

Request to Establish New Academic Program in Arizona

Please complete all fields. Boxes may be expanded to accommodate longer responses. Clarifying field descriptions can be found below.

University: University of Arizona

Name of Proposed Academic Program: PhD in Software Engineering
Academic Department: Systems & Industrial Engineering / Electrical & Computer Engineering
Geographic Site: UA Main (Tucson)
Instructional Modality: Online
Total Credit Hours: 63
Proposed Inception Term: Fall 2023
<p>Brief Program Description:</p> <p>The PhD Software Engineering curriculum applies software engineering fundamentals to develop and produce computing-based products/solutions. The MS SFWE program is grounded in solid engineering practices and principles governed by the IEEE Software Engineering Body of Knowledge (IEEE SWEBOK). IEEE SWEBOK recommends specific skills that all software engineers should possess regardless of their programming languages and platforms. Our curriculum focuses on the application of a systematic, disciplined, quantifiable approach to the development, operation, and maintenance of software. The PhD curriculum also builds upon the MS Software Engineering program by adding additional coursework and research opportunities for students wishing to pursue a PhD in Software Engineering.</p> <p>The PhD SFWE program has a firm engineering foundation that encompasses discovery-based education utilizing an experiential learning approach. As a part of the curriculum, students will complete projects in areas that emphasize software engineering, communication, teamwork, critical thinking, and engineering professionalism. In the PhD program, students will also conduct novel research in many diverse software engineering related areas. The program's flexibility allows students to design their course of study / research from a diverse pool of courses and research opportunities in software and computer engineering domains such as web and mobile applications, embedded systems, cybersecurity, machine learning, systems, and other interdisciplinary areas.</p>
<p>Learning Outcomes and Assessment Plan:</p> <p>Learning Outcome #1: Demonstrate broad knowledge in the student's field in software engineering.</p> <p>Concepts: Students will study and research diverse topics in software engineering including software engineering fundamentals, software development and security operations (SW DevSecOps), software requirements analysis and test, software architecture and design,</p>

distributed computing, data mining, cloud computing, software for industrial control systems, robotics and a variety of other computing topics that vary based on the electives the student opts to take.

Competencies: Students will demonstrate the ability to design, develop, test, integrate and evaluate software applications/products/systems in diverse computing and engineering domains. Students will also apply their acquired knowledge in these areas to conduct original and novel research in state-of the-art and advanced software engineering principles, processes, and methodologies to meet the requirements/needs of diverse engineering applications.

Assessment Methods: For every new 5xx / 6xx SFWE course, a rubric will be created that identifies criteria/source of evidence, assessment measures, and an achievement level rating for specified course performance indicators used to measure this outcome. For each course that contributes to this outcome, specific student artifacts for a given course will be evaluated and assessed.

The sources of evidence can include class assignments, exams, projects, papers / reports and other forms of student work. For new courses, the specific evidence used will be defined as the course is developed and re-evaluated as part of the continuous improvement activities for the program/course. For existing courses (predominately technical electives), the evidence used to measure the effectiveness of the student outcome have been defined and will be followed. The rubric achievement levels will include: “Exemplary”, “Satisfactory”, “Developing”, and “Unsatisfactory”.

At the end of every semester, a team comprised of the course instructor and the SIE/ECE Graduate Studies Committee (GSC)s, will score the rubric using the assessment measures identified for the course. A root cause and corrective action plan will be developed for any course that scores “Developing” or below. Assessment results are documented and formally maintained in a controlled location at the end of each semester and will be published as appropriate. The scores will be tracked over time to facilitate the continuous improvement and corrective action plans remain effective from semester to semester, year to year.

Measures: Rubrics will be used for the specific graded student artifact for a given course that clearly evaluates the learning objectives and outcomes of the assignment and/or projects that students are asked to complete. All rubrics are developed by faculty members with expertise in software engineering domains. Faculty may consult with instructional designers as appropriate to ensure the course learning outcomes are measurable and contribute to the overall program learning outcomes. Exams are also used to assess and measure student learning. Throughout the degree program, the student’s core course cumulative GPA will be used as a global measure of the overall student software engineering knowledge.

