.

1. ARRIVING

1.1 Meet the Faculty

The first thing that you need to do upon arriving at the University is to meet the faculty members you will be working with. Drop by their office (or call and make an appointment) and get acquainted. You can find out about the courses they teach, their research interests, and their role in the program; they can find out about your background and your interests.

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You will be assigned a temporary advisor. Meet with your advisor and work out a course of study; this is an outline of all the courses that you plan to take for your degree. Options are discussed in the next section. Your course of study is not set in concrete; you will meet with your advisor before each semester starts to review your course of study and revise it as necessary.

Feel free to discuss your proposed course plan with any of the faculty; however, your plan must be formally approved by your advisor. He/she is the only person who can remove your registration lock from the SIS system (i.e., the computer system used for registering for your courses).

Eventually you will select a faculty member to act as the research supervisor for your report, thesis or dissertation. Your research supervisor need not necessarily be the same individual as your advisor; choice of a research supervisor is made later. At this later time, you and your research advisor will also select a graduate committee for your degree examination.

1.2 Do Right Away

If you are a US citizen or permanent resident and have come from out of state, you should, as soon as possible, take steps to establish Colorado residency. This includes getting a Colorado driver's license, registering your car in Colorado and registering to vote in Colorado. Establishing residency qualifies you for much lower in-state tuition after 12 months.

There are many computer resources on campus and in the department and you should immediately sign-up for computing accounts. In general, it is important to sign-up for two separate accounts: campus and department. You can easily get a campus account through the PLUS system, available through the campus web site <http://www.colorado.edu/>. The CEAE Department also manages some of its own computer resources through the Bechtel Lab in the Civil Engineering wing. The Lab is especially used for upper division and graduate coursework and you should obtain a separate account by consulting the posted instructions in the Bechtel Lab. It is also valuable to establish an account in the Integrated Teaching and Learning Laboratory (ITLL), which is across the enclosed bridge at the end of the Civil Engineering wing. Account arrangements can be made through the ITLL main office.

We have established a listserver for BSP colleagues. It is very important that you subscribe to this BSP email list by sending email to listproc@lists.colorado.edu with the following line in the message body (where Your Name is your real name)

subscribe ceae-bsp Your Name

2. PROGRAM OF STUDY

Your overall course of study must be discussed with and approved by your advisor before each semester starts. This will avoid any surprises occurring when you try to graduate. Your course of study may be wide or narrow; it will depend on your personal career plans. People who are thinking of a future in research work may take a different approach than those who see themselves working in industry or for a consulting engineering firm. However your advisor will ensure that you do end up with

a good grounding in all aspects of building systems. Your program of study may be modified at any time (in consultation with your advisor). However, you should always have an overall plan.

Some students, especially those from non-engineering backgrounds, may need to make up undergraduate-level deficiencies. In some cases you will need to take courses for which you will not receive credit for your graduate degree. The makeup courses that you need to take will be determined in discussion with your advisor. As a guide, however, you should have in your background undergraduate-level courses in Calculus, Physics, Thermodynamics, and Fluids and Heat Transfer. The courses AREN 2110 Thermodynamics, and AREN 2120 Fluids and Heat Transfer are pre-requisite courses for several BSP courses. Other courses may be taken as make-up courses. (Up to two courses at the 3000 level and above can be taken for graduate credit by doing extra work and by enrolling in them as independent studies. However, this can only be done with the agreement of the course instructor). Note that you are allowed a maximum of six hours of "independent study" in your degree.

For students with no background in Illumination, circuits, or mechanical systems, CVEN5830: Building Engineering Systems is a required course and should be taken in the first semester.

There are also courses in other departments that may be of value. You should also be (or become) competent in computer programming, word processing and spreadsheet usage to solve engineering problems. There are other undergraduate-level courses offered in some of the Building Systems areas that may be useful for you to take prior to, or instead of, the graduate-level courses.

If you wish to gain registration as a Professional Engineer but do not have a B.S. in engineering from an ABET-accredited engineering program, there are several factors you need to know about. The Colorado Board of Registration can provide you the current rules.

3. BUILDING SYSTEMS PROGRAMS AREAS

For students entering the Building Systems Program without any fundamental understanding of illumination, electrical circuits, or mechanical systems, CVEN 5830: Building Engineering Systems is a required course.

Courses offered in the Building Systems Program may be separated into four main areas. Students may decide to concentrate in one of these areas, or they may wish to take a broad selection from the courses; there is no requirement for picking a specific main area. However, Students are required to take at least one course in each of the four areas:

- *Energy Analysis*
- *HVAC Systems*
- *Illumination*
- *Solar and Renewable Energies*

The associated courses, and the semesters in which they are usually offered, are:

Energy Analysis

- CVEN 5020 Building Energy Measurements and Audits (Fall)
- CVEN 5070 Thermal Analysis of Buildings (Spring)
- CVEN 5080 Computer Simulation of Building Energy Systems (Fall/Summer)

HVAC Systems

- AREN 4110/CVEN 5110 HVAC System Design (Spring)
- AREN 4570 Building Electrical Systems Design (Spring)
- CVEN 5010 HVAC Control Systems (Spring)

Illumination

- AREN 4550 Illumination II (Spring)
- CVEN 5830 Color Theory and Light Sources (Fall)
- CVEN 5830 Daylighting (Spring)

Renewable and Sustainable Energies

- CVEN 5050 Advanced Solar Design (Fall)
- CVEN 5830 Sustainable Building Design (Spring)
- CVEN 5830 CFD Analysis of Buildings and Environment (Spring)

Note that many of these courses are not offered every year. In fact, depending on faculty availability, these courses could even be offered in the opposite semester. The college policy for teaching by research-active faculty is three courses per year. For many faculty members who are required to offer undergraduate courses each year, the main implication of this policy is that graduate courses will be offered with less regularity. However, since most students take two years to complete their studies, all courses should be available to you with good planning.

3.1 Masters Degree

For a Masters degree, the student may undertake "Plan I" with a thesis or "Plan II" based on course work. Plan I requires 24 hours of course work plus a 6 credit-hour thesis. The thesis generally discusses an organized research topic. Experience has shown that it takes a student from 18 to 24 months to complete this plan. Financial support is generally limited to exceptionally well-qualified students selecting Plan I.

Plan II requires 30 hours of course work. The 30 hours may be all formal course work (Plan II B), or may include (for Plan II A) the 3-hour course entitled Master's Project (or "Report"). Note that: one half of the course work must be taken in the Civil, Environmental and Architectural Engineering Department. (An exception may be made if the relevant courses were taken as part of an undergraduate degree). Departmental approval is required to select this plan. The Plan II can be successfully completed in 12 - 18 months by a diligent student. Non-CEAE courses at the 4000 level may be used for graduate credit up to a maximum of 6 hours, with the approval of the advisor.

Up to 6 hours of "independent study" may be taken where an individual course of study is worked out between the student and a faculty member. Up to 9 hours of graduate courses can be transferred from another institution.

3.2 Doctoral Degree

For a Ph.D., you need at least 30 hours of graduate-level course work plus a dissertation. For an entrant from another university, up to 15 hours of acceptable graduate courses may be transferred leaving at least 15 hours of course work to be done at the University of Colorado. For students already in the Master's program in the CEAE department, 21 hours of graduate course work performed at CU is applicable towards the Ph.D. degree. The Ph.D. also requires that 30 hours of dissertation credit be taken with a minimum residency of 2 years.

After passing the Comprehensive Exam, described below, Ph.D. candidates are required to maintain continuous registration. Candidates must register for at least 5 hours of dissertation credit each semester.

4. SIGNIFICANT EVENTS

Significant events along the way are:

- (1) For a Masters degree, you will take a Final Exam, taken at the end of your studies and report or thesis writing. If you choose the thesis or report option, your final examination is generally your oral thesis or report defense.

For Plan II A, the students are required to submit to all members of their committee at least one week before the final examination date, a project report and a technical paper suitable for publication in peer-reviewed conference proceedings.

For Plan I, the students are required to submit to all members of their committee at least one week before the final examination date, a thesis report formatted according to the University of Colorado Graduate School specifications and a technical paper suitable for publication in refereed journals.

- (2) For a Ph.D. you will have a Preliminary Exam, taken in the first year of your studies. This exam is given in order to test your background knowledge and diagnose areas for further study. You will also have a Comprehensive Exam, taken after course work is completed and at the beginning of research work on the dissertation. Candidacy requires passing the comprehensive exam. Your final examination is the defense of your dissertation.

PhD students are required to submit to all members of their committee at least two weeks before the final examination date, a dissertation report formatted according to the University of Colorado Graduate School specifications. They are also required to have at least one technical paper be submitted and accepted for publication in refereed journals

4.1 Master's degree Final Exam

The Final Exam is taken after course work and report or thesis are completed. The exam is an oral exam of at least two hours duration if you have chosen the thesis or report option. It is your responsibility to arrange the schedule for the exam and to complete the Departmental and Graduate School forms associated with it. The first part of the exam is open to the public, and starts with a 40-50 minute presentation of the work undertaken for the report or thesis. The remainder of the first part is taken up with discussion of this work including questions from the committee and general public.

The meeting is then closed to the public, and for the remainder of the time the committee examines the candidate on any appropriate engineering topic. This examination will be based on, but not limited to, the graduate course work.

The thesis or report is prepared in consultation with the student's research supervisor. The candidate is expected to supply to the committee members, at least one week before the exam, a complete copy of the final draft of the report or thesis and a list of the courses taken for graduate studies. Incomplete or late drafts will probably result in cancellation of the exam.

If you have selected the course-only option for your MS degree, your final examination is written and must be arranged with your advisor who will assemble the exam from questions submitted by BSP and other faculty members.

4.2. *Ph.D. Preliminary Exam*

This exam will be scheduled in the first year following admission to the Ph.D. program. The exam is designed to test the candidate's background knowledge. It is also partly a diagnostic exam to identify areas of weakness. It will be a day-long written exam in which the candidate may be questioned on any engineering topic. A student who fails the Preliminary Exam is suspended from the program.

4.3. *Ph.D. Comprehensive Exam*

The Comprehensive Exam is taken by a Ph.D. candidate after course work is completed and at the beginning of dissertation work. It is a two-part exam. The first part is a written exam and the second part is an oral exam. The written exam is a week-long take-home exam on all areas of the BSP program. If the student does not pass the exam, all or part of the exam may be retaken once.

After the written exam is successfully completed, the oral exam may be scheduled. The oral exam has two parts and usually lasts 2 hours. It is your responsibility to arrange the schedule for the exam and to complete the Departmental and Graduate School forms associated with it. During the first part of this exam, the candidate may be questioned on any engineering topic. The comprehensive exam will be based on, but not limited to, the graduate course work done by the candidate. During the second part of the oral exam, the candidate presents a proposal for the Ph.D. dissertation research. The proposal typically includes a statement of the problem and research objectives, a review of the literature, and a description of preliminary work and results. A written proposal should be provided to each committee member at least one week prior to the oral exam. The committee may approve the proposal at the time of the presentation or ask that the proposal be developed more fully.

4.4 *Ph.D. Final Exam*

As for the MS degree, the Ph.D. Final Exam is taken after the dissertation has been completed. The exam is an oral exam of at least two hours duration. It is your responsibility to arrange the schedule for the exam and to complete the Departmental and Graduate School forms associated with it. The first part of the exam is open to the public, and starts with a 40-50 minute presentation of the work undertaken for the dissertation. The remainder of the first part is taken up with discussion of this work including questions from the committee and general public. The meeting is then closed to the public, and for the remainder of the time the committee examines the candidate on any appropriate engineering topic.

4.5. *Fundamental Expectations of BSP Graduates*

Upon graduation, you will hold an advanced degree in engineering and the work will have fundamental expectations about your knowledge. During the Master's Degree Final Examination or the Ph.D.

Comprehensive Examination you should be able to correctly answer fundamental questions on the following topics:

Thermodynamics - first and second laws, open and closed systems
thermodynamic properties
thermodynamic cycles, Carnot efficiency

Heat Transfer - conduction, steady and unsteady
convection, forced and natural
radiation, spectral phenomena, basic laws of

Buildings - thermal analysis
HVAC system basics including controls
electrical system basics
heating and cooling loads
basic system concepts
energy conservation

Illumination - fundamental concepts
basic calculation methods

Solar Energy - solar geometry
solar flux calculations
solar systems - PV and thermal

Economics - time value of money
discounted cash flow basics

Mathematics - integral and differential calculus
ordinary differential equations
basic numerical methods
experimental accuracy analysis and statistics

NOTICE: *Regulations of the Graduate School or of the CEAE Department supersede any of the above if there should be a conflict.*