THE UNIVERSITY OF ARIZONA
COLLEGE OF AGRICULTURE & LIFE SCIENCES
COLLEGE OF ENGINEERING
Biosystems Engineering

# BIOSYSTEMS ENGINEERING

# Graduate Program Manual

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May 2018

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## BIOSYSTEMS ENGINEERINGMISSION, PURPOSE, VISION, VALUES

# Mission

Our mission is to improve the quality of life in the Southwest through excellence in instruction, research, and extension programs. To achieve this, BE will provide technologies and information systems for safe and secure food, water, energy, and biological products to adapt to a changing world.

# Purpose

BE develops and facilitates the use of innovative technologies for generation of food, bioenergy, and bioproducts, with smart utilization of water, resources, and information, suitable for arid and semi-arid environments. Our faculty, staff, and students work across interfaces between science and engineering.

# Vision

BE will be a world leader known for developing technologies and systems for the safe production of food, bioenergy, bioproducts, and biological information for sustainable use of arid and semi-arid environments. Students, constituents, and professionals will come from across the world to participate in our programs.

# Shared Values

*Excellence*
Faculty, staff, and students will have academic freedom and our research and educational programs will be of the highest quality.

*Openness*
We will communicate openly and treat people fairly because we value the opinions and respect the needs of all.

*Ethics*
High ethical standards and sound decision-making will be at the heart of our business and financial practices.

*Diversity*
Diverse people, ideas, backgrounds, and perspectives produce lasting solutions. We will make it our duty to encourage and help all to be successful.

*Cooperation*
We will forge partnerships on and off campus in our drive to solve society's complex problems and improve the quality of life.

## 1.0 INTRODUCTION

The purpose of this handbook is to provide students with information on the requirements and procedures for pursuing a graduate degree (MS, AMP, or Ph.D.) in the Department of Biosystems Engineering (BE) at The University of Arizona. The Department is active in research. We have four general emphasis areas: Biometry and Biosystems Informatics; Controlled Environment Agriculture; Food, Bioproducts, and Renewable Energy; and Water Resources. However, students will find that a graduate program in the BE department can be designed to fit almost any need in the general field of the application of engineering principles to the solution of agricultural and biological engineering problems. The flexibility of the program allows foreign and domestic students, in consultation with their advisors, to develop programs specifically suited to their career goals and interests. The University of Arizona is a diverse institution, and therefore provides courses in many different areas to support specific and general programs.

This manual is a compilation of current policies, practices, and procedures of the Graduate School and the Department of Biosystems Engineering. Information found in the Graduate catalog [http://catalog.arizona.edu/policy-audience/graduate], which the student is expected to be familiar with, is to be used as the basis for the resolution of any special problems, the treatment of any extraordinary conditions, and the source for details not covered by this manual. In some instances, requirements differ between the Graduate College and the Department. In these instances, the departmental requirements supersede Graduate College requirements. If a topic is not covered in this handbook, the Graduate College policies will be enforced.

Contained in this manual are general program information, admission requirements, general administration of the graduate program, and deadlines for the submission to the Graduate College of items such as study programs, reports on examinations, etc. The Graduate College publishes official specific deadline dates. A copy of official deadline dates can be obtained from the BE Academic Advisor or the Graduate College website [http://grad.arizona.edu/].

## 2.0 DEGREE PROGRAM INFORMATION

The Department offers the following degrees in Biosystems Engineering: Master of Science (MS), Accelerated Master of Science (AMP), and Doctor of Philosophy (Ph.D.). There are two options in both the MS and AMP degrees: thesis and report. The thesis option (MS/AMP) is intended for students who want to study in a specialized area and to work closely with a faculty member on a unique research topic. The report option is intended for students desiring a broad education and engineering practice, and it is comprised of coursework in several areas and an engineering report done under the supervision the student's major professor and the student's committee members.

# 3.0 ADMISSION

## 3.1 General Admission Requirements

All Candidates must apply online through the Graduate College application site located at: https://apply.grad.arizona.edu/users/login. Graduate Admission Requirements are at: https://grad.arizona.edu/prospective-students . The application for admission includes official transcripts from all previous colleges and universities attended, resume (CV), scores from the Graduate Records Examination (GRE), three letters of recommendation, and the applicant's statement of purpose.

A departmental review committee made up of faculty from the student's area of interest evaluates the candidate's application. Applicants are evaluated on the individual merits of their academic achievements and scholarly potential to complete graduate-level coursework and research requirements. Once the decision is made, the departmental recommendation will be transmitted to the Graduate College and the candidate will be notified of the decision.

To be considered for the MS program, the candidate must hold a Bachelor's degree. To be considered for the Ph.D. program, the candidate must hold a BS and/or MS degree. Candidates with degrees from non-engineering programs will be required to take additional engineering undergraduate courses to overcome deficiencies.

For more details on the admission process please see: http://grad.arizona.edu/admissions/requirements.

## 3.2 Requirements for International Candidates

In addition to the academic requirements for all applicants, international students must satisfy English proficiency, financial guarantee, and health insurance requirements. To demonstrate proficiency in English, a minimum score of 550 (or a computer-based score of 213) on the Test of English as a Foreign Language (TOEFL) is required for all applicants whose native language is not English. The 550 score (or a computer-based score of 213) is a Graduate College requirement and cannot be waived. The Educational Testing Service should send an official report to The University of Arizona (institution code is 4832). For more information on the additional requirements for international candidates/students please refer to: https://grad.arizona.edu/international-students.

## 3.3 Summary of Admission Requirements

Qualified candidates must meet the minimum criteria to qualify for the BE Graduate Programs:

GPA: MS 3.0; PhD 3.3

GRE: Quantitative minimum 151, Verbal minimum 138, Analytical minimum 3.0

Intentional language test requirements

TOEFL: IBT– 79; CBT - 213R; PBT- 550

IELTS: minimum composite score of 7 (no subject below 6)

# 4.0 FINANCIAL SUPPORT IN THE BE DEPARTMENT

Although there is no guarantee of funding for pursuing a graduate degree, there are several options available to graduate students.

## 4.1 Graduate Research and Teaching Assistantships

Depending on funding allocations, Research Assistantships (RAs) and Teaching Assistantships (TAs) may be available. Department policy provides that MS students will be supported for no more than four (4) semesters (2 years) and Ph.D. students for no more than eight (8) semesters (4 years). The non-resident tuition fee is waived for students on assistantships of 25% time or more; the registration fee is *not* waived. There is a tuition remission of 50% or more of the registration fee depending on the level of appointment (0.25, 0.33, or 0.50). Graduate assistants on half-time (0.50 FTE) assistantships are expected to work 20 hours per week.

### 4.1.1 Research Assistantships (RAs)

Research Assistantships (RAs) are provided by an individual faculty member's research grants. Faculty members are responsible for identifying students to work on funded projects.

### 4.1.2 Teaching Assistantships (TAs)

Students hired on Teaching Assistantships (TAs) need to review policies, and complete training and orientations required by the Graduate College [see https://grad.arizona.edu/funding/ga].

## 4.2 Graduate College Thesis/Dissertation Scholarship

International students who have completed their coursework and are within 2 years of completing their Ph.D. degree or 2 semesters of completing their MS degree may qualify for this Scholarship. This award *excludes* the mandatory registration fees and any additional tuition charged by the individual programs. Students who are hired on an appointment as a Research Assistant do not qualify for this waiver.

To be *eligible for a Graduate College Thesis/Dissertation Scholarship*, students must be enrolled at the University of Arizona for not less than one (1) and not more than six (6) units of 910/909/920 level units only. Generally, waivers for students enrolling in 1 unit will be approved. Students must have met all course and unit requirements and be finishing up his/her Thesis/Dissertation.

*International students* who qualify for the Graduate College Thesis/Dissertation Scholarship should request this scholarship through the BE Academic Program Coordinator at least two months prior to the beginning of the semester that they are eligible to apply for the scholarship. For more information on this scholarship, see https://grad.arizona.edu/funding/opportunities/thesis-dissertation-tuition-scholarships.

## 4.3 Hourly Graders

The BE Department often has hourly grader positions available.

# 5.0 GENERAL ADMINISTRATION OF THE GRADUATE PROGRAM

## 5.1 Orientations

### 5.1.1 Graduate School

New students and students who are hired as Graduate Assistants are required to attend all of the Graduate College orientations. Locations and times will be posted each year on the following site: https://grad.arizona.edu/announcements.

### 5.1.2 Departmental

Most semesters, departmental Orientations are conducted for graduate students by the department's Director of Graduate Studies and the Academic Program Coordinator.

## 5.2 Registration

Registration is accomplished using UAccess, the University's web-based course registration program [http://www.uaccess.arizona.edu/]. Registration for the first semester in residence should be completed after meeting with the Director of Graduate Studies and the Academic Program Coordinator.

## 5.3 Deficiencies

Candidates with deficiencies identified in the recommendation letter from the department head must complete the required coursework satisfactorily prior to completing their graduate degree program.

If a student disagrees with the written statement of deficiencies given at the time of admission, he/she should contact the Academic Program Coordinator to a file petition to request for a review of the deficiencies and previous coursework completed.

## 5.4 Continuous Enrollment Policy for Domestic Students

To be considered full-time, domestic graduate students need to enroll in 3 units per semester.
To maintain your student status but are unable to enroll in fall or spring semester, you need to submit a Leave of Absence form. If you fail to meet the continuous enrollment policy and do not register, you will need to reapply to the Graduate College and be approved for readmission by the Associate Dean of Academic Programs.

### 5.4.1 Summer Enrollment

MS students who are graduating in summer are required to enroll during Summer Session II. Ph.D. students who have completed their coursework and are graduating in summer do not need to enroll in a Summer Session.

### 5.4.2 International Students

International students need to follow his or her individual visa enrollment requirements. For more information regarding University of Arizona's policy for international graduate student enrollment policies, see https://global.arizona.edu/international-students.

### 5.4.3 Graduate Assistantships

Students who are supported by or through The University of Arizona, via assistantships as a Graduate Assistant in Teaching (GAT) or Graduate Assistant in Research (GAR) are expected to officially enroll in at least nine 9 units per

semester. Individual Colleges may set their own GAT/GAR enrollment requirements. For more information on enrollment requirements for students on assistantships, see https://grad.arizona.edu/funding/ga.

Graduate students hired on an assistantship through the College of Agriculture & Life Sciences must be enrolled in at least 10 units, per college requirements.

Those students holding a Graduate Teaching Assistantship must be evaluated by their instructor at the end of each semester.

### 5.4.4 Graduate Scholarships

Students who have been awarded Graduate Registration Scholarships or Graduate Tuition Scholarships are required to be enrolled as a full-time student per Graduate College policies. For more information, see http://grad.arizona.edu/funding/opportunities.

## 5.5 Major Professor

The Academic Program Coordinator will serve as the Administrative Advisor. The Administrative Advisor will assist the candidate with all graduate forms, entering information into GradPath, checking procedures, and other administrative activities.

In the first few weeks after joining the program, students should meet with the BE Director of Graduate Studies to discuss options and procedures for choosing a Major Professor. A permanent Major Professor must be chosen by the *end of the first semester of study*. The candidate's Major Professor should specialize in the student's main field of interest. The primary role of the Major Professor is to guide the student in coursework and to keep the student informed on whether he/she is making satisfactory progress. The Major Professor will act as the student's mentor, be responsible for *helping* the student select his/her MS/ Ph.D. Committee members, and serve as the Thesis/Report Committee chair as well as developing and completing a Plan of Study in collaboration with the Thesis/Report Committee. The Major Professor is responsible for meeting with the student a minimum of once per semester to review the student's progress.

## 5.6 Graduate Committee Meetings

The Candidate is expected to meet with his/her committee members at least once a semester. The purpose of the meeting is to have the overall committee review the academic progress of the candidate.

## 5.7 Leave of Absence Policy

It is not necessary for a student to apply for a Leave of Absence (LOA) if he or she has a registration record for that semester. A "W" counts as a registration record. An LOA is inappropriate for a student who withdraws from all classes after the start of a semester and receives "W' grades since a Leave of Absence presupposes no registration at all for a term. Since, in such cases, the student has maintained continuous enrollment by having a registration record, he or she is eligible to register the following semester (or Summer or Winter term) and will suffer no adverse effects due to the fact that he or she was not eligible to apply formally for a Leave of Absence. Only academic services or facilities available to the general public can be used during the LOA. An LOA may affect the status of a graduate student's financial aid. Students are responsible for determining the requirements of their funding agency and/or academic unit prior to applying for a Leave of Absence.

International students must check with the International Students Programs and Services before filing for a Leave of Absence.

If a student fails to register and does not have a Leave of Absence on file, the student will be discontinued from his/her program. A new application will be necessary for the student to continue in the program. Re-admission is not guaranteed. See Continuous Enrollment and Re-admission Policies for more information [http://grad.arizona.edu/policies/enrollment-policies/leave-absence].

### 5.8 Enrollment in Departmental Graduate Seminar (BE 696A/B)

All graduate students are expected to enroll in the departmental Graduate Seminar class each semester they are in the BE graduate program. BE 696A is for graduate students who will be presenting their research. BE 696B is for graduate students who will not be presenting their research. Please contact the Academic Program Coordinator, Graduate Program Director, or instructor to ensure that you are enrolled in the appropriate class.

#### 5.8.1 BE 696A

Two presentations are required for MS and AMP candidates and for those Ph.D. candidates who received a BE MS degree. These students will enroll in BE 696A two (2) semesters and earn 2 units towards their degree. Ph.D. students who *did not* receive a BE MS degree are required to enroll in BE 696A and make *4 presentations* to earn 4 units towards their degree. Students who have proof that they have made a presentation in another institution, may petition and receive a waiver for the number of units required. Grades available are A, B, C, D, E, I, W.

#### 5.8.2 BE 696B

MS, AMP, and Ph.D. students who are not presenting that semester are required to enroll in 696AB. Grades available are S, P, F, I, W.

#### 5.8.3 International Students on a Thesis/Dissertation Scholarship Award

International students on a Thesis or Dissertation Scholarship Award are waived from the enrollment requirement for 696A. However, these students are required to attend the course and meet all other requirements.

### 5.9 UAccess GradPath

Graduate Students are required to use GradPath [http://uaccess.arizona.edu/], the Graduate College's nearly paperless degree audit process that makes tracking and monitoring student progress much easier. Students will be expected to complete their Graduate College degree certification forms through GradPath. GradPath can be found by selecting the drop down box located in the Academics section in UAccess. Once a student completes the required form in GradPath, the form automatically routes to everyone who needs to see or approve the form. The BE Academic Program Coordinator can assist with this process.

### 5.10 UAccess GradPath Forms

Each of the following steps requires completion and should be taken at the appropriate time during the student's tenure in the department. To keep on schedule for graduation, please refer to the dates and deadlines posted on http://grad.arizona.edu/gsas/degree-requirements/important-degree-dates-and-deadlines. The appropriate student forms may be accessed through UAccess [http://uaccess.arizona.edu/].

#### 5.10.1 Responsible Conduct of Research Statement

This is the first form to complete in order to go forward in GradPath. The next form cannot be opened until this form is completed.

### 5.10.2 Plan of Study (POS) Form

In conjunction with his/her major professor, each student is responsible for developing and submitting a Plan of Study (POS) during his/her semester in residence. For further information on the POS, MS students should see section 6.4 and the Ph.D. students should see section 7.8. Prior to creating the POS, students should read the Graduate College's requirements at http://grad.arizona.edu/gsas/degree-requirements.

### 5.10.3 Committee Appointment Form

Students should complete their Committee Appointment Form in GradPath no later than the last day of class during their second semester. Students will be required to enter their Committee Members, expected graduation term and year, and title of their Thesis/Dissertation. For more information on submitting and archiving your thesis/dissertation, please refer to https://grad.arizona.edu/gsas/degree-requirements/masters-degrees#thesis-committee.

### 5.10.4 Degree (MS, AMP, Ph.D.) Completion Form

This GradPath form is completed by the Academic Program Coordinator after receiving the results of the Final Oral Defense (Examination) from the Major Professor (Committee Chair). For more information, please refer to http://grad.arizona.edu/gsas/degree-requirements.

## 5.11 Graduate Student Academic Progress Reports

All BE graduate students are required to submit a Graduate Student Academic Progress Report (Progress Report) once a semester as a course requirement for BE 696A or 696B.

## 5.12 Enrollment in Multiple Graduate Degree Programs

University of Arizona students may pursue simultaneous multiple graduate degrees. This process is controlled by the Graduate College. Students must go through the UA Graduate College application system and meet all admission requirements for any additional graduate program. Please refer to the Program Description Guide at the Graduate College website for future students https://grad.arizona.edu/futurestudents/.

## 5.13 Thesis/Dissertation Publication Requirements

All MS thesis option and Ph.D. candidates are required to submit papers or receive committee approval meeting the standard for publication in a refereed scientific or engineering journal by the time of their Final Oral Defense. Details about the Thesis and Dissertation paper submission requirements and forms can be found in Appendix B.

## 5.14 Archiving the Thesis/Dissertation

A student who is completing a thesis/dissertation (with enrollment in course number 910 or 920) is required to archive her/his thesis/dissertation upon final approval of his/her graduate committee. The thesis/dissertation will be added to the University of Arizona Campus Repository and to the national archive of theses/dissertations and maintained by ProQuest/UMI. There is no charge to the student for archiving the thesis/dissertation. The thesis/dissertation must have been successfully defended and approved by the candidate's committee with all final edits completed in time for the student to submit it online for archiving by the graduation deadline for the student's graduation term.

## 5.15 Commencement

The University of Arizona, the College of Agriculture and Life Sciences, College of Engineering, and the Department of Biosystems Engineering all celebrate graduate degree completion.

### 5.15.1 University Commencement

The University of Arizona holds their commencement once a year in May. UA Commencement information can be found at http://grad.arizona.edu/gsas/commencement. The diploma will be mailed to the address you have listed on UAccess student link as your 'permanent' address. If you do not want it sent to your 'permanent' address, you should create a 'diploma' address and it will be mailed there instead.

### 5.15.2 College of Agriculture & Life Sciences (CALS)

The College of Agriculture and Life Sciences has hooding ceremonies twice a year, at the end of each academic semester. Graduate students have the option of attending both this ceremony and the College of Engineering hooding ceremony. Graduate students will be expected to select a Faculty Member to perform the Hooding ceremony.

### 5.15.3 College of Engineering (COE)

The College of Engineering holds a commencement/hooding ceremony at the end of the fall semester. Graduate students have the option of attending both this ceremony and the CALS hooding ceremony. Graduate students will be expected to select a Faculty Member to perform the Hooding ceremony.

### 5.15.4 Biosystems Engineering Department

The BE department holds a pre-commencement reception/dinner twice a year -- at the end of each academic semester. Students completing degree requirements in August have the option of attending either the May or December pre-commencement events. Students not completing all graduation requirements, but are close, may attend one pre-commencement reception/dinner of their choosing.

## 5.16 International Student Resources

International students should familiarize themselves with the Office of Global Initiatives for International Students [see http://global.arizona.edu/] as well as review the Student Resource Manual at http://global.arizona.edu/international-students/student-resource-manual.

International students should check with the Office of International Student Programs to be sure they are in compliance with their visa status obligation, since they may be required to be enrolled in additional units to maintain full-time student status. Students should also check their I-20 expiration date and if necessary begin the renewal process. Students need to give themselves plenty of time to maintain their status. The process may take up to 6 months or more.

## 5.17 Graduate Student Learning Outcomes Assessment

### 5.17.1. Expected Learning Outcomes

By the completion of the Graduate programs (MS Thesis/MS Engineering Report/ Ph.D.) in Biosystems Engineering, a student will:

1. demonstrate a broad knowledge of his/her focus area in BE,
2. critically analyze published research results in his/her focus area in BE,
3. conduct original research on a significant BE problem, and
4. effectively communicate and defend results of research to peers and broader scientific audiences.

### 5.17.2. Assessment Activity

Assessments will be conducted throughout the graduate student's tenure in the BE Department as shown in Table 1. Common to all graduate programs in the BE department are the requirements of graduate seminar presentations and the oral and written defense of the research or creative activity. In addition to these common elements, the BE Ph.D. program requires a student to complete a written and oral comprehensive exam based upon coursework and the student's focus area. These already-existing assessment activities are also used to gather program level assessment data. Appendix F has all the rubrics for assessments in Table 1.

Table 1. Graduate program assessments.

| Assessment Activities | Outcome 1: Knowledge of the Focus Area | Outcome 2: Critical Analysis of Research in the Focus Area | Outcome 3: Conduct Original Research | Outcome 4: Communicate and/or Defend Research |
|---|---|---|---|---|
| Graduate Seminar Presentations[1] | X | X | | X |
| Written Comprehensive Exams[2] | X | | | |
| Oral Comprehensive Exams[2] | X | X | | |
| Written Dissertation & Oral Defense of the Dissertation[1] | | X | X | |
| Exit Survey[1] | X | X | X | |
| [1]For example of rubrics, see Appendix F<br><br>[2]For example of rubrics, see Appendix E | | | | |

# 6.0 Master of Science (MS) Degree in Agricultural & Biosystems Engineering

This section summarizes the requirements and steps for completing a master's degree. MS students are responsible for knowing the BE program and Graduate College requirements. MS students also need to review the Graduate College Policies and Procedures located at http://grad.arizona.edu/policies and the degree requirements for Master's degrees located at https://grad.arizona.edu/catalog/. The requirements for Master's Degrees on the Graduate College website (http://grad.arizona.edu/gsas/degree-requirements) provides additional details. There are two MS program options in BE: MS Thesis and MS Report. The checklist for completing the steps towards a master's degree is located in Appendix C.

## 6.1 Credit Requirements

All coursework must be in courses graded A, B, or C except for BE 696B and up to one independent study course. To complete degree requirements, the cumulative GPA in graduate level courses must be 3.0. A student whose GPA falls below 3.0 will not be permitted to register for additional courses. See Graduate College Policies online at https://grad.arizona.edu/admissions/requirements.

### 6.1.1 Minimum Course Requirements

30 units minimum consisting of the following:

1. 3 units STAT 571B
2. 3 units either Statistics (different than STAT 571B), Numerical Analysis, or a Mathematics/Modeling course
3. 2 units of BE 696A (students who are presenting)
4. 2 units of BE 501
5. 12 units of BE courses
6. 5 units of either BE 910 Thesis (thesis option) or BE 909 Engineering Report (non-thesis option) under his/her Major Professor's section number
7. 3 units of an Elective course (per Major Professor's approval)
8. BE 696B for each semester the candidate is not presenting. Students must receive approval from the Department to be excused from this requirement. The BE696B units are not listed on the students UAccess POS.

## 6.2 Time Limitation

All requirements for the master's degree must be completed within six (6) years. Time-to-degree begins with the earliest course to be applied toward the degree, including credits transferred from other institutions. Coursework more than six (6) years old are not accepted toward meeting degree requirements: http://grad.arizona.edu/gsas/degree-requirements/masters-degrees#time-limitation.

## 6.3 Transfer Credit

Transfer credits may apply towards the BE MS degree. Students who wish to have Transfer units apply towards their BE degree need to file a petition with the Academic Program Coordinator. The Graduate Program Committee will review the petition and determine if the transfer course is equivalent. If approval is granted, the course may be listed on the Plan of Study (POS). More information on Graduate College Transfer Credit policies is found at http://grad.arizona.edu/academics/program-requirements/masters-degrees or by contacting the BE Academic Program Coordinator and/or their Graduate College Degree Auditor. Up to six (6) units for a master's degree may

be transferred from other accredited institutions. To transfer, the coursework must have been taken for graduate credit, and an A or B grade must have been earned. These grades will not be included in the student's GPA.

### 6.4 Master's Plan of Study (POS) Form

In conjunction with the Major Professor, each student is responsible for developing a Plan of Study (POS) by the end of their first semester. The Plan is to be filed in GradPath no later than the end of the first semester in residence. The Plan of Study identifies:

1. Courses already completed and planned at The University of Arizona which the student intends to apply toward the graduate degree and
2. Approved Transfer courses.

The student should receive approval from the entire Thesis/Report Committee before submitting his or her Plan of Study into the GradPath. The Plan of Study must have the approval of the Academic Program Coordinator, the Major Professor, the Minor Advisor, the BE Director of Graduate Studies, and the Graduate College. For more information on the plan of study, please refer to http://grad.arizona.edu/gsas/degree-requirements/masters-degrees#plan-of-study.

### 6.5 MS Thesis/MS Report Committee Members

Master's Thesis/ Report Committee must consist of three members. At least two members of the committee must be tenure, tenure-track, or continuing appointment UA BE faculty members (this includes jointly-appointed faculty members). The third member can be another BE faculty or a faculty member from another department. If the third member is not a tenure-track UA faculty member, he or she must be approved by the Graduate College as a Special Member. Contact the Academic Program Coordinator if you need to request a Special Member. More information about the Graduate College's policy on Thesis/ Report Committee Member qualifications can be found at https://grad.arizona.edu/gsas/degree-requirements/masters-degrees.

The Major Professor, who serves as the chair of the committee, must be a tenure, tenure-track, or continuing appointment BE faculty member. A member who is not tenure-eligible/continuing appointment will not be eligible to serve as sole chair of the committee but can serve as co-chair if approved to do so by the Graduate College. A list of faculty who can serve on graduate committees as the sole graduate committee chair is in Appendix D. The student's Major Professor must approve the Master's Thesis/Engineering Report Committee members.

The Master's Thesis/Engineering Report Committee approves the program of study and the master's thesis/report and participates in the Final Oral Defense for the Master's degree.

### 6.6 MS Thesis/MS Report Requirements

#### 6.6.1 Thesis Option

Students are required to:

1. Submit a minimum of one paper for publication;
2. Receive approval for submission to a refereed journal from their Thesis/Report Committee and Major Professor; and
3. Listed as the first author in at least one paper approved for submission.

Copies of filed sample Thesis papers are available for check out with the Academic Program Coordinator or via the University Libraries at http://arizona.openrepository.com/arizona/handle/10150/129649/.

### 6.6.2 Engineering Report Option

Students are required to submit a report to their committee following the format required by the department. Typically, if the student is conducting experimental research, they will use the thesis option format minus the paper requirement. If the student is not conducting experimental research or doesn't have a formal research project, they can use the format in Appendix B.

## 6.7 Research Proposal for Thesis/Engineering Report

The Research Proposal is the general research plan that the candidate will pursue to obtain his/her master's degree and is of sufficient academic merit on a topic that satisfies his/her Thesis Committee. The candidate is encouraged to include the title of his/her Research Proposal in his/her Plan of Study. A draft of the Research Proposal will be completed by the completion of BE 501 (as a course requirement). The final Research Proposal will be completed by the end of the 2nd semester in the program and submitted to the Academic Program Coordinator.

## 6.8 Final Oral Defense/Examination

### 6.8.1 Dates and Deadlines

NOTE: All students should refer to the Graduate College Dates and Deadlines website prior to beginning the following steps: https://grad.arizona.edu/gsas/degree-requirements/important-degree-dates-and-deadlines. Scheduling the Final Oral Defense and satisfying all the requirements relating to Final Oral Defense is the sole responsibility of the student.

### 6.8.2 MS Thesis/Report Defense Process

The following lists the steps needed to complete the Master's Thesis or Engineering Defense (and are also found in table format in Appendix C):

1. Upon completion of the research work, student writes his/her thesis/report and presents to his/her Thesis/Engineering Report Committee a draft of the thesis/report one month before the proposed defense date recognizing that the defense date should be at least one week before the deadline set for final submission to the graduate college of the semester the student plans to graduate.
2. One week after the submission of the draft, the student meets with her/his committee to present his/her work to the committee.
3. At the meeting, the committee makes the decision whether the student is ready to defend his/her work based on the presentation and draft thesis/report.
4. If the committee agrees that the student is ready to defend his/her thesis/report/, they signify this by signing the Defense Approval Form.
5. If the committee determines that the student is not ready to defend, the Committee Chair/Advisor and student will then send an email notice with the new "Program Completion Date (Graduation Term," to the Academic Program Coordinator, the BE Director of Graduate Studies, and Graduate College Degree Check Advisor.
6. Once the candidate is approved to defend, the student submits the signed copy of Defense Approval Form to the Academic Program Coordinator within 24 hours of approval by the committee.
7. Students should be aware of the submission date for the final approved thesis for archiving before they set their final defense date see Dates and Deadlines for their graduation term posted on Graduate Website: https://grad.arizona.edu/gsas/degree-requirements/important-degree-dates-and-deadlines.
8. If a committee member is absent from the committee meeting, then it is the student's responsibility to meet with that committee member(s) individually and have them sign the Defense Approval Form.

9. Upon receiving the signed Defense Approval Form from the candidate, the Academic Program Coordinator will notify the BE Director of Graduate Studies via GradPath, and the student may then set the defense date a minimum of two weeks after consultation with the committee members.
10. The Academic Program Coordinator will have the necessary paperwork sent to the Graduate College and also send email to the department faculty, students, and staff with the date and location of the defense.
11. The candidate is responsible for posting the announcement of his/her defense (at least one week prior to the defense) with the title, date, and location in the appropriate buildings.

The Major Professor (Graduate Committee Chair) presides over the defense examination. Each of the Thesis/Engineering Report Committee members must receive a copy of the thesis/project report approved by the student's Academic Advisor (not necessarily library-ready copies) at *least two weeks prior to the oral examination*.

The examination may last over two hours, but cannot be more than three hours and is composed of two parts. During the first part (about 30 minutes), the student gives an oral presentation of the thesis/project report in an open seminar. The presentation may be interrupted to permit questions to clarify points and questions concerning fundamental principles that are directly related to the thesis/project report. The second part of the examination consists of a closed-to-the-public questioning by the thesis/engineering report committee members on the student's knowledge of the discipline and his/her research project.

For Final Oral Examination Instructions, please refer to https://grad.arizona.edu/forms/sites/default/files/uagc_page/finaldefenseinstructions.pdf.

Members of the committee must be present for the entire examination. Per Graduate College policies, a member may participate in the Defense via Skype or GoToMeeting. If a member is not able to participate in person or via Skype or GoToMeeting, the student will need to find another tenured, tenure-track, or continuing-appointment committee member, and update their Committee Appointment form.

### 6.8.3 Reporting Final Oral Defense (Examination) Results

After the Defense, the Thesis/Engineering Report Committee will determine if the student passed, passed with revisions, or failed the exam. The Major Professor (Committee Chair) will submit the results to the Academic Program Coordinator via email. Results must be reported to the Graduate College prior to the date on which the degree is to be conferred; specific deadlines from the Graduate College are posted online at https://grad.arizona.edu/gsas/degree-requirements/important-degree-dates-and-deadlines.

If the candidate passed the final oral defense without revisions, the student may proceed with the submission process. The Major Professor (Committee Chair) should submit a Change of Grade Form to the Graduate College Degree Certification Office. The candidate then submits the approved thesis/report in an electronic format to the Graduate College. For further details, refer to the Dissertation/Thesis Submission link at http://dissertations.umi.com/arizona/. The thesis/report must be submitted in PDF format on a readable CD to the BE Academic Program Coordinator. The candidate's Major Professor and Thesis/Engineering Report Committee may require copies of the thesis/report as well, either in electronic format, hardbound, and/or loose pages. The candidate is advised to check with his/her Major Professor for any special requirements.

If the candidate passed the final oral defense with revisions, the following steps need to be taken:
1. The Thesis/Engineering Report Committee must determine the date that the student needs to resubmit the corrections to the committee.
2. The Major Professor (Committee Chair) is responsible for ensuring that the student makes the committee's recommendations and notifying the Academic Program Coordinator that the revisions are completed and the student has met the degree requirements. The Chair should submit a Change of Grade Form.

3. The candidate then submits the approved thesis/report in an electronic format to the Graduate College. For further details, refer to the Dissertation/Thesis Submission [http://dissertations.umi.com/arizona/]. The thesis/engineering report must be submitted in PDF format on a readable CD to the BE Academic Program Coordinator. The candidate's Major Professor and Thesis/Engineering Report Committee may require copies of the thesis/report as well, either in electronic format, hardbound, and/or loose pages. The candidate is advised to check with his/her Major Professor for any special requirements.

If the candidate failed the final oral defense, the candidate, upon the recommendation of the major department, may be granted a second examination. The result of the second examination is final.

## 6.9 Accelerated Master of Science Program (AMP)

The Accelerated Master's Program (AMP) in Biosystems Engineering is designed to enable advanced UA undergraduate students to complete both the Bachelor of Science degree in Biosystems Engineering and the Master of Science degree in Biosystems Engineering in a total of five (5) years. This program is available only for undergraduate students in Engineering at the UA. Research experience as an undergraduate is not a requirement, but it is desirable. Thesis and Engineering Report options are available to AMP students. Please refer to section 6.6 for more details on these two options.

### 6.9.1 Eligibility Criteria

To be eligible to apply for the Accelerated Master's Program, students must:

1. Be a continuing, undergraduate Biosystems Engineering Major at the University of Arizona.
2. Have a minimum cumulative GPA of 3.3.
3. Have completed a minimum of 75 units of undergraduate coursework at the time of application with a minimum of 12 undergraduate units completed in the student's major at the University of Arizona's main campus.

### 6.9.2 Application

Interested students should contact the Academic Program Coordinator. Only qualified candidates will receive the BEAMP application access code.

Students should complete their application online in the January of their junior year through the Graduate College at https://apply.grad.arizona.edu. Once the student receives the access code, the student will complete the Biosystems Engineering Accelerated Master's Program application. After acceptance into the program, students will register during their senior year to take a combination of undergraduate and graduate courses. These courses will serve both as electives for the BS degree and as core or elective courses for the MS degree. In the fifth and final year, students will focus on graduate coursework and their research or project.

### 6.9.3 Accelerated Steps to the MS Degree

In the first semester of the senior year (first semester in the AMP), students need to:

1. Review the BE Graduate Student Handbook.
2. Select their Major Professor.
3. Develop the Plan of Study (POS) (an example is in Appendix A).
4. Review the Thesis/Engineering Report Committee requirements.

In the second semester of the senior year (second semester in the AMP), students need to:

1. Select their Thesis/Engineering Report Committee members.
2. Choose their research or project topic.

### 6.10 Steps in Completing MS Degree

A summary of the steps to complete an MS degree is listed in Appendix C.

## 7.0 Doctor of Philosophy (Ph.D.) Degree in Agricultural & Biosystems Engineering

Attainment of a Doctor of Philosophy (Ph.D.) degree at The University of Arizona requires outstanding scholarship and demonstration of distinguished research leading to a dissertation that contributes significantly to the general pool of knowledge in the discipline. This section describes the requirements for completion of the Ph.D. degree within the Biosystems Engineering Department. A general timetable for completing the steps for the Ph.D. is given in Appendix C.

Ph.D. students are responsible for knowing the BE program and Graduate College requirements. Ph.D. students also need to review the Graduate College Policies and Procedures located at http://grad.arizona.edu/degreecert and the degree requirements for Ph.D. degrees located at http://grad.arizona.edu/gsas/degree-requirements/doctor-philosophy.

### 7.1 Pursuing Ph.D. after MS at the University of Arizona

A student may use up to a total of 30 credits from his/her master's degrees towards their doctorate program. More information may be found at https://grad.arizona.edu/gsas/degree-requirements/doctor-philosophy#credit-requirements.

### 7.2 Dissertation Committee

The Dissertation Committee consists of at least three faculty members who represent the major subject area and one or more faculty members who represent the minor subject area. The Dissertation Committee approves the Doctoral Degree Plan of Study and constitutes the committee for the Final Oral Defense of the doctoral dissertation. They also constitute the Comprehensive Examining Committee. Since the Dissertation Committee plays such a central role in the doctoral program, it should be formed soon after selection of the major professor.

The Graduate College requires a minimum of three members, all of whom must be University of Arizona tenured, tenure-track, or approved as equivalent (continuing appointment). The BE Department requires that a minimum of two (2) members be from the BE Department and one (1) representative from any UA department from within the student's program specialty area.

The Major Professor (chair of the Dissertation Committee) must be a current UA tenured, tenure-track, or continuing appointment BE faculty member. A list of eligible BE Faculty who can serve as sole graduate committee chairs can be found in Appendix D. Special members must be pre-approved by the Dean of the Graduate College. A Special Member Form must be completed and submitted to the Graduate College for Dissertation Committee members who are non-tenured or are outside of The University of Arizona. The Graduate College requires the Graduate Coordinator to initiate the Special Member Request [https://grad.arizona.edu/forms/gsas/special-member-request]. Please contact the Academic Program Coordinator to process the Special Member request.

## 7.3 Credit Requirements

For a Ph.D. in Biosystems Engineering, a candidate must complete 63 units minimum consisting of 45 non-Dissertation units and 18 Dissertation (BE 920) units. All required units of credit must be at the 500-level or above at The University of Arizona or, in the case of transfer units, their equivalent at other institutions.

### 7.3.1 Minimum Requirements

63 units minimum, consisting of the following:

9. 3 units of STAT 571B
10. 9 units of either Statistics (can't repeat STAT 571B), Numerical Analysis, Mathematics/ Modeling
11. 2 units of BE 501 (601)
12. 4 units of BE 696A (students who are presenting).
    12.13 EXCEPTION: Candidates with a BE MS degree are only required to take 2 units as the other 2 units were earned from their MS program.
13. 12 units of BE courses
14. 1 unit of BE 693 (section # under faculty sponsor)
15. 18 units (minimum) of Dissertation units (BE 920)
16. 3 to 6 units of elective courses per approval of Major Professor (depending on the required minor units).
17. 9 to 12 units in the minor, depending on the Minor Department requirements.
18. Enrollment in BE696B for each semester he/she is not presenting. Students must receive approval from the Department, to be excused from this requirement. The BE696B units are not listed on the students POS in UAccess.
19. All courses in the Plan of Work must be taken for a grade (A, B, C) except for BE 693 (Teaching Internship).

## 7.4 Transfer Credit

Graduate credit earned at other approved institutions, if accepted by the department and the Graduate College, may be counted toward the requirements of this degree. Students who wish to use transfer credit must submit a request through the Academic Program Coordinator before the end of their first year of study to the Graduate College.

Transferred units are subject to the following restrictions:

1. The credits must be approved by the major or minor department and the Graduate College.
2. The minimum grade for transferred credits must be an A or B or the equivalent at the institution where the course was taken.
3. Transferred units may not count toward more than one doctorate.
4. A maximum of 30 units of transfer coursework may be used toward the Ph.D. requirements.

The Graduate Committee will review the petition and determine if the transfer course is equivalent. If the request is approved, the course may be listed on the Plan of Study. For more information on Graduate College Transfer Credit policies, students should consult http://grad.arizona.edu/academics/program-requirements/doctor-of-philosophy/credit-requirements-and-transfer-credit, contact the BE Academic Program Coordinator, and/or contact their Graduate College Degree Auditor.

## 7.5 Ph.D. Minor Requirements for BE Ph.D. Candidates

BE Ph.D. students are required to complete a minor. The minor subject area may be taken inside or outside of the BE Department, BUT it must be in a different area than the major focus. The student may choose one or two minor areas, which are determined in consultation with his/her Major Professor. The department in which the minor is

sought determines specific requirements. The Graduate College requires that the minimum number of minor coursework is nine (9) units, but most minor programs require twelve (12) units of coursework.

The following are some suggested minors for BE students: Soil, Water, and Environmental Science; Plant Sciences; Chemical and Environmental Engineering; Civil Engineering and Engineering Mechanics; Electrical and Computer Engineering; Hydrology and Water Resource; Agricultural & Resource Economics; Mathematics; Renewable Natural Resource; Systems and Industrial Engineering; Aerospace and Mechanical Engineering; Biomedical Engineering; and Optical Science.

### 7.6 Requirements for Minoring in BE

To minor in Biosystems Engineering, a candidate must complete 10 units consisting of:

- 9 units of BE courses determined by the student and his/her BE minor advisor, and
- at least 1 unit of BE 696A, Graduate Seminar presentation.

Students should select their Minor Advisor, and receive approval from their Major advisor, prior to completing the Graduate College Minor application and filing his/her POS. The Minor Advisor will serve on the Graduate Dissertation Committee.

### 7.7 Teaching Experience Requirement

The BE department recognizes that many Ph.D. students will have a faculty role and teach at universities or colleges. We want to help prepare our students for that event. Therefore, all Ph.D. students are required to have one unit of BE 693, Teaching Internship, to document their teaching experience. The following are methods to achieve this teaching experience.

Graduate Teaching Experience Options:

1. Take FCSC/CALS 696E, Learner-Centered Teaching for Online Delivery: This seminar course is designed to introduce students to common pedagogical issues associated with both assisting in, and teaching learner-centered courses in online formats.
2. Take IA 697A, Learner-Centered Teaching: This seminar course is designed for graduate students who will be serving as teaching assistants/graders or who plan to pursue a career in teaching. Pedagogical issues central to teaching/learning at the college level such as learning styles, classroom climate and culture will be covered.
3. Take IA 697B, Using Technology in Teaching: This seminar course combines in-depth reading and discussion related to pedagogical issues in the use of technology in teaching and learning with guided, individually focused training and practice in using technology in teaching.
4. Take IA 697G, Universal Design: Inclusive Learning Environments: This course provides a comprehensive review of the theory, strategies, and techniques used in instructional design processes that foster inclusive learning environments for all learners. The curriculum addresses characteristics of learners such as learning differences and preferences and 21st-century learning attributes, approaches for utilizing differentiated instruction, engagement and motivation techniques, classroom management tactics, and universal design strategies. Emphasis will be placed on critical review of the literature as practically applied to various learning environments and contexts in post-secondary education.
5. Complete the Graduate Teaching Certificate through the Office of Instruction & Assessment (http://cct.oia.arizona.edu).
6. Serve as a GTA for one semester if the GTA experience has significant teaching responsibilities.

Students are required to complete the BE 693 Teaching Experience plan (see Appendix E). Students are required to have a plan and must select a teaching experience advisor and receive approval from their Major Professor. The

Teaching Experience Advisor needs to be a BE Faculty member, but not necessarily the Major Professor. At the end of the teaching internship, a report must be submitted to the internship advisor.

### 7.8 Time Limitation

Students must complete their degree within five years of passing the Comprehensive Examination. A student not finishing within that time period may be allowed to re-take the Comprehensive Examination with permission of the BE Graduate Program Director.

### 7.9 Plan of Study

In conjunction with the Major Professor, each student is responsible for developing a Plan of Study by the end of their first semester. The Plan is to be filed in GradPath no later than the end of the first semester in residence. The Plan of Study identifies:

1. Approved Transfer courses;
2. Courses already completed and planned at The University of Arizona which the student intends to apply toward the graduate degree;
3. Approved Minor courses.

Before submitting his/her Plan of Study in GradPath, the student must receive approval from his/her Dissertation Committee, Major Professor, Minor Advisor, the BE Director of Graduate Studies, BE Academic Program Coordinator, and the Graduate College. For more information on the doctoral plan of study, please refer to https://grad.arizona.edu/gsas/degree-requirements/doctor-philosophy#plan-of-study.

### 7.10 Research Proposal (Prospectus) for the Dissertation

The Research Proposal is the general research plan that the candidate will pursue to obtain their doctoral degree and is of sufficient academic merit on a topic that satisfies his/her Dissertation Committee. The candidate is encouraged to include the title of his/her Research Proposal in their Plan of Study. A draft of the Research Proposal will be completed by the completion of BE 501 (as a course requirement) OR, in the case of Ph.D. candidates already completing BE 501 in their master's degree program, the Research Proposal draft will be completed no later than the end of the 2nd semester in the program. The final Research Proposal will be completed by the end of the 3rd semester in the program and submitted to the Academic Program Coordinator. Once the final Research Proposal is received, the Academic Program Coordinator will submit the Research Proposal form in GradPath.

### 7.11 Comprehensive Examination

Admission to graduate study does not imply admission to candidacy for an advanced degree. Before admission to candidacy for the doctoral degree, the student must pass the doctoral Comprehensive Examination (a general examination in the chosen fields of study). This examination is intended to test the student's comprehensive knowledge of the major and minor subjects of study, both in breadth across the general field of study and in-depth within the area of specialization. Therefore, the examination should not take place until the student has completed all, or almost all, of his/her coursework. The exam will determine whether the student will be permitted to continue the Ph.D. program as a BE Ph.D. candidate.

### 7.11.1 Comprehensive Examination Structure

The Comprehensive Examination is considered a single examination and is composed of two parts:

1. A written portion covering the major and minor fields, and
2. An oral portion, which is to be conducted before the candidate's Comprehensive Examination Committee members. The BE Department recommends that the oral portion is taken no later than two weeks after the successful completion of the written portion. However, the Graduate College allows the oral portion of the Comprehensive Examination to be completed as late as three (3) months before the Final Oral Defense.

### 7.11.2 Comprehensive Examination Committee and Form

Students should receive verbal approval from their Major Professor and Dissertation Committee members prior to submitting the Comp Exam form in GradPath. The Comprehensive Examination Committee must consist of a minimum of four (4) members. In the BE department, the practice is for the Comprehensive Examination Committee to consist of the Dissertation Committee with an additional member(s). The additional member(s) should be tenured or tenure-track, or an approved special member. Special members must be pre-approved by the Dean of the Graduate College. Please contact the Academic Program Coordinator to process the Special Member request. Any members beyond the fourth can also be current tenured or tenure-track faculty members or approved special members. Once the committee has been approved by the assigned approvers, the student will proceed to the Announcement of Comprehensive Examination.

NOTE: All committee members, including the Minor Advisor, must be present and participate in the Comprehensive Examination.

### 7.11.3 Announcement of Comprehensive Examination

Once the Comprehensive Examination Committee has agreed on a time and place for the exam, the student must complete the Announcement of Comprehensive Examination form in GradPath. Prior to completing the form in GradPath, the form must be approved by the Major Professor, Minor Advisor, BE Director of Graduate Studies, BE Academic Program Coordinator, and the Graduate College. Once approved, the form will notify the examining committee of the date and time of the Comprehensive Exam.

### 7.11.4 Reporting the Results of the Comprehensive Examination

Based on the student's combined performance in the written and oral portions, the examining committee awards a grade of pass or fail. The Major Professor reports the final results of the Comprehensive Examination in GradPath.

If the student passed the comprehensive exam, the student will be Advanced to Candidacy and proceed to complete the Dissertation Committee Appointment form.

If the student failed the comprehensive exam, the student may be permitted a second attempt to pass the examination, but only if recommended by the examining committee. Students will be allowed *no more* than one re-take. For more information on the Comprehensive Examination, please refer to https://grad.arizona.edu/gsas/degree-requirements/doctor-philosophy and Policies and Procedures for Oral Comprehensive Examination for Doctoral Candidacy https://arizona.app.box.com/v/grad-gsas-comporalexam.

### 7.12 Dissertation Requirements

Students are required to submit a minimum of two (2) papers for publication. The publication papers, along with the Dissertation, must be submitted to the Dissertation Committee for review and approval *three weeks prior to scheduling the defense*. The student needs to:

1. Receive approval for submission to a refereed journal from their Dissertation Committee and Major Professor.
2. Be listed as the first author in at least one of the papers approved for submission.

Dissertation format requirements can be found in Appendix B. BE Ph.D. candidates should review the Graduate College manual to ensure that their Dissertation is in the proper format. For more information on formatting, please refer to https://grad.arizona.edu/gsas/dissertations-theses/dissertation-and-thesis-formatting-guides. Copies of Filed Dissertation papers are available for check out with the Department Academic Program Coordinator or via the University Libraries at http://arizona.openrepository.com/arizona/handle/10150/129649/.

### 7.13 Final Oral Defense

Upon the completion and approval of the Dissertation by the Committee, the student is ready to schedule the Final Oral Defense. A student must be in good academic standing to schedule the Final Oral Defense. The examination focuses on the dissertation itself but can include general questioning related to the field(s) of study within the scope of the dissertation. The exact time and place of this Final Oral Defense must be scheduled through GradPath at least two weeks in advance. The Major Professor, who serves as the chair of the committee, presides over the examination. The Defense is closed to the public, except for an initial seminar portion during which the student presents the dissertation and entertains questions. The Final Oral Defense should be concluded within the three-hour time period. Members of the Dissertation Committee must be present for the entire examination. Students should send the Graduate College link for the Final Oral Defense Instructions to their Major Professor at least 1 week prior to the date of the defense. For more information on the UA's policy on the Final Oral Defense, go to https://arizona.app.box.com/v/grad-gsas-finaldefnsinstr. NOTE: The BE faculty support the UA's policy that all members of the committee must be present for the entire examination.

Per Graduate College policies, a member may participate in the Defense via Skype or GoToMeeting. If a member is not able to participate in person or via Skype or GoToMeeting, the student will need to find another tenured, tenure-track, or continuing-appointment committee member, and update their Committee Appointment form.

#### 7.13.1 Dates and Deadlines

NOTE: All candidates should refer to the Graduate College Dates and Deadlines website prior to beginning the following steps at https://grad.arizona.edu/gsas/degree-requirements/important-degree-dates-and-deadlines. Scheduling the Final Oral Defense and satisfying all requirements relating to this examination is the sole responsibility of the student.

#### 7.13.2 Final Oral Defense Process

The following lists the steps to completing the final oral defense of a student's dissertation (also available in table format in Appendix C):

1. Upon completion of the research work, the student writes his/her dissertation and presents to his/her Dissertation Committee a draft of the dissertation one month before the proposed defense date recognizing that the defense date should be at least one week before the deadline set for final submission to the graduate college of the semester the student plans to graduate.
2. One week after the submission of the draft, the student meets with her/his Dissertation Committee to present his/her work.

3. At the meeting, the Dissertation Committee makes the decision whether the student is ready to defend her/his work based on the presentation and draft dissertation.
4. If the committee agrees that the student is ready to defend his/her dissertation, they signify by signing the Defense Approval Form (see Academic Program Coordinator for a copy of this form).
5. Students should be aware of the submission date for the final approved dissertation for archiving before they set their final oral examination date. Refer to the Graduate College's Dates and Deadlines for graduation at https://grad.arizona.edu/gsas/degree-requirements/important-degree-dates-and-deadlines.
6. The student is also responsible to complete the Announcement of Final Oral Defense in UAccess.
7. If the Dissertation Committee determines that the Ph.D. student is not ready to defend, the Academic Program Coordinator will decline the Announcement of Final Oral Defense form in UAccess and notify the BE Director of Graduate Studies and Department Head of the findings. The Major Professor and the student will send an email notice with the new "Program Completion Date (Graduation Term)" to the Academic Program Coordinator, the BE Director of Graduate Studies, and Graduate College Degree Check Advisor.
8. Upon receiving the signed Defense Approval Form from the candidate, the Academic Program Coordinator will notify the BE Director of Graduate Studies via GradPath, and the candidate may then set the Final Oral Defense date a minimum of two weeks after consultation with their Dissertation Committee members.
9. The Academic Program Coordinator will have the necessary paperwork sent to the Graduate College and also send an email to the department faculty, students, and staff with the date and location of the final oral defense.
10. The student is responsible for posting the announcement, at least a week prior to the final oral defense date. The announcement should include the title, date, and location of the defense.
11. The Academic Program Coordinator will approve the Announcement of Oral Defense form in GradPath. Approval by the Director of Graduate Studies completes the process.

### 7.13.3 Reporting Results of the Final Oral Defense

After the Final Oral Defense, the candidate's Dissertation Committee will determine if the student passed, passed with revisions, or failed. The Committee should follow the Graduate College procedures for the Final Oral Defense located at https://arizona.app.box.com/v/grad-gsas-finaldefnsinstr.

If the student passed the final oral defense without revisions, the student may proceed with dissertation submission. The Major Professor should submit a Change of Grade Form to the Academic Program Coordinator and report the results in GradPath.

### If the student passed the final oral defense with revisions,

1. The Dissertation Committee must determine the date that the student needs to resubmit the corrections to the committee.
2. The Major Professor will need to enter this date in the GradPath form.
3. After the Dissertation Committee approves the final corrected revisions, the Major Professor sends an email to the Graduate Auditor and the Graduate Coordinator confirming the final results for degree completion as well as submits a Change of Grade Form in GradPath. Once the final revisions are approved, the student will be advised to complete the submission process.

If the student failed the final oral defense, he/she should contact the Graduate College.

## 7.14 Dissertation Submission

Following a successful Final Oral Defense, the candidate must submit an approved dissertation in electronic format to the Graduate College for forwarding to the University of Arizona Library at http://www.etdadmin.com/cgi-bin/school?siteId=63. For further instructions, refer to the Dissertation/Thesis Submission site at https://grad.arizona.edu/gsas/degree-requirements/doctor-philosophy#final-oral-defense. The dissertation must

also be submitted as an electronic copy to the BE department. In addition, the candidate's Major Professor and Dissertation Committee may require copies of the dissertation in electronic format. Check with your Major Professor for any special requirements.

Upon receipt of the finalized dissertation, the Dean of the Graduate College will recommend conferral of the doctoral degree by the Arizona Board of Regents. Once the Graduate College Degree Auditor receives the final result for the Defense they will send the student information on the Dissertation Submission process.

### 7.15 Dual Degrees

Dual degree programs allow qualified students an opportunity to earn two degrees with a reduction in the total number of credit hours required by allowing students to use a certain number of units in common between the two degrees. The number of shared units varies by the dual degree program. Please contact individual departments for more specific information about their dual degree programs.

# APPENDIX A

## EXAMPLE OF PLAN OF STUDY FOR THE ACCELERATED MASTER'S PROGRAM (AMP)

Senior Year/1st Year in AMP

| Course | Unit | Course | Unit |
|---|---|---|---|
| Fall Semester | | Spring Semester | |
| BE 496a (Seminar in Engr Careers & Professions) | 1 | BE 498b (Biosystems Engineering Design 2) | 3 |
| BE 498a (Biosystems Engineering Design 1) | 3 | 500-level BE Elective | 3 |
| 500-level BE Elective | 3 | 500-level BE Elective | 3 |
| 500-level TECH Elective | 3 | 400-level TECH Elective | 3 |
| AME 324a (Mechanics of Materials) | 3 | Tier 2 ART/HUM | 3 |
| Tier 2 INDV | 3 | | |
| BE 493 (Internship) | 1 | | |
| Total | 17 | Total | 15 |

AMP 2nd Year

| Course | Unit | Course | Unit |
|---|---|---|---|
| Fall Semester | | Spring Semester | |
| BE 696a-002 (Presenting Seminar) | 1 | BE 696a-002 (Presenting Seminar) | 1 |
| 500-level BE Elective | 3 | STAT 571b | 3 |
| 500-level TECH Elective | 3 | BE 501 | 2 |
| BE 910 (Thesis) or BE 909 (Engineering Report) | 3 | BE 910 (Thesis) or BE 909 (Engineering Report) | 2 |
| Total | 10 | Total | 8 |

# APPENDIX B

## THESIS/MS ENGINEERING REPORT/DISSERTATION REQUIREMENTS

### Thesis/Dissertation Paper Requirements

Objectives

MS Thesis Option and Ph.D. students are required to submit papers for publication refereed scientific journals by the time of their Final Oral Examination. The primary objectives of the option are:

i. To encourage graduate students to learn the submission/publication processes of refereed journals before graduation and
ii. To shorten the process of publishing papers from thesis/dissertation.

Similar options are available in many European and US institutions (including at least two departments at the UA). Sample Thesis and Dissertation papers completed under this option are available in the department for check out. These are also available through the UA library. If you have any questions, please do not hesitate to contact the Director of Graduate Studies and/or your Faculty Advisor.

Guidelines

- MS – one paper/manuscript with the student as the first author-approved for submission to a refereed journal by the committee and the major advisor is required.
  Ph.D. – two papers/manuscripts with the student as the first author in at least one paper approved for submission to a refereed journal by the committee and the major advisor is required.

- Prior to the submission of each manuscript, a Faculty Advisor's (and co-advisors, if any) approval is required. After the Faculty Advisor's review, each manuscript must be approved by a majority of the Advisory Committee members (or all Dissertation Committee members if there are three or less). Please remember to attach the signature page for the BE paper for each manuscript. Signature page can be obtained Appendix E.

- The Advisory Committee will decide when the paper is ready for defense. Students must give a copy of the penultimate paper ***three weeks*** (minimum) before the scheduled defense.

## Recommended Thesis/Dissertation Format

Title Page

Signature Page (dissertation only)

Statement by Author

Acknowledgments

Dedication

Table of Contents (begins with List of Illustration/Tables)

List of Illustrations (from Introduction & Present Study)

List of Tables (from Introduction & Present Study)

Abstract

**Chapter 1.** Introduction

- Explanation of the problem(s), objectives, and uniqueness.
- The relationship of the manuscripts included and your contribution to each of the manuscripts.
- Specify your role in the research and production of the manuscript(s). Where research efforts are part of the larger collaborative project, identify one aspect of the project as your own and demonstrate an original contribution.
- An overall literature review and background.

**Chapter 2.** Present Study

- Overall summary.
- Overall conclusions and recommendations.

**Appendices:**

- Manuscript No. 1[1]
- Manuscript No. 2[1]
- Supplementary materials - Materials such as data tables, additional references, graphs, computer programs, and maps.
- All appendix pages are part of the single pagination sequence of the thesis/dissertation.

[1]The first page each manuscript must include the title, a list of co-authors, and a refereed journal to which the manuscript was submitted. The statement of permission for use of copyrighted material should be attached if needed.

## Recommended Engineering Report (Non-thesis) Format

NOTE: This format is intended for those students not conducting specific research. If conducting experimental research, follow the Thesis format guidelines minus the requirement for submitting a paper.

Executive Summary
Abstract
Acknowledgments
Introduction
- Statement of Problem
- Background
- Purpose and Overview of the Project

Methods and Design Approach
- Alternative Analysis
  - Preferred Alternative Decision Matrix
- Technical Description
- Specifications
- Construction Materials
- External Constraints

Operation & Maintenance
Lifecycle Cost
Intellectual Property
Draft Business Plan (Advisor's Discretion, can be an appendix)
- Company Structure
  - Company Type (LLC, S Corp, C Corp)
  - Organization and Management
- Market Analysis
  - Need/Market analysis
  - Sales Strategy
  - Sales Projections

Financial Analysis

Capital Financing Requirements

Operating Capital Requirements

Cash Flow Projections

Growth Potential

## Conclusions

How well does the product actually work?

Does the product solve the problem that your company wanted to be solved?

What are the weaknesses and limitations of your product?

What parts of the original problem were more difficult than anticipated?

What hopes for your solution did not turn out?

## Recommendations

What recommendations do you have for the company?

Should they begin immediate production of the prototype?

Should they do further testing of the prototype?

Should they put out an RFP for further research? Should they do a market study?

## References and Citations

Follow APA standard format throughout the text.

# APPENDIX C

## CHECKLISTS FOR COMPLETING THE STEPS IN THE MS, AMP, AND PhD DEGREES

THE UNIVERSITY OF ARIZONA
COLLEGE OF AGRICULTURE & LIFE SCIENCES
COLLEGE OF ENGINEERING
Biosystems Engineering

# CHECKLIST FOR COMPLETING THE STEPS IN THE MS DEGREE

This checklist is to be completed by the end of your first semester in the program in agreement with your major professor as indicated by his/her signature at the bottom of this form/checklist. Once this form is signed, please submit a copy to the Academic Program Coordinator, Ms. Dava Jondall.

**Name:**

| Activity | Proposed Deadline | Actual Date Completed |
|---|---|---|
| Choose Major Professor<br>**DEADLINE:** End of 1st semester | | |
| Choose Graduate Committee<br>**DEADLINE:** End of 1st semester | | |
| Meet with Major Professor and Graduate Committee to establish PLAN OF STUDY and RESEARCH TOPIC<br>**DEADLINE:** End of 1st semester | | |
| Submit the PLAN OF STUDY to GradPath<br>**DEADLINE:** End of 1st semester | | |
| Complete draft of RESEARCH PROPOSAL<br>**DEADLINE:** upon completion of BE 501 | | |
| Complete final RESEARCH PROPOSAL and submit to Academic Program Coordinator<br>**DEADLINE:** no later than the end of 2nd semester in the program | | |
| Submit draft THESIS/ENGINEERING REPORT to Graduate Committee for approval to defend<br>**DEADLINE:** ***Final Semester:*** 1 month ***before*** proposed defense date AND 1 week ***before*** meeting with Graduate Committee | | |
| Meet with Graduate Committee<br>**DEADLINE:** ***Final Semester:*** 1 week ***after*** submitting draft Thesis/Engineering Report | | |
| Submit signed DEFENSE APPROVAL form to Academic Program Coordinator<br>**DEADLINE:** ***Final Semester:*** Within 24 hours of meeting with Graduate Committee to review draft Thesis/Engineering Report | | |
| Schedule FINAL ORAL DEFENSE date with Graduate Committee<br>**DEADLINE:** ***Final Semester:*** Date must be no later than 1 week ***before*** Graduate College deadline for final submission AND 2 weeks ***after*** meeting with Graduate Committee to review draft Thesis/Engineering Report | | |
| Post FINAL ORAL DEFENSE announcement<br>**DEADLINE:** ***Final semester:*** A minimum of a week before the defense date | | |

| Activity | Proposed Deadline | Actual Date Completed |
|---|---|---|
| COMPLETION OF DEGREE REQUIREMENTS done by the Academic Program Coordinator after receiving the final defense result from the major professor<br>DEADLINE: ***Final semester:*** The major professor should report to the Academic Program Coordinator on the day of the defense:<br>1. If pass with revision, the revision due date must be entered and must be before the graduate college due date.<br>a. On the date the revision is due, the major professor needs to report results of either pass or fail.<br>b. If the revisions are not completed on time, the major professor should contact the Academic Program Coordinator and the Graduate College.<br>If fail, contact the Academic Program Coordinator and the Graduate College. | | |
| Meet with Department Head to complete EXIT SURVEY<br>DEADLINE: ***Final semester:*** within 2 weeks of graduation | | |
| Submit an electronic copy of THESIS/ ENGINEERING REPORT to the Graduate Degree Certification Office. For instructions, see Thesis Archiving at https://grad.arizona.edu/gsas/degree-requirements/masters-degrees#thesis-archiving<br>DEADLINE: ***Final semester:*** upon completion of degree requirements | | |
| Submit an electronic copy to BE Department Head<br>DEADLINE: ***Final semester:*** upon completion of degree requirements | | |

_____ _____

Major Professor signature Date

THE UNIVERSITY OF ARIZONA
COLLEGE OF AGRICULTURE & LIFE SCIENCES
COLLEGE OF ENGINEERING
Biosystems Engineering

# CHECKLIST FOR COMPLETING THE STEPS IN THE ACCELERATED MASTER'S PROGRAM (AMP)

This checklist is to be completed by the end of first semester in the program in agreement with your major professor as indicated by his/her signature at the bottom of this form/checklist. Once this form is signed, please submit a copy to the Academic Program Coordinator, Ms. Dava Jondall.

**Name:**

| Activity | Proposed Deadline | Actual Date Completed |
|---|---|---|
| Choose Major Professor<br>DEADLINE: End of last semester of the senior year | | |
| Choose Thesis/Engineering Report Committee<br>DEADLINE: End of last semester of the senior year | | |
| Meet with Major Professor and Graduate Committee to establish PLAN OF STUDY and RESEARCH TOPIC<br>DEADLINE: End of last semester of the senior year | | |
| Submit the PLAN OF STUDY to GradPath<br>DEADLINE: Semester following the end of last semester of the senior year | | |
| Complete draft of RESEARCH PROPOSAL<br>DEADLINE: upon completion of BE 501 | | |
| Complete final RESEARCH PROPOSAL and submit to Academic Program Coordinator<br>DEADLINE: no later than the end of the 2nd semester in the program | | |
| Submit draft THESIS/ENGINEERING REPORT to Graduate Committee for approval to defend<br>DEADLINE: *Final Semester:* 1 month ***before*** proposed defense date AND 1 week ***before*** meeting with Graduate Committee | | |
| Meet with Graduate Committee<br>DEADLINE: *Final Semester:* 1 week ***after*** submitting draft Thesis/Engineering Report | | |
| Submit signed DEFENSE APPROVAL form to Academic Program Coordinator<br>DEADLINE: *Final Semester:* Within 24 hours of meeting with Graduate Committee to review draft Thesis/Engineering Report | | |
| Schedule FINAL ORAL DEFENSE date with Graduate Committee<br>DEADLINE: *Final Semester:* Date must be no later than 1 week ***before*** Graduate College deadline for final submission AND 2 weeks ***after*** meeting with Graduate Committee to review draft Thesis/Engineering Report | | |
| Post FINAL ORAL DEFENSE announcement<br>DEADLINE: *Final semester:* A minimum of a week before the defense date | | |

| Activity | Proposed Deadline | Actual Date Completed |
|---|---|---|
| COMPLETION OF DEGREE REQUIREMENTS done by the Academic Program Coordinator after receiving the final defense result from the major professor<br>DEADLINE: ***Final semester:*** The major professor should report to the Academic Program Coordinator on the day of the defense:<br>1. If pass with revision, the revision due date must be entered and must be before the graduate college due date.<br>a. On the date the revision is due, the major professor needs to report results of either pass or fail.<br>b. If the revisions are not completed on time, the major professor should contact the Academic Program Coordinator and the Graduate College.<br>2. If fail, contact the Academic Program Coordinator and the Graduate College. | | |
| Meet with Department Head to complete EXIT SURVEY<br>DEADLINE: ***Final semester:*** within 2 weeks of graduation | | |
| Submit an electronic copy of THESIS/ ENGINEERING REPORT to the Graduate Degree Certification Office. For instructions, see Thesis Archiving at https://grad.arizona.edu/gsas/degree-requirements/masters-degrees#thesis-archiving<br>DEADLINE: ***Final semester:*** upon completion of degree requirements | | |
| Submit an electronic copy to BE Department Head<br>DEADLINE: ***Final semester:*** upon completion of degree requirements | | |

_____ _____

Major Professor signature Date

THE UNIVERSITY OF ARIZONA
COLLEGE OF AGRICULTURE & LIFE SCIENCES
COLLEGE OF ENGINEERING
Biosystems Engineering

# CHECKLIST FOR COMPLETING THE STEPS IN THE Ph.D. DEGREE

This checklist is to be completed by the end of the first semester in the program in agreement with your major professor (as indicated by his/her signature at the bottom of this form/checklist. Once this form is signed, please submit a copy to the Academic Program Coordinator, Ms. Dava Jondall.

**Name:**

| Activity | Proposed Deadline | Actual Date Completed |
|---|---|---|
| Meet with BE Director of Graduate Studies to discuss options and procedures for choosing a Major Professor<br>**DEADLINE:** First few weeks beginning the program | | |
| Choose Major Professor<br>**DEADLINE:** End of 1st semester | | |
| Choose Dissertation Committee<br>**DEADLINE:** End of 1st semester | | |
| Meet with Major Professor and Dissertation Committee to establish PLAN OF STUDY and RESEARCH TOPIC<br>**DEADLINE:** End of 1st semester | | |
| Submit the PLAN OF STUDY to GradPath<br>**DEADLINE:** End of 1st semester | | |
| Complete draft of RESEARCH PROPOSAL<br>**DEADLINE:** upon completion of BE 501 or end of 2nd semester | | |
| Complete final RESEARCH PROPOSAL and submit to Academic Program Coordinator<br>**DEADLINE:** end of 3rd semester | | |
| Completion of the Announcement of COMPREHENSIVE EXAMINATION in GradPath<br>**DEADLINE:** After completing all/most of coursework | | |
| Complete written portion of COMPREHENSIVE EXAMINATION<br>**DEADLINE:** After completing all/most of coursework | | |
| Complete oral portion of COMPREHENSIVE EXAMINATION<br>**DEADLINE:** Within 2 weeks of successful completion of the written portion | | |
| Submit 2 papers for publication and draft DISSERTATION to Dissertation Committee for approval to defend<br>**DEADLINE:** ***Final Semester:*** 1 month ***before*** the proposed date of the oral defense | | |
| Meet with Dissertation Committee<br>**DEADLINE:** ***Final Semester:*** 1 week ***after*** submitting draft Thesis/Engineering Report | | |

| Activity | Proposed Deadline | Actual Date Completed |
|---|---|---|
| Submit signed DEFENSE APPROVAL form to Academic Program Coordinator<br>DEADLINE: ***Final Semester:*** Within 24 hours of meeting with Dissertation Committee to review draft Dissertation and 2 publications | | |
| Schedule FINAL ORAL DEFENSE date with your Dissertation Committee<br>DEADLINE: ***Final Semester:*** Date must be no later than 1 week ***before*** Graduate College deadline for final submission AND 2 weeks ***after*** meeting with Dissertation Committee to review draft dissertation and 2 publications | | |
| Schedule FINAL ORAL DEFENSE date through GradPath<br>DEADLINE: ***Final semester:*** At least 2 weeks in advance of the Oral Defense And at least 2 weeks ***after*** meeting with Dissertation Committee | | |
| Post FINAL ORAL DEFENSE announcement<br>DEADLINE: ***Final semester:*** A minimum of a week before the defense date | | |
| COMPLETION OF DEGREE REQUIREMENTS form to the Graduate Degree Certification Office<br>DEADLINE: ***Final semester:*** The major professor should report to the Academic Program Coordinator AND login to GradPath on the day of the defense:<br>1. If pass with revision, the revision due date must be entered and must be before the graduate college due date.<br>a. On the date the revision is due, the major professor needs to report results of either pass or fail.<br>b. If the revisions are not completed on time, the major professor should contact the Academic Program Coordinator and the Graduate College.<br>2. If fail, contact the Academic Program Coordinator and the Graduate College. | | |
| Meet with Department Head to complete EXIT SURVEY<br>DEADLINE: ***Final semester:*** within 2 weeks of graduation | | |
| Submit an electronic copy of DISSERTATION to the Graduate Degree Certification Office. For instructions, see Storage and Publication of Dissertation at https://grad.arizona.edu/gsas/degree-requirements/doctor-philosophy#store-publish-dissertation<br>DEADLINE: ***Final semester:*** upon completion of degree requirements | | |
| Submit an electronic copy to BE Department Head<br>DEADLINE: ***Final semester:*** upon completion of degree requirements | | |

_____ _____

Major Professor signature Date

## APPENDIX D

## List of Faculty Who Can Serve on Committees as Sole Graduate Committee Chairs

NOTE: Anyone not on this list may serve as a co-chair, but not as a sole chair.

An, Lingling, Associate Professor, Ph.D., 2008, Purdue University. Statistical bioinformatics, statistical methods for detecting and predicting biological threats.

Andrade-Sanchez, Pedro, Associate Professor & Extension Specialist, PhD, 2004, University of California, Davis. Precision agriculture.

Barton, Jennifer, Interim Vice President for Research and Jointly-appointed Professor in Biomedical Engineering, Ph.D., 1998, The University of Texas at Austin. Translational biomedical optics, and the prevention and early detection of cancer.

Cuello, Joel, Professor, Ph.D., 1994, Pennsylvania State University. Bioreactor design and scale up, algae production systems, controlled-environment systems, cell and organ cultures regulations.

Didan, Kamel, Associate Professor, Ph.D., 1999, University of Arizona. Remote sensing data, algorithms, and modeling time series analysis.

Duan, Guohong "Jennifer," Jointly-appointed Associate Professor in Civil Engineering & Engineering Management, Ph.D., 1998, University of Mississippi. Experimental studies and computational simulation of turbulent flow, sediment transport, and channel morphological processes.

Farrell-Poe, Kathryn "Kitt," Department Head, Professor, and Extension Specialist, Ph.D., 1990, Purdue University. Water quality, onsite wastewater treatment, safe drinking water, extension education/outreach.

Fitzsimmons, Kevin, Jointly-appointed Professor in Soil, Water, and Environmental Sciences, Ph.D., 1999, University of Arizona. Aquaculture.

Franklin, Edward, Jointly-appointed Associate Professor in Agricultural Education, Ph.D., 2000, Oklahoma State University. Renewable energy.

Giacomelli, Gene, Professor, Extension Specialist, and Director of the Controlled Environment Agriculture Program, Ph.D., 1983, Rutgers University. Horticultural engineering, energy conversions engineering, bioresource engineering, greenhouse engineering design, hydroponic crop production.

Hurwitz, Bonnie, Assistant Professor, Ph.D., 2012, University of Arizona. Bioenvironment & one health, functional metagenomics, big data, system biology, bioinformatics and computational biology.

Kacira, Murat, Professor, Ph.D., 2000, Ohio State University. Controlled environment agriculture, food, agricultural, and biological engineering.

Lyons, Eric, Associate Professor, Ph.D., 2008, University of California, Berkeley. Biosystems analytics, cyberinfrastructure for life sciences, computational systems for genomes, advanced visualization of genomic data.

Martin, Edward, Professor, Extension Specialist, and Director of the Maricopa County Extension, Ph.D., 1992, Michigan State University. Water resources, irrigation management.

Ogden, Kimberly, Jointly-appointed Professor in Chemical & Environmental Engineering, Ph.D., 1991, University of Colorado, Boulder. Bioreactor design for the production of alternative e fuels from algae and sweet sorghum and microbiological water quality.

Pepper, Ian, Jointly-appointed Professor in Soil, Water, and Environmental Sciences and Director of the Water Quality Center, Ph.D., 1975, The Ohio State University. Soil microbiology.

Piegorsch, Walter, Jointly-appointed Professor in Mathematics & Chair of Statistics GIDP, Ph.D., 1984, Cornell University. Statistics.

Poe, Stephen, Professor and Extension Specialist, Ph.D., 1987, Purdue University. System mechanization, livestock waste management, ventilation housing, and computer software development.

Pryor, Barry, Professor, Ph.D., 1999, University of California, Davis. Controlled environment agriculture, mycology, fungal detection, and control.

Siemens, Mark, Associate Professor, and Extension Specialist, Ph.D., 1996, University of Arizona. Specialty crops mechanization, agricultural machine design and testing, tillage.

Slack, Donald, Professor, PE, Ph.D., 1975, University of Kentucky. Irrigation scheduling, water resources, infiltration, porous media flow, soil, and water conservation engineering.

U'Ren, Jana, Assistant Professor, Ph.D., 2011, University of Arizona. Earth systems genomics.

Waller, Peter, Associate Professor, Ph.D., 1990, University of California, Davis. Water quality engineering, irrigation engineering, drainage engineering.

Yitayew, Muluneh, Professor and BE Director of Graduate Studies, Ph.D., 1982, University of Arizona. Irrigation engineering, hydraulics, water resources engineering.

Yoon, Jeong-Yeol, Professor, Ph.D., 2004, University of California, Los Angeles. Biosensors, water safety, lab-on-a-chip, protein nanoarray, immunoassay, biomaterials.

**APPENDIX E**

# FORMS

THE UNIVERSITY OF ARIZONA
COLLEGE OF AGRICULTURE & LIFE SCIENCES
COLLEGE OF ENGINEERING
Biosystems Engineering

## BE 693, TEACHING EXPERIENCE INTERNSHIP

The BE department recognizes that many Ph.D. students will end up in faculty roles and teaching at universities or colleges. We want to help prepare you for that event. Therefore, all PhD students are required to have one unit of BE 693, Teaching Experience Internship, to document their teaching experience. You have six methods from which to choose to meet the teaching experience internship. Methods 1-4 outlined below are classes that you can take, in lieu of signing up for BE 693, to help you learn more about teaching in upper education.

## METHODS

1. FCSC/CALS 696E, Learner-Centered Teaching for Online Delivery (1 unit; Fall, Spring). This seminar course is designed to introduce students to common pedagogical issues associated with both assisting in, and teaching learner-centered courses in online formats.
2. IA 697A, Learner-Centered Teaching (3 units; Fall, Spring). This course provides a foundation in learner-centered teaching and includes theories of adult learning, approaches to course and lesson design, techniques to assess learning, and development of reflective teaching practices. It is appropriate for instructors who want to improve their teaching and is required for students in the Certificate in College Teaching program.
3. IA 697B, Using Technology in Teaching (3 units; Fall, Spring). This course combines in-depth reading and discussion related to pedagogical issues in the use of technology in teaching and learning with guided, individually focused training and practice in using technology in teaching.
4. IA 697G, Universal Design: Inclusive Learning Environments (3 units; Fall, Spring). This course provides a comprehensive review of the theory, strategies, and techniques used in instructional design processes that foster inclusive learning environments for all learners. The curriculum addresses characteristics of learners such as learning differences and preferences and 21st-century learning attributes, approaches for utilizing differentiated instruction, engagement and motivation techniques, classroom management tactics, and universal design strategies. Emphasis will be placed on critical review of the literature as practically applied to various learning environments and contexts in post-secondary education.
5. Complete the Certificate in College Teaching through the Office of Instruction & Assessment (https://grad.arizona.edu/catalog/programinfo/CLTCRTG or http://cct.oia.arizona.edu)
6. Serve as a GTA for one semester – *if the GTA experience has significant teaching responsibilities.*

## PROOF OF COMPLETION

| Graduate Teaching Experience Option | Proof of Completion |
|---|---|
| FCSC/CALS 696E, | Class grade |
| IA 697A | Class grade |
| IA 697B | Class grade |
| IA 697G | Class grade |
| Certificate in College Teaching through OIA | Copy of Certificate |
| GTA, one semester | Assessment by GTA instructor |

THE UNIVERSITY OF ARIZONA
COLLEGE OF AGRICULTURE & LIFE SCIENCES
COLLEGE OF ENGINEERING
Biosystems Engineering

# BE TEACHING EXPERIENCE PLAN for Ph.D. Students

Student Name _____ Student ID #_____

## Method to Achieve BE 693 credit

- ☐ FCSC/CALS 696E (in lieu of signing up for BE 693)
- ☐ IA 697A (in lieu of signing up for BE 693)
- ☐ IA 697B (in lieu of signing up for BE 693)
- ☐ IA 697G (in lieu of signing up for BE 693)
- ☐ Graduate Teaching Certificate
- ☐ GTA, 1 semester*

## Semester and Year to Complete BE 693 _____

## Student's Signature_____ _____

## Date _____

*If GTA is chosen to meet BE 693, the following section needs to be completed

Teaching Experience Advisor Name _____

Instructor's Section Number _____

Instructor's Signature _____ Date _____


THESIS/DISSERTATION PAPER CERTIFICATION FOR SUBMITTED/PUBLISHED MANUSCRIPT

As members of the Graduate Committee/final examination committee, we have read the manuscript(s)

*Prepared by:* _____

*Entitled:* _____

*Approved submission to:* _____

*In partial fulfillment of the requirements for the degree of:* _____

APPROVED BY:

| | |
|---|---|
| Major Professor *(print and sign name)* | Date |
| Committee Member *(print and sign name)* | Date |
| Committee Member *(print and sign name)* | Date |
| Committee Member *(print and sign name)* | Date |


FINAL ORAL DEFENSE APPROVAL FORM

As members of the Graduate Committee, we certify that we have read the Thesis/Engineering Report/Dissertation and confirm that the student is ready to defend.

*Student:* _____ *Student ID:*_____

Title: _____

APPROVED BY:

| | |
|---|---|
| Major Professor *(print and sign name)* | Date |
| Committee Member *(print and sign name)* | Date |
| Committee Member *(print and sign name)* | Date |
| Committee Member *(print and sign name)* | Date |

**APPENDIX F**

# ASSESSMENT RUBRICS

THE UNIVERSITY OF ARIZONA
Department of Biosystems Engineering
BE 696A GRADUATE SEMINAR

## Speaker Evaluation Sheet

NAME OF SPEAKER_____DATE:_____
Use the following areas of consideration to comment positively or negatively, but always helpfully, on the presentation given.

| | **Rating 5 = Best 1 = Worst** |
|---|---|
| Articulation and professional demeanor: Did the speaker speak out with a clear voice? Pronounce all words well? Was there a voice drop off? Were there any distracting mannerisms? Did the speaker speak too fast or too slow? | 5 4 3 2 1<br>Comments: |
| Organization: Was there a meaningful introduction to the topic that set the stage for what was to come? Were the ideas presented in a logical order? Was the speaker easy to follow? Was there a solid summary and/or conclusions? Were we prepared for the end? | 5 4 3 2 1<br>Comments: |
| Quality and appropriateness of visual aid: Did slides meet all dimensional requirements? Were there enough slides to support the message? Could you understand all slides? | 5 4 3 2 1<br>Comments: |
| Use of Time: Was an appropriate amount of time devoted to each part of the presentation? Did the speaker end on time? Did he/she appear rushed? Was time used effectively? | 5 4 3 2 1<br>Comments: |
| Response to questions: Were questions answered clearly? Was response limited to the question asked? | 5 4 3 2 1<br>Comments: |

OTHER COMMENTS:

THE UNIVERSITY OF ARIZONA
COLLEGE OF AGRICULTURE & LIFE SCIENCES
COLLEGE OF ENGINEERING
Biosystems Engineering

## Engineering Report/Thesis/Dissertation Oral Defense Evaluation Form

Student Name: _____

Title of Report/Thesis/Dissertation: _____

Committee Member: _____ Date: _____

**Directions:**
Evaluate this student's engineering report/thesis/dissertation oral defense of the research with a score between 1 (Poor) and 4 (Excellent) for each of the criteria described below using the attached rubric. Briefly comment on the rationale if your score is less than 4. Submit your completed scoring sheet to the committee chair before leaving the defense.

| Score (1 – 4) | Criterion | Comment |
|---|---|---|
| | Organization of Oral Defense | |
| | Presentation Style | |
| | Presentation Pace | |
| | Content: Depth | |
| | Content: Accuracy | |
| | Use of Visual Aids | |
| | Responsiveness to Audience | |

## Engineering Report/Thesis/Dissertation Oral Defense Presentation Rubric

| Criteria | Excellent (4) | Good (2) | Fair (3) | Poor (1) |
|---|---|---|---|---|
| Organization | The presentation is clear and logical. The listener can easily follow the line of reasoning. | The presentation is generally clear. A few minor points may be confusing. | The listener can follow the presentation with effort. The organization not well thought out | The presentation is very confused and unclear. Listeners cannot follow it. |
| Style | The level is appropriate for presentation of engineering results. Not too casual. Speakers are easy to hear and understand. | The level is generally appropriate. May have some trouble in hearing or understanding a speaker. | The presentation is too informal or unprepared. Difficult to hear or understand speakers. Much information is read. | The presentation is consistently at an inappropriate level. Information is read. Speakers can't be heard or understood. |
| Pace (N/A for peer evaluation) | The presentation is a planned conversation, paced for audience understanding. | One speaker 's pacing is too fast or too slow, repetitive or skipping important details. | More than one speaker is too fast or too slow, repetitive or skipping important details. | The presentation is far too long or far too short. Speakers generally are too fast or too slow. |
| Content: Depth | Design, methods, results, conclusions are clearly stated. Implications of results and "where do we go from here" discussed. | Description of project and results are generally clear. Some discussion of what results mean. | Some components of project description are minimal or missing. Little discussion of what results mean. | Description of project and results are very difficult to follow. No discussion of the meaning of results. Listeners learn little. |
| Content: Accuracy | Information given is consistently accurate. Facts and calculations are correct. | No significant errors are made. Listeners recognize errors as result of oversight or nervousness. | Enough errors made to be distracting, but some information is accurate. | Information is so inaccurate that listener cannot depend on the presentation. |
| Use of Visual Aids (N/A for peer evaluation) | Aids prepared in a professional manner. The font is large enough to be seen by all. Well organized. Main points stand out. | Aids contribute, but not all material supported by aids. Font size is appropriate for reading. | Aids are poorly prepared or used inappropriately. The font is too small. Too much information is included. | No aids are used, or they are so poorly prepared that they detract from the presentation. |
| Responsiveness to Audience | Responds well to questions. Restates and summarizes when needed. | Generally responsive to questions. | Reluctantly interacts with the audience. Responds poorly to questions. | Avoids audience interaction. Not responsive to the group. |

THE UNIVERSITY OF ARIZONA
COLLEGE OF AGRICULTURE & LIFE SCIENCES
COLLEGE OF ENGINEERING
Biosystems Engineering

## Exit Survey for Graduate Students

Place an "X" in each row to indicate the degree to which your graduate program provided you the opportunity to:

| | Excellent | Good | Neutral | Fair | Comments |
|---|---|---|---|---|---|
| Acquire broad knowledge in my focus area | | | | | |
| Develop skills in critical analysis of research literature in the program | | | | | |
| Design and conduct original research on the BE problem | | | | | |
| Improve my ability to defend research results in scientific peers | | | | | |

1. Please describe learning opportunities for other specific skills or knowledge that this academic program should improve upon.

2. Please provide us with your email and mailing address for future communications from the BE Department.