Additionally, the student’s score on the Doctoral Qualifying Exam (DQE) is used to assess the student’s fundamental knowledge in specific SFWE domains and whether students have a comprehensive understanding of the concepts and theories taught in those domains. The student’s score on the Doctoral Comprehensive Exam will also be used to measure the student’s background and expertise in the field of their research / dissertation.

Learning Outcome #2: Critically analyze and review published research results and other literature related to the student’s area of study.

Concepts: Students will learn various research techniques to interpret methods used and results from software related research papers, journals, presentations, and projects. Throughout the program, students will have the opportunity to attend several seminars presented by a diverse group of researchers / scholars and faculty from a broad spectrum of software and computing related fields/areas. They will learn techniques used to critically read published research papers/journals, explore writing techniques used in technical/academic works, learn to develop evidence-based arguments,

and draw conclusions from the sources being reviewed. They will also be provided numerous resources and learn to develop strategies for acquiring and using technical references from a variety of sources.

Competencies: Students will demonstrate their ability to read and interpret various forms of software research information, papers, conference proceedings, and data collected to support the research. Students will also demonstrate their understanding of techniques used to write technical papers and journal articles. Students will also be able to explain and analyze research approaches taken and results included in published software engineering research papers, journals and conference proceedings.

Assessment Methods: This outcome will be assessed in software engineering related research papers written and submitted to various technical publications and journals or conferences. If the student elects the MS Thesis option as part of their plan of study, the thesis project under the guidance of a faculty advisor, is reviewed by an examining committee prior to an oral presentation. This learning outcome is also be assessed via the written Doctoral Comprehensive Exam which includes a dissertation proposal related to the students SFWE area of specialization. The written exam is followed by an Oral Comprehensive Exam which is held with a review committee and typically contains a presentation based on the proposed dissertation research.

Measures: Instructor grading of research related coursework in SFWE 513, results from a student's thesis defense using the collective results of a Program Assessment Survey completed by various thesis committee members, and the results of the student's final oral defense of their dissertation.

Learning Outcome #3: Conduct in-depth original research in a software engineering application area/field.

Concepts: Students will utilize their acquired knowledge and new research strategies to conduct novel research in a software engineering field of specialization. Students will meet regularly with their faculty advisor and others within the ECE / SIE departments to receive guidance and coaching in a variety of research areas. Students will summarize all aspects of their research and their findings in a written dissertation that will be defended orally before a faculty committee appointed by the Dean of the Graduate College.

Competencies: Students will demonstrate their ability to articulate all aspects of the research in a software engineering specialization area, describe and defend the significance of their research, describe methodologies used in conducting the research, and summarize their overall findings resulting from said research.

Assessment Methods: A dissertation committee will assess the originality, merit, and contributions of the candidate's research. The written dissertation and oral defense is facilitated by a faculty committee appointed by the Dean of the Graduate College in consultation with the major department and chaired by the faculty advisor. The presentation portion of the oral defense is open to the public. Following the public presentation and discussion, the candidate will participate in a closed meeting with the committee for further evaluation.

Measures: Evaluation of the student's final written dissertation. The dissertation will be evaluated by a faculty led committee that assesses the originality, merit, and contributions of the candidate's research. This includes their ability to (a) identify and critically evaluate relevant literature, (b) formulate and solve original problems using software engineering theory and methods, and (c) interpret and communicate research ideas, data and findings.

Learning Outcome #4: Communicate and defend (written and oral) results of projects or research to peers and broader engineering audiences.

Concepts: Students will utilize their acquired software engineering skills and knowledge to communicate effectively in both written and oral mediums. This may be accomplished in a

variety of methods including submitting research papers to technical journals, submitting / presenting at technical conferences, and/or presenting their research to others via seminars and colloquium presentations. Additionally, doctoral candidates will prepare a written dissertation that demonstrates all aspects of their research including the significance of their work, a detailed review of relevant literature, methodologies employed and/or developed, significant findings from the work, a critical discussion of the findings, limitations, and the impact, and potential for future research. When the doctoral candidate has met the rigor and standards of scholarship and has documented the research in a dissertation, the candidate will publicly defend the dissertation and answer any general questions related to their work.

Competencies: Students will demonstrate their ability to articulate all aspects of the research in a software engineering specialization area, describe and defend the significance of their research, describe methodologies used in conducting the research, and summarize their overall findings resulting from said research.

Assessment Methods: A dissertation committee will assess the originality, merit, and contributions of the candidate’s research. The written dissertation and oral defense is facilitated by a faculty committee appointed by the Dean of the Graduate College in consultation with the SIE and/or ECE departments and chaired by the faculty advisor. The presentation portion of the oral defense is open to the public. Following the public presentation and discussion, the candidate will participate in a closed meeting with the committee for further evaluation.

Measures: Evaluation of the student’s final written and oral dissertation. The dissertation will be evaluated by a faculty led committee that assesses the originality, merit, and contributions of the candidate’s research. This includes their ability to (a) identify and critically evaluate relevant literature, (b) formulate and solve original problems using software engineering theory and methods, and (c) interpret and communicate research ideas and findings.

Projected Enrollment for the First Three Years:

Degree	Year 1 (2023 / 2024)	Year 2 (2024 / 2025)	Year 3 (2025 / 2026)	Year 4 (2026 / 2027)	Year 5 (2027 / 2028)
PhD	4	8	12	20	30

Evidence of Market Demand:

The market demand for those trained in engineering computing /software engineering disciplines (CIP code 14.093 - Computer Software Engineering) is projected to have significant growth in both the near-term and long-term future. As shown in the diagram below, sourced from Lightcast Q3 2022 data⁴, the number of regional⁵ jobs in the workforce with a MS or PhD or other professional degree is expected to see a 11.3% increase over 5 years, between 2021 - 2026.

Similar Programs Offered at Arizona Public Universities:

University	Program	College
University of Arizona	BS Software Engineering <i>(Proposal submitted for MS SFWE)</i>	College of Engineering
University of Arizona	MS Computer Science	College of Science

	PhD Computer Science	
Arizona State University	MS Software Engineering	School of Computing and Augmented Intelligence, IRA A Fulton Schools of Engineering
Arizona State University	MS Computer Science PhD Computer Science	School of Computing and Augmented Intelligence, IRA A Fulton Schools of Engineering
Northern Arizona University	MS Computer Science PhD Information and Computing	School of Informatics, Computing, and Cyber Systems

Objection(s) Raised by Another Arizona Public University? YES NO

Has another Arizona public university lodged a written objection to the proposed program with the proposing university and the Board of Regents within seven days of receiving notice of the proposed program?

If Yes, Response to Objections:

Please provide details of how the proposing university has addressed the objection. If the objection remains unresolved, please explain why it is in the best interests of the university system and the state that the Board override it.

New Resources Required? (i.e. faculty and administrative positions; infrastructure, etc.):

Resources	Quantity
Faculty	2
Staff	1
Other (TAs, Graders, LAs) <i>(Semester hires over 5 years)</i>	0 TAs <i>(total # semester TA hires over 5 years, averaging 3.5 TAs/year)</i> 0 Graders 0 LAs
Equipment	None
Facilities	Office and lab space <i>(for new faculty)</i>

Plan to Request Program Fee/Differentiated Tuition? YES NO

Estimated Amount:

Program Fee Justification:

If planning to levy a program fee, please justify the estimated amount.

Note: The fee setting process requires additional steps, and forms need to be completed. Please work with your university and the ABOR Finance team (Leatta.McLaughlin@azregents.edu) to complete a fee request.

Specialized Accreditation? YES NO

Accreditor: