THE UNIVERSITY OF ARIZONA

New Academic Program Workflow Form

General

Proposed Name: Comp Science and Engineering

Transaction Nbr: 00000000000159

Plan Type: Major

Academic Career: Graduate

Degree Offered: Master of Science

Do you want to offer a minor? N

Anticipated 1st Admission Term: Fall 2024

Details

Department(s):

ENGR

DEPTMNT ID	DEPARTMENT NAME	HOST
2303	Electrical & Computer Engineering	Y

Campus(es):

MAIN

LOCATION	DESCRIPTION
TUCSON	Tucson

ONLN

LOCATION	DESCRIPTION
ONLN	Online

Admission application terms for this plan: Spring: Y Summer: Y Fall: Y

Plan admission types:

Freshman: N Transfer: Y Readmit: Y Graduate: Y

Non Degree Certificate (UCRT only): N

Other (For Community Campus specifics): N

Plan Taxonomy: 11.0701, Computer Science.

Program Length Type: Program Length Value: 0.00

Report as NSC Program:

SULA Special Program:

Print Option:

Diploma: Y Master of Science Computer Science and Engineering

Transcript: Y Master of Science Computer Science and Engineering

Conditions for Admission/Declaration for this Major:

Bachelors degree from an institution recognized by the UA. Students who do not have a degree equivalent to a UA Bachelor of Science degree in a computing related program may be admitted into the graduate CSE program but may be required to complete some undergraduate deficiency courses prior to enrolling in graduate courses. This policy also applies to students in the MS non-thesis option.

- Minimum grade-point average 3.0.
- Applicants whose native language is not English are required by the Graduate College to take an English Proficiency test (see Graduate College website for list of approved tests).
- Students in the MS non-thesis option are expected to be self-supported or supported by external fellowships or industry.

Requirements for Accreditation:

N/A

Program Comparisons

University Appropriateness

Two of the College of Engineering's strategic pillars are:

1) Driving student success for a rapidly changing world, and
2) Tackling critical problems at the edges of human endeavor

The new Computer Science and Engineering MS and PhD degree programs play a critical role in both pillars. The students graduating with an MS or PhD in Computer Science and Engineering degree will be better positioned to develop the skills and mindsets to be leaders in the areas of computing machine learning, ever-increasing automation and connectivity, human and intelligent systems, data science, quantum information engineering, and network sciences.

By offering competitive, relevant, and experiential-based learning to prospective students, the proposed program has the potential to build a strong pipeline for undergraduate and graduate education in Computer Science and Engineering. It will contribute to the much-needed workforce development to close the talent gap in computing and expand the ability to grow research programs that are attractive to forthcoming undergraduate and graduate students. To support the proposed program, we will recruit faculty who can significantly impact computing areas of research and education. These faculty will pursue externally funded, competitive research to advance the state-of-the-art in applied computer science in engineering and integrate their research into the curricula. The broader impacts of these faculty will ultimately lead to a nationally recognized computer science and engineering program at the University of Arizona. It is also anticipated to catalyze collaboration and strengthen the existing electrical and computer engineering program and other engineering disciplines in the College.

Another goal of offering the Computer Science and Engineering degrees is to increase the number of female and other underrepresented students in the College of Engineering by leveraging Broaden Participation in Computing (BPC) - a national initiative by the Computing Research Association with support from the National Science Foundation's (NSF) Directorate for Computer and Information Science and Engineering (CISE). Additional features and programs that contribute to enhancing student success and increasing diversity and inclusion will be included in the support infrastructure for the degrees, aiming to foster academic cultures that are more inclusive of non-dominant identities and infuse policy-driven, identity-inclusive strategies throughout the entire program.

Arizona University System

NBR	PROGRAM	DEGREE	#STDNTS	LOCATION	ACCRDT
3	Computer Science	MS	245	ASU - Main / Online	N
4	Software Engineering	MS	148	ASU - Main / Online	N
6	Computer Science	MS	20	NAU / Main	N
7	Computer Science	MS	36	UofA - Main	N

Peer Comparison

Refer to the attached document which compares the proposed MS Computer Science and Engineering program to the University of Florida and University of Michigan MS CSE programs.

Resources

Library

Acquisitions Needed:

None

Physical Facilities & Equipment

Existing Physical Facilities:

Office and laboratory space will be required for new faculty. It is currently anticipated that for the first 3 years of the program, the new facilities required can be accommodated in the current Electrical and Computer Engineering building.

Additional Facilities Required & Anticipated:

New laboratory equipment needed for Tenure Track faculty is included in estimated start-up packages and will vary depending on the nature of the research for acquired new faculty members.

Other Support

Other Support Currently Available:

The College of ENGR and ECE Dept is currently well structured and to be able to accommodate the new program, including IT support. Additional staff will be required and described below.

Other Support Needed over the Next Three Years:

It is planned to acquire one additional graduate advisor for graduate students, and 1 additional staff member to support the additional faculty that are recruited into the department.

Comments During Approval Process

11/30/2022 3:50 PM

WILLIAMSCINDY

Comments
Removed Distance Campus and Chandler & Yuma Locations.

3/30/2023 4:48 PM

MHWU

Comments
Approved.

11/8/2023 10:23 AM

ESANDMAR

Comments
Uploaded new: additional info, peer comparison, and budget analysis.

11/8/2023 10:23 AM

ESANDMAR

Comments
Approved.

THE UNIVERSITY OF ARIZONA

NEW ACADEMIC PROGRAM – MAJOR
Preliminary Proposal Form

I. **Program Details**

a. **Name (and Degree Type) of Proposed Academic Program:** MS Computer Science and Engineering (CSE)

i. **Emphases (if applicable):** None

b. **Academic Unit(s)/College(s):**

College of Engineering:
2303 - Electrical and Computer Engineering

c. **Campus/Location(s):** Main (Tucson) and UA Online

d. **First Admission Term:** Fall 2024

e. **Primary Contact and Email:** Sharon ONeal sharononeal@arizona.edu

II. **Executive Summary:**

Develop a Computer Science and Engineering (CSE) MS program with a planned Fall 2024 start date.

- Provides an interdisciplinary engineering curriculum in closely related computing fields (computer science, software engineering, and computer engineering)
- Serve local, state, and national increasing needs in engineering computing talent related to economic development and national security
    a. Aligned with Arizona's New Economic Initiative
- Support and enable the University of Arizona's growth goals / initiatives
    a. Increase student enrollments
    b. Increase research opportunities and collaborations

III. **Brief Program Description:**

The MS program in Computer Science and Engineering will provide a unique opportunity for students to deepen their knowledge of computer science and engineering topics by combining theory-based concepts with advanced, enabling computational techniques and technologies to create solutions that address the grand challenges of the 21st century, and beyond.

The MS Computer Science and Engineering curriculum applies computer science theory and software development fundamentals to produce computing-based solutions. It includes substantial coverage of engineering principles applied to the design of large, networked, scalable computing systems. Competencies include algorithms and complexity, concepts of multiple programming languages, software development, real-time, embedded, and IoT systems design and other broad-based engineering principles. The program has a firm engineering foundation that encompasses discovery-based education utilizing an experiential learning approach. Students will complete projects in areas that emphasize computing theory, communication, teamwork, critical thinking, and engineering professionalism. The MS program's flexibility allows students to design their course of study / research from a diverse pool of courses and research opportunities in software, computer science and computer engineering domains such as web and mobile applications, embedded systems, cybersecurity, machine learning, Quantum computing, systems, and other interdisciplinary areas.

Program Rationale:

Two of the College of Engineering's strategic pillars are:

1) Driving student success for a rapidly changing world, and
2) Tackling critical problems at the edges of human endeavor

The new Computer Science and Engineering MS degree program plays a critical role in both pillars. The students graduating with a MS in Computer Science and Engineering degree will be better positioned to develop the skills and mindsets to be leaders in the areas of computing machine learning, ever-increasing automation and connectivity, human and intelligent systems, data science, quantum information engineering, and network sciences.

By offering competitive, relevant, and experiential-based learning to prospective students, the proposed program has the potential to build a strong pipeline for undergraduate and graduate education in Computer Science and Engineering. It will

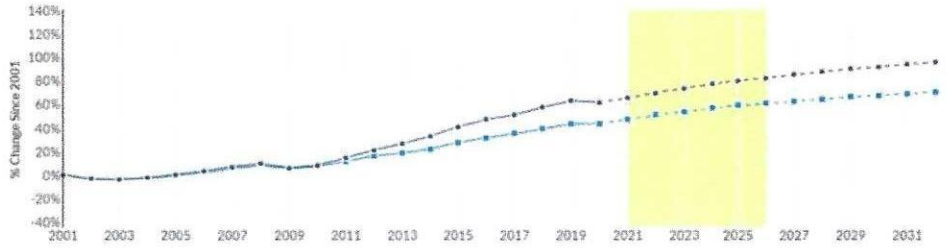
contribute to the much-needed workforce development to close the talent gap in computing and expand the ability to grow research programs that are attractive to forthcoming undergraduate and graduate students. To support the proposed program, we will recruit faculty who can significantly impact computing areas of research and education. These faculty will pursue externally funded, competitive research to advance the state-of-the-art in applied computer science in engineering and integrate their research into the curricula. The broader impacts of these faculty will ultimately lead to a nationally recognized computer science and engineering program at the University of Arizona. It is also anticipated to catalyze collaboration and strengthen the existing electrical and computer engineering program and other engineering disciplines in the College.

Another goal of offering the Computer Science and Engineering degree is to increase the number of female and other underrepresented students in the College of Engineering by leveraging Broaden Participation in Computing (BPC) – a national initiative by the Computing Research Association with support from the National Science Foundation's (NSF) Directorate for Computer and Information Science and Engineering (CISE). Additional features and programs that contribute to enhancing student success and increasing diversity and inclusion will be included in the support infrastructure for the degrees, aiming to foster academic cultures that are more inclusive of non-dominant identities and infuse policy-driven, identity-inclusive strategies throughout the entire program.

IV. **Projected Enrollment for the First Five Years:** The planned start date for the BS in Computer Science and Engineering is Fall 2023. However, for the MS program in CSE, the start date is planned to be shifted to one year later, **Fall 2024**. The projected enrollment in the MS Computer Science Engineering degree program is shown in the table below *(note that it was extended over a 4-year projection beginning in 2024 / 2025 and going thru 2027 / 2028)*. The basis for these projections was derived by comparing enrollments at other AAU universities that have a similar dual Computer Science programs in both their College of Engineering (or similar) and another college, and also using current enrollments in similar UArizona College of Engineering programs.

Degree	Year 0 (2023 / 2024)	Year 1 (2024 / 2025)	Year 2 (2025 / 2026)	Year 3 (2026 / 2027)	Year 4 (2027 / 2028)
MS	0 ***(Fall 2024 start)***	10	30	60	120

V. **Evidence of Market Demand:** The market demand for those trained in engineering computing disciplines is projected to have significant growth in both the near- and long-term futures. Specifically, the chart below shows the growth in computing-related jobs up to 2021, as well as the projected growth through 2033, both regionally (Arizona, California, Nevada, New Mexico, Utah) and nationally.[1]



Region	2021 Jobs	2026 Jobs	Change	% Change
Region	1,010,147	1,115,128	104,981	10.4%
Nation	5,406,515	5,892,114	485,599	9.0%

Note that computing-related job growth within our region is projected to grow at a faster pace than the nation as a whole. Thus, the new MS degree program will serve both local, state, and national needs related to employment, economic development, and national security. Indeed, this degree program is among the most important in support of the ongoing fourth industrial revolution and in close alignment with Arizona's New Economy Initiative[2].

The full marketing and analysis report for the state of Arizona can be found at the following link:
https://arizona.box.com/s/k4d8cj657sqv6bban2yyi4gcf0paqi0e

The full marketing and analysis report for the nation can be found at the following link:
https://arizona.box.com/s/stizctd27mfeltaxsv2ylmgfa8zgsoco

[1] Emsi Q2 2022 Data Set, www.economicmodeling.com
[2] World Economic Forum. https://www.weforum.org/agenda/2016/01/the-fourth-industrial-revolution-what-it-means-and-how-to-respond/

VI. Similar Programs Offered at Arizona Public Universities:

University	Program	College
University of Arizona	MS Computer Science	College of 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	School of Computing and Augmented Intelligence, IRA A Fulton Schools of Engineering
Northern Arizona University	MS Computer Science	School of Informatics, Computing, and Cyber Systems

VII. Resources

a. Summarize new resources required to offer the program *time phased over the next 5 academic years (2023 – 2028)*:

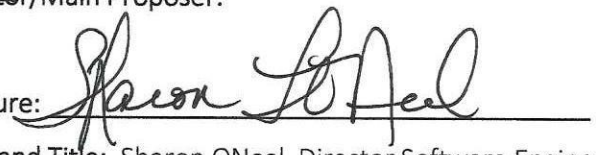
Resources	Quantity
Faculty	8
Staff	2
Other (TAs, Graders, LAs) *(Semester hires over next 5 academic years)*	12 TAs *(total over next 5 years)* 0 Graders 0 LAs
Equipment	New research and lab equipment is included in the startup packages for new TT faculty
Facilities	Office and lab space *(for new faculty)*

b. Estimate total expected cost: *$6,000,464 (extrapolated over 2023 – 2028)*

c. Estimate total expected revenue of the program: *$2,294,055 (extrapolated over 2023 – 2028)*

VIII. Required Signatures

a. ~~Program Director~~/Main Proposer:

i. Signature: 

ii. **Name and Title:** Sharon ONeal, Director Software Engineering

iii. **Date:** 10/21/2022

b. Managing Unit/Department Head:

i. Signature: 

ii. **Name and Title:** Dr Michael Wu, Electrical and Computer Engineering (ECE) Dept Head

iii. **Date:** 10/21/2022

c. College Dean/Associate Dean:

i. Signature: 

ii. **Name and Title:** Dr David Hahn, Dean College of Engineering

iii. **Date:** 10/21/2022

THE UNIVERSITY OF ARIZONA

ACADEMIC ADMINISTRATION
Administration Building, 402
1401 E. University Blvd.
PO Box 210066
Tucson, AZ 85721-0066

To: David Hahn, Dean, College of Engineering
Michael Wu, Department Head, Electrical and Computer Engineering (ECE), College of Engineering
Sharon O'Neal, Director, Software Engineering Program, College of Engineering

From: Greg Heileman, PhD, Vice Provost for Undergraduate Education

Date: December 1, 2022

Subject: Approval of Preliminary Proposal for BS, MS and PhD in Computer Science Engineering

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Thank you for submitting the preliminary proposal for a BS, MS, and PhD in Computer Science Engineering. The proposed academic programs should provide an excellent educational opportunity and useful degrees for students. We believe your ideas are sufficiently well developed that it now makes sense to advance through the stages of the formal academic program approval process.

Please proceed to the development of a full proposal, and do not hesitate to reach out the Curricular Affairs Office for assistance with this process.

CC: Liesl Folks, Senior Vice President for Academic Affairs and Provost
Liz Sandoval, Director, Curricular Affairs

THE UNIVERSITY OF ARIZONA

ACADEMIC PROGRAM – ADDITIONAL INFORMATION FORM

To be used once the preliminary proposal has been approved.

I. MAJOR REQUIREMENTS -

Master of Science (MS) – Computer Science and Engineering

Total units required to complete the degree	30
Pre-admissions expectations (i.e., academic training to be completed prior to admission)	Bachelor's degree from a regionally accredited USA university or equivalent international university recognized by the UA. Students who do not have a degree equivalent to the UA Bachelor of Science degree in a computing related program may be admitted into the graduate CSE program but may be required to complete additional graduate-level pre-requisite courses prior to enrolling in some graduate courses. This policy also applies to students in both the MS-thesis and the MS non-thesis option. • Grade-point average of 3.0 in the overall undergraduate degree or meet Graduate College minimum admissions requirements. • Applicants whose native language is not English are required by the Graduate College to take an English proficiency test. A description of acceptable tests can be found at: https://grad.arizona.edu/admissions/requirements/international-applicants#english-proficiency • Students in the MS non-thesis option are expected to be self-supported or supported by external fellowships or industry.
Major requirements. List all major requirements including core and electives. If applicable, list the emphasis requirements for each proposed emphasis*. Courses listed must include course prefix, number, units, and title. Mark new coursework (New). Include any limits/restrictions needed (house number limit, etc.). Provide email(s)/letter(s) of support from home	Complete one of the following options: ***Thesis Option:*** Complete a total of 30 units as outlined below. • Students are encouraged to select at least one CSE course from each of the three CSE categories (defined below) in their Plan of Study:

department head(s) for courses not owned by your department.	○ Systems and Applications ▪ CSE 501 (3) – Operating System Design (NEW) ▪ CSE 504 (3) – Embedded Systems Computing (NEW) ○ Theory of Computation ▪ CSE 503 (3) – Analysis of Algorithms for Engineering Applications (NEW) ▪ CSE 507 (3) – Computer Science and Engineering Research Methods (NEW) ○ Knowledge and Data Engineering ▪ CSE 506 (3) – Database Engineering (NEW) ▪ CSE 505 (3) – Advanced Data Structures (NEW) • Complete 6 units of thesis (CSE 910) (NEW). • Select the remaining required units from the technical computing electives below or in closely related computing field (must be approved by Graduate Studies Committee*).* ○ CSE 501 (3) - Operating System Design (NEW) ○ CSE 502 (3) - Compiler Design (NEW) ○ CSE 503 (3) - Analysis of Algorithms for Engineering Applications (NEW) ○ CSE 504 (3) - Embedded Systems Computing (NEW) ○ CSE 505 (3) – Advanced Data Structures (NEW) ○ CSE 506(3) – Database Engineering (NEW) ○ CSE 507(3) – Computer Science and Engineering Research Methods (NEW) ○ CSE 599 (3) – Independent Study ○ CSE 910 (1-6) - Thesis ○ ECE 503(3) - Probability and Random Processes for Engineering Applications ○ ECE 506 (3) – Reconfigurable Computing ○ ECE 509(3) –Cybersecurity Concept, Theory, Practice ○ ECE 513(3) –Web Development and the IoT

- ECE 523(3) –Engineering Applications of Machine Learning and Data Analytics
- ECE 540 (3) – Quantum Sensing and Quantum Machine Learning
- ECE 562(3) - Computer Architecture and Design
- ECE 564(3) – Advanced Topics in Computer Networks
- ECE 569(3) – High Performance Computing
- ECE 571(3) – Fundamentals of Information and Network Security
- ECE 572 (3) – Design, Modeling, and Simulation for High Technology Systems in Medicine
- ECE 574A (3) – Computer Aided Logic Design
- ECE 576A(3) – Engineering of Computer Based Systems
- ECE 576B(3) – Embedded System Design and Optimization
- ECE 578(3) – Fundamentals of Computer Networks
- ECE 579(3) –Principles of Artificial Intelligence
- ECE 677 (3) – Distributed Computing Systems
- SFWE 506 (3) – Distributed and Parallel Processing
- SFWE 507 (3) –Data Mining
- SIE 533(3) –Fundamentals of Data Science for Engineers
- SIE 577(3) – Introduction to Biomedical Informatics
- *Other courses may be added at the discretion of the faculty advisor with prior approval of the Graduate Studies Committee (GSC)*

Non-Thesis Option:

- Complete a total of 30 units from the 5xx/6xx technical computing courses list below or in a closely related computing field (must be approved by Graduate Studies Committee*).*

- Students are encouraged to select at least one CSE course from each of the three CSE categories (defined below) in their Plan of Study:
  - Systems and Applications
    - CSE 501 (3) – Operating System Design (NEW)
    - CSE 504 (3) – Embedded Systems Computing (NEW)
  - Theory of Computation

	▪ CSE 503 (3) – Analysis of Algorithms for Engineering Applications (NEW) ▪ CSE 507 (3) – Computer Science and Engineering Research Methods (NEW) o Knowledge and Data Engineering ▪ CSE 506 (3) – Database Engineering (NEW) ▪ CSE 505 (3) – Advanced Data Structures (NEW) • Select the remaining required units from the technical computing electives below: o CSE 501 (3) - Operating System Design (NEW) o CSE 502 (3) - Compiler Design (NEW) o CSE 503 (3) - Analysis of Algorithms for Engineering Applications (NEW) o CSE 504 (3) - Embedded Systems Computing (NEW) o CSE 505 (3) – Advanced Data Structures (NEW) o CSE 506(3) – Database Engineering (NEW) o CSE 507(3) – Computer Science and Engineering Research Methods (NEW) o CSE 599 (3) – Independent Study o CSE 910 (1-6) - Thesis o ECE 503(3) - Probability and Random Processes for Engineering Applications o ECE 506 (3) – Reconfigurable Computing o ECE 509(3) –Cybersecurity Concept, Theory, Practice o ECE 513(3) –Web Development and the IoT o ECE 523(3) –Engineering Applications of Machine Learning and Data Analytics o ECE 540 (3) – Quantum Sensing and Quantum Machine Learning o ECE 562(3) - Computer Architecture and Design o ECE 564(3) – Advanced Topics in Computer Networks o ECE 569(3) – High Performance Computing o ECE 571(3) – Fundamentals of Information and Network Security

	○ ECE 572 (3) – Design, Modeling, and Simulation for High Technology Systems in Medicine ○ ECE 574A (3) – Computer Aided Logic Design ○ ECE 576A(3) – Engineering of Computer Based Systems ○ ECE 576B(3) – Embedded System Design and Optimization ○ ECE 578(3) – Fundamentals of Computer Networks ○ ECE 579(3) –Principles of Artificial Intelligence ○ ECE 677 (3) – Distributed Computing Systems ○ SFWE 506(3) – Distributed and Parallel Processing ○ SFWE 507(3) –Data Mining ○ SIE 533(3) –Fundamentals of Data Science for Engineers ○ SIE 577(3) – Introduction to Biomedical Informatics ○ *Other courses may be added at the discretion of the faculty advisor with prior approval of the Graduate Studies Committee (GSC)*
Research methods, data analysis, and methodology requirements (Yes/No). If yes, provide description.	If the student selects the Thesis Option, they are required to complete 6 units of Thesis development in an area related to computer science engineering. It is also recommended (but not required) that one of their technical electives be CSE 507 – Computer Science and Engineering Research Methods.
Internship, practicum, applied course requirements (Yes/No). If yes, provide description.	None
Master thesis or dissertation required (Yes/No). If yes, provide description.	If the student selects the *Thesis Option*, they are required to complete 6 units of research in an area related to computer science and engineering. The thesis will capture the results of the research that was completed under the guidance of a faculty member. The thesis paper should demonstrate the students core knowledge, technical skills, and the ability to articulate and synthesize the findings of a project they were engaged in over multiple semesters. Students must pass an oral defense of their thesis.
Additional requirements (provide description)	A cumulative GPA of 3.0 / 4.0 or higher must be maintained on all coursework taken for graduate credit. A grade of C or higher is required for a course to be used to satisfy the degree requirements (A or B for transfer credits). Grade Replacement Option cannot be used for graduate courses.

	Additionally, all students:
	• Must complete the draft Plan of Study by the end of the student's first semester.
	• Must submit a Plan of Study in GRADPATH by the end of the 3rd semester.
	• Other stipulations:
	  ○ A maximum of 6 units of non- CSE/ECE coursework. All non- CSE/ECE coursework must be pre-approved by the Graduate Studies Committee (GSC) prior to registration.
	  ○ A maximum of 3 units of CSE independent study (CSE 599) (NEW). Non-CSE independent study does not apply toward the coursework requirement. CSE independent study must be taken with an CSE/ECE faculty and must be pre-approved.
	For thesis students only:
	• Must submit at least one paper to a refereed conference or journal.
	• Must meet Graduate College thesis requirements.

Minor options (as relevant)	No required minor options for the MS degree.

*Emphases are officially recognized sub-specializations within the discipline. ABOR Policy 2-221 c. Academic Degree Programs Sub specializations requires all undergraduate emphases within a major to share at least 40% curricular commonality across emphases (known as "major core"). Total units required for each emphasis must be equal. Proposed emphases having similar curriculum with other plans (within department, college, or university) may require completion of an additional comparison chart. Complete the table found in Appendix B to indicate if emphases should be printed on student transcripts and diplomas.

II. CURRENT COURSES–using the table below, list all existing courses included in the proposed major. You can find information to complete the table using the UA course catalog or UAnalytics (Catalog and Schedule Dashboard> "Printable Course Descriptions by Department" On Demand Report; right side of screen).

Course prefix and number (include cross-listings)	Units	Title	Pre-requisites	Modes of delivery (online, in-person, hybrid)	Typically Offered (F, W, Sp, Su)	Dept signed party to proposal? (Yes/No)

ECE 503	3	Probability and Random Processes for Engineering Applications	None	In-person	F	Yes
ECE 506	3	Reconfigurable Computing	ECE 562, ECE 574A	In-person, online	Sp	Yes
ECE 509	3	Cybersecurity Concept, Theory, Practice	ECE 578	In-person	Sp	Yes
ECE 513	3	Web Development and the IoT	ECE 275 (or equivalent)	In-person	F	Yes
ECE 523	3	Engineering Applications of Machine Learning and Data Analytics	ECE 503 (or equivalent)	In-person	Sp	Yes
ECE 540	3	Quantum Sensing and Quantum Machine Learning	None	In-person	Sp	Yes
ECE 562	3	Computer Architecture and Design	ECE 369A (or consent of instructor)	In-person	Sp	Yes
ECE 564	3	Advanced Topics in Computer Networks	None	In-person	F	Yes
ECE 569	3	High Performance Computing	Knowledge of computer architecture and digital systems	In-person	F	Yes
ECE 571	3	Fundamentals of Information and Network Security	None	In-person	Sp	Yes
ECE 572	3	Design, Modeling, and Simulation for High Technology Systems in Medicine	None	In-person	F	Yes
ECE 574A	3	Computer Aided Logic and Design	None	In-person	F	Yes
ECE 576A	3	Engineering of Computer Based Systems	ECE 579	In-person	F	Yes

ECE 576B	3	Embedded System Design and Optimization	ECE 576A	In-person	Sp	Yes
ECE 578	3	Fundamentals of Computer Networks	ECE 175 (or equivalent)	In-person, online	F	Yes
ECE 579	3	Principles of Artificial Intelligence	ECE 373 (or equivalent)	In-person	Sp	Yes
ECE 677	3	Distributed Computing Systems	None	In-person, online	F	Yes
SIE 533	3	Fundamentals of Data Science for Engineers	SIE 530 or SIE 500A (or consent of instructor)	In-person, online	F	Yes
SIE 577	3	Introduction to Biomedical Informatics	None	In-person, online	F	Yes

III. NEW COURSES NEEDED – using the table below, list any new courses that must be created for the proposed program. If the specific course number is undetermined, please provide level (i.e., CHEM 4XX). Add rows as needed.

Course prefix and number (include cross-listings)	Units	Title	Pre-requisites	Modes of delivery (online, in-person, hybrid)	Status*	Anticipated first term offered	Typically Offered (F, W, Sp, Su)	Dept signed party to proposal? (Yes/No)	Faculty members available to teach the courses
CSE 501	3	Operating System Design	CSE 201 or ECE 275 (or equivalent)	In-person, online	D	Fall 2024	F	Yes	TBR (potentially new faculty)
CSE 502	3	Compiler Design	CSE 201 or ECE 275 (or equivalent)	In-person, online	D	Spring 2025	Sp	Yes	TBR (potentially new faculty)
CSE 503	3	Analysis of Algorithms for Engineering Applications	CSE 201 or ECE 275 (or equivalent)	In-person, online	D	Spring 2025	Sp	Yes	TBR (potentially new faculty)

CSE 504	3	Embedded Systems Computing	CSE 201 or ECE 275 (or equivalent)	In-person, online	D	Fall 2025	F	Yes	TBR (potentially new faculty)
CSE 505	3	Advanced Data Structures	CSE 201 or ECE 275 (or equivalent)	In-person, online	D	Fall 2024	F	Yes	TBR (potentially new faculty)
CSE 506	3	Database Engineering	None	In-person, online	D	Spring 2026	Sp	Yes	TBR (potentially new faculty)
CSE 507	3	Computer Science and Engineering Research Methods	None	In-person, online	D	Fall 2025	F	Yes	TBR (potentially new faculty)
CSE 599	3	Independent Study	None	In-person, online	D	Fall 2024	F,Sp	Yes	Varying
CSE 900	3	Research	None	In-person	D	Fall 2024	F,Sp	Yes	Varying
CSE 910	6	Thesis	Thesis Option	In-person, online	D	Fall 2025	F, Sp	Yes	Varying

*In development (D); submitted for approval (S); approved (A)

The proposed new CSE courses may be sorted into three categories as identified below. Students will be strongly encouraged by graduate advisors to take at least one course from each category in their degree program. Additional new courses will be added as the program grows to increase course selections in each of the category areas. The current proposal is weighted with more existing ECE courses relevant to the CSE graduate degree programs than there are proposed new CSE courses. This is a natural result of the growth process for these degree programs. The CSE graduate program degree proposal specifies robust hiring goals that will necessarily result in the development of a large number of new graduate-level CSE courses that are aligned with new faculty research specializations and areas of emphasis.

	Systems and Applications	Theory of Computation	Knowledge and Data Engineering
Applicable CSE Courses	CSE 501 and CSE 504	CSE 503 and CSE 507	CSE 506 and CSE 505

Click or tap here to enter text.

IV. FACULTY INFORMATION- complete the table below. If UA Vitae link is not provided/available, add CVs to a Box folder and provide that link. UA Vitae profiles can be found in th. Add rows as needed. **NOTE: full proposals are distributed campus-wide, posted on committee agendas**

and should be considered "publicly visible". Contact Office of Curricular Affairs if you have concerns about CV information being "publicly visible".

Faculty Member	Involvement	UA Vitae link or Box folder link
Dr Tosiron Adegbija	Teach ECE 562 and Conduct/collaborate in CSE related research	Tosiron Adegbija | UA Profiles (arizona.edu)
Dr Abhijit Mahalanobis	Teach ECE 523 and Conduct/collaborate in CSE related research	https://arizona.box.com/s/eximdtrp92tutik04yrfclbyyzj1zidh
Dr Loukas Lazos	Teach ECE 578 and Conduct/collaborate in CSE related research	Loukas Lazos | UA Profiles (arizona.edu)
Dr Salim Hariri	Teach ECE 509 and Conduct/collaborate in CSE related research	Salim A Hariri | UA Profiles (arizona.edu)
Dr Soheil Salehi Mobarakeh	Teach ECE 513 and Conduct/collaborate in CSE related research	Soheil Salehi | UA Profiles (arizona.edu)
Dr Ali Akoglu	Teach ECE 569 and Conduct/collaborate in CSE related research	Ali Akoglu| UA Profiles (arizona.edu)
Dr Michael Marefat	Teach ECE 579 and Conduct/collaborate in CSE related research	Michael M. Marefat | UA Profiles (arizona.edu)
Dr Ravi Tandon	Teach ECE 503 and Conduct/collaborate in CSE related research	https://profiles.arizona.edu/person/tandonr
Dr Tomas Cerny	Teach SFWE 508	Tomas Cerny | UA Profiles (arizona.edu)
Dr Jerzy Rozenblit	Teach ECE 576 A and 576B Conduct/collaborate in CSE related research	https://profiles.arizona.edu/person/jerzyr
Dr Marwan Krunz	Teach ECE 564 and Conduct/collaborate in CSE related research	https://profiles.arizona.edu/person/krunz
Dr Ming Li	Teach ECE 571 and Conduct/collaborate in CSE related research	https://profiles.arizona.edu/person/lim
Dr Michael Wu	Conduct/collaborate in CSE related research	https://arizona.box.com/s/zktwrqsna7r7f53bcubhe4b82m7w9mkd

V. **GRADUATION PLAN –** provide a ***sample*** degree plan, based on your program that includes all requirements to graduate with this major and takes into consideration course offerings and sequencing.

The table below represents a ***sample*** MS CSE degree plan. Because of the flexibility in the CSE MS degree program, the degree plan of an individual student may differ from what is shown. Each student will develop a tailored degree plan with a member of the CSE graduate advisor and faculty advisor. The student's degree plan will then be approved by the student's faculty advisor and/or the graduate studies committee.

Semester 1		Semester 2		Semester 3		Semester 4	
Course prefix and number	Units	Course prefix and number	Units	Course prefix and number	Units	Course prefix and number	Units
CSE 501 or CSE 504	3	CSE 503 or CSE 507	3	Technical Elective	3	Technical Elective	3
Technical Elective	3	Technical Elective	3	Technical Elective	3	Technical Elective/CSE 910 (Thesis Option)	3
CSE 505 or CSE 506	3			Technical Elective/CSE 910 (Thesis Option)	3		
Total	9	Total	6	Total	9	Total	6

Semester 5		Semester 6		Semester 7		Semester 8	
Course prefix and number	Units	Course prefix and number	Units	Course prefix and number	Units	Course prefix and number	Units
N/A		N/A		N/A		N/A	
Total	-	Total	-	Total	-	Total	-

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VI. **Curriculum Map and Assessment Map** - Complete this table as a summary of your learning outcomes and assessment plan, using these examples as a model. If you need assistance completing this table and/or the Curriculum Map, please contact the Office of Instruction and Assessment. Attach your Curriculum Map here.

Program: MS Computer Science and Engineering

Learning Outcome #1 (Thesis and Non-Thesis Options): *Demonstrate broad knowledge in student's field in Computer Science and Engineering.*
Concepts: Study diverse topics in computer science and engineering in the topic areas such as of Systems and Applications, Theory of Computation, and Knowledge and Data Engineering, and others. Students have the option to select from a broad range of software, electrical engineering and computing related technical electives. Courses may include computing topics such as operating system design, compiler design, analysis of algorithms for engineering applications, advanced data structures, database/data engineering, cloud computing, robotics and a variety of other computing topics that vary based on the electives the student opts to take.
Competencies: Demonstrate the ability to research, design, develop, test, integrate and evaluate varied software applications/products/systems in diverse computing and engineering domains. Students opting for the *Thesis-Option* to satisfy their course requirements may also apply their acquired knowledge in these areas to conduct original and novel research in state-of the-art and advanced computer science and engineering principles, processes, and methodologies to meet the requirements/needs of diverse engineering applications.
Assessment Methods: For every new 5xx / 6xx CSE 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 include: "Exemplary", "Satisfactory", "Developing", and "Unsatisfactory". At the end of every semester, a team comprised of the course instructor and the ECE Graduate Studies Committee (GSC), 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.

Additionally, students are asked to complete a survey near the end of their MS program to self-evaluate how well they feel they met the Student Learning Outcomes for the MS program. In addition to the survey, the student is required to compose a brief description of how a project or projects completed during the course of their program serves to demonstrate their ability to analyze, design, and implement a computing system. The written description and survey are used to gather program-level assessment data.

A rubric is used to evaluate a student's written description. The completed survey and written description are returned to the CSE Graduate Advisor, who archives this data. At the end of the spring semester, the surveys and written descriptions are provided to the ECE department head, who ensure the written descriptions are evaluated. The results of the surveys and descriptions will be organized and formatted over the summer. During the following academic year, the Graduate Studies Committee reviews the direct measures (written descriptions) and the indirect measures (student surveys) and then make recommendations for changes in response to the findings. Once each year, the summarized data, and proposed changes, if any, are reviewed and discussed by the ECE faculty.

Measures: Rubrics will be used for the specific graded student projects in a given 5xx 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 computing 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 computer science and engineering knowledge. Student surveys and program written description are also collected and evaluated to determine the overall program outcomes as students exit the program.

Learning Outcome #2 (Thesis Option): *Critically analyze published research results in student's area of study.*

Concepts: Synthesize various research techniques to interpret methods used and results from computing related research papers, journals, presentations, and/or conferences. 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: Demonstrate the ability to read and interpret various forms of computing research information, papers, conference proceedings, and data collected to support research. Students will also demonstrate their understanding of techniques used to write technical papers and journal articles. Students will also be able to analyze and explain research approaches taken and results included in published computing research papers, journals and conference proceedings.

Assessment Methods: This outcome will be assessed in the student's computer science and engineering related research project and written thesis under the guidance of a faculty advisor. The thesis is reviewed by an examining committee consisting of at least 3 faculty (2 of which must be Graduate Faculty) from the ECE department and chaired by the faculty advisor prior to the student conducting an oral presentation/defense of their thesis. The outcome will also be assessed in specific research-oriented assignments from CSE 507 coursework.
Measures: This outcome will be measured by instructor grading of research related coursework in CSE 507. It will also be assessed by the student's written thesis and oral defense using the collective results of a Program Assessment Survey completed by all thesis committee members.
Learning Outcome #3 (Thesis Option): *Conduct original research on a significant computer science and engineering problem.*
Concepts: Utilize acquired knowledge and new research strategies to conduct novel research in a computer science and engineering field of specialization. Students will meet regularly with their faculty advisor and others within the ECE department 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 thesis that will be defended orally before a faculty thesis committee.
Competencies: Demonstrate the ability to articulate all aspects of their research in a CSE 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 thesis committee will assess the originality, merit, and contributions of the candidate's research. The written thesis and oral defense is facilitated by a faculty committee consisting of at least 3 faculty (2 of which must be graduate faculty) from the ECE department and chaired by the faculty advisor. All members of the thesis committee will be asked to complete a Program Assessment Survey, and the results will be culminated together to form an overall assessment of the student's thesis.
Measures: Evaluation of the student's final written thesis. The thesis 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 computing theory and methods, and (c) interpret and communicate research ideas, data and findings.
Learning Outcome #4 (Thesis and Non-Thesis Options): *Communicate (written & oral) and defend results of projects or research to peers and broader engineering audiences.*
Concepts: Utilize acquired computer science and engineering skills and knowledge to communicate effectively in both written and oral mediums. This may be accomplished in a variety of methods including presenting the results of software / computing related projects to peers, faculty, and potentially industry experts. Additionally, students that opt for the *Thesis-Option* will prepare a written thesis 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. *Thesis* students will also be required to present their research findings in an oral defense of their project / research.

Competencies: Demonstrate their ability to articulate all aspects of the product development and/or research in a computer science and engineering specialization area. Students opting for the course work only option of the degree program, will describe the relevant design or implementation details of projects that they have developed/implemented, describe methodologies used in developing computing products, and demonstrate designs and/or working products. Students opting for the *Thesis-Option* of the degree program will also describe and defend the significance of their projects / research in a thesis, describe the methodologies used in conducting the computer science and engineering related research, and summarize their overall findings resulting from said research in written and oral mediums.
Assessment Methods: For all CSE students, specific project rubrics will be used for the specific graded student project for a given course that clearly evaluates the learning objectives and outcomes of the projects that students are asked to complete. All rubrics are developed by faculty members with expertise in associated computing 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. Additionally, for *Thesis-Option* students, a thesis committee will assess the originality, merit, and contributions of the candidate's research. The written thesis and oral defense is facilitated by a faculty committee appointed consisting of at a minimum 3 faculty from the ECE departments and chaired by the faculty advisor.
Measures: For all students, rubrics will be used for specific graded student projects in a given 5xx 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 computing 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 computer science and engineering knowledge. For *Thesis-Option* students, evaluation of the student's final written and oral thesis. The thesis 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 computational engineering theory and methods, and (c) interpret and communicate research ideas and findings.
Learning Outcome #2 (Non-Thesis Option): *Analyze a computing system related to computer science and engineering.*
Concepts: Derive, develop and analyze the algorithms, design, and implementation for a computing system / subsystem. Additionally, students will also develop plans and procedures that verify/validate the correct implementation and performance of the specified product. Students will also evaluate whether a software implementation meets its associated requirements as specified.
Competencies: Evaluate, analyze and implement computing algorithm(s), products and/or other computing solutions to meet a specified problem statement. Students will derive, develop and analyze the implementation and performance requirements for a

specific computing product / system / subsystem. Students will also analyze / evaluate how well the computing solution meets its intended use/requirements.

Assessment Methods: This outcome will be assessed predominately through implementation and/ or evaluation of computing product that meets a given or derived specification for a software / computing product. Midterm and final exams that test the students comprehension of the computer science and engineering concepts taught and competencies acquired will also be used. Rubrics will be created that identify 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 project artifacts for a given course will be evaluated and assessed.

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 ECE Graduate Studies Committee (GSC), 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: Instructor grading of course exams and computing projects for each course that contributes to this outcome. Rubrics will be used to measure the specific project evidence for each course. Descriptions that clearly measure the given evidence are used to assign the students achievement level. The achievement levels for the rubrics include: "Exemplary", Satisfactory", "Developing", and "Unsatisfactory". Student surveys and program written description are also collected and evaluated to determine the overall program outcomes as students exit the program.

Learning Outcome #3 (Non-Thesis Option): *Design and implement a computing system in a related computer science and engineering discipline based on given specifications.*

Concepts: Use industry best practices, methods, and tools in architecting, modeling, and designing computing systems. Students also investigate and evaluate the importance of developing a sound computing architecture and design as part of the evolution of the implementation of a computing system/product. Working in teams on larger-scale semester projects, students implement their designs and show the traceability between specifications, computing design, and the resulting implementation for a specified computing system/product.

Competencies: Architect/design specified software/computing products for diverse applications including mobile, cloud, embedded, or other computing applications. Students will collaborate with other students and CSE advisors to complete projects using modern modeling tools and methodologies (i.e., UML or equivalent). Students will also implement/develop their designs for

a variety of computing-based products. Students will present/review their designs and implementations in a professional setting with other CSE students, faculty and industry professionals.
Assessment Methods: This outcome will be assessed predominately through implementation of a semester project that meets a given specification for a software / computing-based product. Midterm and final exams that test the students comprehension of the engineering concepts taught and competencies acquired will also be used. Rubrics will be created that identify 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 project artifacts for a given course will be evaluated and assessed. 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 include: “Exemplary”, “Satisfactory”, “Developing”, and “Unsatisfactory”. At the end of every semester, a team comprised of the course instructor and the ECE Graduate Studies Committee (GSC), 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: Instructor grading of course exams and computing projects for each course that contributes to this outcome. Rubrics will be used to measure the specific project evidence for each course. Descriptions that clearly measure the given evidence are used to assign the students achievement level. The achievement levels for the rubrics include: “Exemplary”, Satisfactory”, “Developing”, and “Unsatisfactory”. Student surveys and program written description are also collected and evaluated to determine the overall program outcomes as students exit the program.

The Taskstream Curriculum Map is shown below. Note that the assessment plan includes only new CSE courses that are part of this program. Existing ECE courses used to fulfill the degree requirements are not included. The assessment plans for existing courses will be followed per the department’s assessment plan for each respective existing course.

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MS Computer Science and Engineering

Courses and Activities Mapped to MS Computer Science and Engineering

	Outcome					
	SLO 1 Demonstrate broad knowledge in his/her field in Computer Science and Engineering.	SLO 2: Non-Thesis Option Analyze a computing system or a subsystem related to computer science engineering.	SLO 2:Thesis Option Critically analyze published research results in his/her area of study.	SLO 3: Non-Thesis Option Design and implement a computing system in a computer science engineering area based on given specifications.	SLO 3: Thesis Option Conduct original research on a significant computer science engineering problem.	SLO 4 Communicate and defend (written and oral) results of projects or research to peers and broader engineering audiences.
Courses and Learning Activities						
CSE 501 Operating System Design	P/A	P/A		P/A		
CSE 502 Compiler Design	P/A	P/A		P/A		
CSE 503 Analysis of Algorithms for Engineering Applications	P/A	P/A		P/A		P/A
CSE 504 Embedded Systems Computing	P/A	P/A		P/A		
CSE 505 Advanced Data Structures	P/A	P/A		P/A		
CSE 506 Database Engineering	P/A	P/A		P/A		
CSE 507 Computer Science and Engineering Research Methods			IPA		IPA	P/A
CSE 910 Thesis			IPA		IPA	IPA
Exit Survey Exit survey (Indirect)	A	A	A	A	A	A

Legend : I Introduced | P Practiced | A Assessed | I/P Introduced/Pract

VII. PROGRAM ASSESSMENT PLAN- using the table below, provide a schedule for program evaluation 1) while students are in the program and 2) after completion of the major. Add rows as needed. Delete EXAMPLE rows.

MS Thesis Students

The Computer Science and Engineering (CSE) MS Thesis Option program requires a student complete an oral defense of their thesis. The student also completes a survey near the end of their MS program to self-evaluate how well they feel they met the Student Learning Outcomes for the MS program. The thesis defense and survey are used to gather program-level assessment data.

A rubric to evaluate a student's thesis work has been developed by the ECE/CSE faculty. Each faculty committee member completes the rubric at the end of the oral thesis defense. These completed rubrics are returned to the ECE/CSE Graduate Advisor, who archives this data. At the end of the Spring semester, the completed rubrics and surveys and provided to the ECE Department Head and /or Associate Department Head, who organize and formats the results during the summer. During the following academic year, the Graduate Studies Committee reviews the direct measures (thesis rubrics) and the indirect measures (student surveys) and then makes recommendations for changes in response to the findings. Once each year, the summarized data, and proposed changes, if any, are reviewed and discussed by the CSE faculty.

MS Non-Thesis Students

The Computer Science and Engineering (CSE) MS Non-Thesis Option program requires a student complete 30 units of graduate coursework. This coursework has limitations as described in the CSE Graduate Handbook. The student completes a survey near the end of their MS program to self-evaluate how well they feel they met the Student Learning Outcomes for the MS program. In addition to the survey, the student is required to compose a brief description of how a project or projects completed during the course of their program served to demonstrate their ability to analyze, design, and implement a CSE-related system. The written description and survey are used to gather program-level assessment data.

A rubric is used to evaluate a student's written description. The completed survey and written description are returned to the ECE/CSE Graduate Advisor, who archives this data. At the end of the spring semester, the surveys and written descriptions are provided to the ECE Department Head and /or Associate Department Head, who makes sure the written descriptions are evaluated and then organizes and formats the results of the written descriptions and surveys during the summer. During the following academic year, the Graduate Studies Committee reviews the direct measures (written descriptions) and the indirect measures (student surveys) and then makes recommendations for changes in response to the findings. Once each year, the summarized data, and proposed changes, if any, are reviewed and discussed by the CSE faculty.

Assessment Measure	Source(s) of Evidence	Data Collection Point(s)
Rubrics for all new courses used to assess each student outcome that identifies criteria, measure of assessment, and an	Specifically targeted: • Class assignments • Exams • Course Projects	End of each semester the specific courses are taught.

achievement level rating *(i.e., Exemplary, Satisfactory, Developing, Unsatisfactory).*	• Course Reports • Other forms of student work tailored to any specific course)	
MS final written thesis *(Thesis-Option only)*	Written thesis	Written and evaluated at the conclusion of the student's thesis efforts to assess the merit and contributions of the student's research and findings.
Thesis oral presentation / defense (*Thesis-Option* only)	Oral presentation / defense of the student's thesis	At the completion of the thesis, the student will present their work to a faculty thesis committee and answer any general questions related to their work
Graduation exit survey (used for indirect measures of outcomes).	Student survey	At student graduation
Academic Program Review	APR reviewer evaluation responses	Minimum of every 7 years
Data from continuous improvement implementation efforts (recommended by the Graduate Studies Committee (GSC))	Assessment data	At the end of an academic year

VIII. ANTICIPATED STUDENT ENROLLMENT-complete the table below. What concrete evidence/data was used to arrive at the numbers?

5-YEAR PROJECTED ANNUAL ENROLLMENT					
	1st Year	2nd Year	3rd Year	4th Year	5th Year
Number of Students					
MS Degree	10	30	60	120	150

Data/evidence used to determine projected enrollment numbers:

Note: the enrollment numbers shown in the table above reflect the enrollments that begin in academic year 2024/2025 (Year 1).

Several regional and/or AAU universities with MS and PhD Computer Science programs inside Engineering were canvassed for program enrollment in 2020. The table that follows shows the total enrollment in some of these programs[1]:

University	MS Computer Science and Engineering Student Enrollment
University of California - Berkeley	4
University of California - Davis	135
University of Michigan	140
University of Florida	390
University of Illinois – Urbana – Champaign	1179
Arizona State University	1245
The Ohio State University	72
University of Minnesota – Twin Cities	154

IX. **ANTICIPATED DEGREES AWARDED**- complete the table below, beginning with the first year in which degrees will be awarded. How did you arrive at these numbers? Take into consideration departmental retention rates. Use National Center for Education Statistics College Navigator to find program completion information of peer institutions offering the same or a similar program.

PROJECTED DEGREES AWARDED ANNUALLY					
	1st Year	2nd Year	3rd Year	4th Year	5th Year
Number of Degrees	0	7	20	40	65

Data/evidence used to determine number of anticipated degrees awarded annually:

The estimates in the table above are based on the projected total enrollments over the first 5 years of the program, which includes

[1] Enrollments derived from https://shinyapps.asee.org/apps/Profiles/

potential student transfers into the program in the earlier years of the program. Students are expected to graduate as soon as the second year of the program.

Additionally, an analysis of other university graduation rates in similar programs was performed as defined in the National Center for Education Statistics[2]. Interestingly, this source did not specifically call out computer science and engineering programs, and therefore we also researched degrees awarded at ASEE[3]. The universities considered are shown in the table below:

University	Number of MS Awards Conferred in 2020 (NCES)	Number of MS Awards Conferred in 2020 (ASEE)
University of California - Berkeley	Not specifically listed	18
University of California - Davis	Not specifically listed	65
University of Michigan	Not specifically listed	143
University of Florida	Not specifically listed	181
University of Illinois – Urbana – Champaign	Not specifically listed	314
Arizona State University	Not specifically listed	373
The Ohio State University	Not specifically listed	58
University of Minnesota – Twin Cities	Not specifically listed	68

X. **PROGRAM DEVELOPMENT TIMELINE-** describe plans and timelines for 1) marketing the major and 2) student recruitment activities.

The graduate level programs in Computer Science and Engineering utilize several existing courses within the College of Engineering, including:

- Electrical and Computer Engineering (ECE) Department
- Software Engineering (SFWE) program (which is co-owned by ECE and SIE)
- Systems and Industrial Engineering (SIE) Dept

[2] https://nces.ed.gov/collegenavigator/

[3] https://shinyapps.asee.org/apps/Profiles/

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The table below shows the preliminary plan for the ***new*** MS Computer Science and Engineering course development required for the program. We will work closely with UArizona's University Center for Assessment, Teaching and Technology (UCATT), UA Online, and Office of Curricular Affairs to execute the plan shown in the table below.

Course Number / Name	Planned Development Timeframe	First Semester Offered
CSE 501 - Operating System Design	Spring 2023	Fall 2024
CSE 502 - Compiler Design	Fall 2024	Spring 2025
CSE 503 - Analysis of Algorithms for Engineering Applications	Fall 2024	Spring 2025
CSE 504 - Embedded Systems Computing	Spring 2025	Fall 2025
CSE 505 - Advanced Data Structures	Spring 2024	Fall 2024
CSE 506 - Database Engineering	Fall 2025	Spring 2026
CSE 507 - Computer Science and Engineering Research Methods	Spring 2025	Fall 2025
CSE 599 – Independent Study	Spring 2024	Fall 2024
CSE 900 – Research (PhD only)	Spring 2024	Fall 2024
CSE 910 - Thesis	Spring 2025	Fall 2025

We will also work closely with the recruitment and marketing teams (MarCom) within the College of Engineering to market the program as soon as ABOR approves the degree program. Additionally, we will work closely with Arizona Online and Distance learning to market the program through their marketing channels.

IX. **Program Fees and Differential Tuition (PFDT) Request** – For implementation of fees, you must work with University Fees. The annual deadline is December 1. For any questions, please contact the University Fees Program Manager.

None planned for this program.

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Appendix B. Emphasis Print Information-if applicable, complete the table below to indicate if proposed emphases should be printed on transcript and diploma. Add rows as needed. Note: emphases are displayed on transcript and diplomas as " _____ Emphasis".

Emphasis	Print on transcript	Print on diploma
MS in Computer Science and Engineering – Thesis Option	No	No
MS in Computer Science and Engineering – Non-Thesis Option	No	No

Graduate Major Peer Comparison Chart-select two peers for completing the comparison chart from (in order of priority) ABOR-approved institutions, AAU members, and/or other relevant institutions recognized in the field. The comparison chart will be used to identify typically required coursework, themes, and experiences for majors within the discipline. The comparison programs are not required to have the same degree type and/or major name as the proposed UA program. Information for the proposed UA program must be consistent throughout the proposal documents. Delete EXAMPLE columns once ready to submit/upload.

Program name, emphasis (sub-plan) name (if applicable), degree, and institution	**Proposed UA Program:**	**Peer 1:** MS in Computer Science – University of Florida / Computer and Information Science and Engineering (CISE) View	**Peer 2:** MSE in Computer Science and Engineering – University of Michigan View
Current # of enrolled students		390 (MS) 88 (PhD)	140 (MS) 233 (PhD)
Major Description. Includes the purpose, nature, and highlights of the curriculum, faculty expertise, emphases (sub-plans; if any), etc.	The MS Computer Science and Engineering curriculum applies computer science theory and software development fundamentals to produce computing-based solutions. It includes substantial coverage of engineering principles applied to the design or large, networked, scalable computer systems. Competencies include algorithms and complexity, concepts of multiple programming languages, software development, real time, embedded, and IoT systems design and other broad based engineering principles. The program has a firm engineering foundation that encompasses discovery-based education utilizing an experiential learning approach. Students will complete projects in areas that emphasize computing theory, communication, teamwork, critical thinking, and engineering professionalism. The MS program's flexibility allows students to design their course of study/research from a diverse pool of courses and research opportunities in software, computer science and computer engineering domains such as web	The Computer Science program combines a strong engineering oriented technical basis with a flexible interdisciplinary component and an emphasis on communication skills. This flexibility will be increasingly important in the future as computers become important tools in an ever-increasing number of fields. Students in the engineering computer science (EG-CSE) program will satisfy the same requirements for general education and obtain the same engineering pre-professional background in mathematics and science as other engineering students. The program contains a strong technical component comprising a set of required courses covering essential areas in computing and a set of technical electives enabling students to deepen their knowledge in chosen areas of computer science and engineering.	The Computer Science and Engineering Division at Michigan is home to one of the oldest and most respected programs in computation in the world. We provide a curriculum that prepares students to tackle modern problems. CSE faculty lead cutting-edge research and mentor students to reach their full potential. Our intellectual community values diversity, interdisciplinary teamwork, entrepreneurial thinking, and inventiveness. The master's degree in CSE is primarily intended for students desiring to substantially advance their knowledge and skill in a field or fields of CSE. The relatively small investment in time to get a master's degree will lead to greater professional opportunities and significantly higher salaries.

	and mobile applications, embedded systems, cybersecurity, machine learning, Quantum computing, systems, and other interdisciplinary areas.	In addition, the program includes a set of interdisciplinary electives in an area of the student's choice. This area may be chosen from anything the university has to offer. Students may choose an established minor, a predefined "track," or if nothing available meets their needs, work with an advisor to develop their own program. To answer the demands of industry for employees with both technical competence and the ability to communicate effectively, the program requires communication courses beyond the usual engineering general education requirements.	
Target careers	• Software developer • Computer Science engineer/researcher for variety of application areas: ○ Web ○ Mobile ○ Embedded systems ○ Avionics ○ Robotics ○ Machine Learning ○ Data Management / Data Science ○ Mobile Application developer ○ Other software related fields	• Software developer • Computer Science engineer / researcher for variety of application areas: ○ Web ○ Mobile ○ Embedded systems ○ Avionics ○ Robotics ○ Machine Learning ○ Data Management / Data Science ○ Mobile Application developer ○ Other software related fields	• Software developer • Computer Science engineer / researcher for variety of application areas: ○ Web ○ Mobile ○ Embedded systems ○ Avionics ○ Robotics ○ Machine Learning ○ Data Management / Data Science ○ Mobile Application developer ○ Other software related fields
Total units required to complete the degree	30	30	30
Pre-admission expectations (i.e. academic training to be completed prior to admission)	• Bachelor's degree from an institution recognized by the UA. Students who do not have a degree equivalent to a UA Bachelor of Science degree in a computing related program may be admitted into the graduate CSE program but may be required to complete some undergraduate deficiency courses prior to	The majority of accepted students have an undergraduate degree in Computer Science, Computer Engineering, or Electrical Engineering, with an undergraduate GPA of at least 3.3/4.0. • GRE: Scores from the general Graduate Record Examination	The MS and MSE degrees differ mainly in name. The degree requirements are the same. Students with a bachelor's degree in engineering can elect either degree. Students without an engineering bachelor's degree are eligible only for the MS.

	enrolling in graduate courses. This policy also applies to students in the MS non-thesis option. • Grade-point average of 3.0 in the overall undergraduate degree or meet Graduate College minimum admissions requirements. • Applicants whose native language is not English are required by the Graduate College to take an English proficiency test. A description of acceptable tests can be found on the Graduate College admissions website. • Students in the MS non-thesis option are expected to be self-supported or supported by external fellowships or industry.	(GRE) are required. Applicant scores are expected to be at least 153 in the Verbal, 155 in the Quantitative, and 3.0 in the Analytical sections for the MS program. GRE is not required for Ph.D. applicants. • TOEFL: 213 on computer-based; 90 on Internet-based. Please note that Indian students are now REQUIRED to submit a TOEFL or IELTS score. Review the list of countries that are exempt from TOEFL. UF's school code for submission of TOEFL scores is 5812. • Students may substitute for TOEFL with IELTS with a minimum overall score of 7.5 is required, with minimum section scores as follows: Reading 6.5, Listening 6.5, Speaking 6.5, Writing 5.5. • TOEFL iBT ≥ 90 (each section must score 19 or higher).	Applicants are expected to have earned their bachelor's degrees by the time they matriculate, and to possess strong backgrounds in computer science or a related discipline. Successful applicants usually have an undergraduate GPA of at least 3.5/4.0 and three strong letters of recommendation. International students must demonstrate English proficiency. Further information may be found here. Students admitted to the PhD program generally exceed these standards. In addition, students admitted to the Ph.D. program often have prior research experience or have demonstrated research aptitude. *Beginning the 2022-2023 admissions cycle, GRE scores are not included in the admissions review of Ph.D. applications (more information available). GRE scores are neither required nor considered for MS applicants.*
Major requirements. List all major requirements including core and electives. If applicable, list the emphasis requirements. Courses listed must include course prefix, number, units, and title. Mark new coursework (New). Include any limits/restrictions needed (house	**Complete one of the following options:** ***Thesis Option:*** Complete a total of 30 units as follows: • Suggested that students select at least one CSE course from each of the three CSE categories (defined below) in their Plan of Study (*9 units*): **Systems and Applications** ▪ CSE 501 (3) – Operating System Design (NEW) ▪ CSE 504 (3) – Embedded Systems Computing (NEW) **Theory of Computation** ▪ CSE 503 (3) – Analysis of Algorithms for Engineering Applications (NEW)	**Core Courses:** • COT 54045 Analysis of Algorithms (3) *Select 3 from the following (9 units):* • CDA 5155 Computer Architecture Principles (3) • COP 5615 Distributed Operating System Principles (3) • COP 5556 Programming Language Principles (3) • CNT 5106C Computer Networks (3) • COP 5536 Advanced Data Structures (3) **Complete one of the following options:**	A CSE Terminal Master's student may earn a CSE M.S./M.S.E. degree by successful completion of the following: • The *Rackham School of Graduate Studies and the College of Engineering* requirements. • The Master's Breadth Requirements including both course and grade requirements. • The required 30 hours of graduate level credit, which must include: • At least 24 credit hours of approved graduate-level technical courses • At least 15 credit hours of CSE technical courses at the 500-level or above

number limit, etc.). Provide email(s)/letter(s) of support from home department head(s) for courses not owned by your department.	▪ CSE 507 (3) – Computer Science and Engineering Research Methods (NEW) **<u>Knowledge and Data Engineering</u>** ▪ CSE 506 (3) – Database Engineering (NEW) • CSE 505 (3) – Advanced Data Structures (NEW) • Complete *6 units* of thesis (CSE 910) (New). • Complete remaining units from the 5xx/6xx technical computing courses listed below or in closely related computing field (must be approved by Graduate Studies Committee). • CSE 501 (3) - Operating System Design (NEW) • CSE 502 (3) - Compiler Design (NEW) • CSE 503 (3) - Analysis of Algorithms for Engineering Applications (NEW) • CSE 504 (3) - Embedded Systems Computing (NEW) • CSE 505 (3) – Advanced Data Structures (NEW) • CSE 506(3) – Database Engineering (NEW) • CSE 507(3) – Computer Science and Engineering Research Methods (NEW) • CSE 599 (3) – Independent Study • CSE 910 (1-6) - Thesis • ECE 503(3) - Probability and Random Processes for Engineering Applications • ECE 506 (3) – Reconfigurable Computing • ECE 509(3) –Cybersecurity Concept, Theory, Practice • ECE 513(3) –Web Development and the IoT • ECE 523(3) –Engineering Applications of Machine Learning and Data Analytics	**<u>Thesis Option:</u>** • 12 units CISE graduate level Core • 6 units MS Thesis research credits • 12 units other CISE 5xx/6xx level courses **<u>Non-Thesis Option:</u>** • 12 units CISE graduate level Core • 18 units other CISE 5xx/6xx level courses A list of CISE graduate level courses and their descriptions can be found at: CISE Graduate Courses	• Up to six credit hours of seminar courses (e.g., EECS 598) and directed study courses, special topics, etc. (e.g., EECS 599). Students must complete one breadth course in each of the following technical areas: • Hardware • Artificial Intelligence • Software • Theory. For a list of courses available to satisfy the breadth requirement in each area, please consult CSE's course and degree satisfaction list for terminal master's students.

	• ECE 540 (3) – Quantum Sensing and Quantum Machine Learning • ECE 562(3) - Computer Architecture and Design • ECE 564(3) – Advanced Topics in Computer Networks • ECE 569(3) – High Performance Computing • ECE 571(3) – Fundamentals of Information and Network Security • ECE 572 (3) – Design, Modeling, and Simulation for High Technology Systems in Medicine • ECE 574A (3) – Computer Aided Logic Design • ECE 576A(3) – Engineering of Computer Based Systems • ECE 576B(3) – Embedded System Design and Optimization • ECE 578(3) – Fundamentals of Computer Networks • ECE 579(3) –Principles of Artificial Intelligence • ECE 677 (3) – Distributed Computing Systems • SFWE 506(3) – Distributed and Parallel Processing • SFWE 507(3) –Data Mining • SIE 533(3) –Fundamentals of Data Science for Engineers • SIE 577(3) – Introduction to Biomedical Informatics • *Other courses may be added at the discretion of the faculty advisor with prior approval of the Graduate Studies Committee (GSC)* ***<u>Non-Thesis Option:</u>*** Complete a total of 30 units as follows: • Suggested that students select at least one CSE course from each of the three CSE categories (defined below) in their Plan of Study (*9 units*): **<u>Systems and Applications</u>**		

	▪ CSE 501 (3) – Operating System Design (NEW) ▪ CSE 504 (3) – Embedded Systems Computing (NEW) **<u>Theory of Computation</u>** ▪ CSE 503 (3) – Analysis of Algorithms for Engineering Applications (NEW) ▪ CSE 507 (3) – Computer Science and Engineering Research Methods (NEW) **<u>Knowledge and Data Engineering</u>** ▪ CSE 506 (3) – Database Engineering (NEW) • CSE 505 (3) – Advanced Data Structures (NEW) • Complete the remaining required *units* from the 5xx/6xx technical computing courses listed below: • CSE 501 (3) - Operating System Design (NEW) (Will be co-convened with CSE 401) • CSE 502 (3) - Compiler Design (NEW) • CSE 503 (3) - Analysis of Algorithms for Engineering Applications (NEW) • CSE 504 (3) - Embedded Systems Computing (NEW) • CSE 505 (3) – Advanced Data Structures (NEW) • CSE 506(3) – Database Engineering (NEW) • CSE 507(3) – Computer Science and Engineering Research Methods (NEW) • CSE 599 (3) – Independent Study • CSE 910 (1-6) - Thesis • ECE 503(3) - Probability and Random Processes for Engineering Applications • ECE 506 (3) – Reconfigurable Computing • ECE 509(3) –Cybersecurity Concept, Theory, Practice • ECE 513(3) –Web Development and the IoT		

	• ECE 523(3) –Engineering Applications of Machine Learning and Data Analytics • ECE 540 (3) – Quantum Sensing and Quantum Machine Learning • ECE 562(3) - Computer Architecture and Design • ECE 564(3) – Advanced Topics in Computer Networks • ECE 569(3) – High Performance Computing • ECE 571(3) – Fundamentals of Information and Network Security • ECE 572 (3) – Design, Modeling, and Simulation for High Technology Systems in Medicine • ECE 574A (3) – Computer Aided Logic Design • ECE 576A(3) – Engineering of Computer Based Systems • ECE 576B(3) – Embedded System Design and Optimization • ECE 578(3) – Fundamentals of Computer Networks • ECE 579(3) –Principles of Artificial Intelligence • ECE 677 (3) – Distributed Computing Systems • SFWE 506(3) – Distributed and Parallel Processing • SFWE 507(3) –Data Mining • SIE 533(3) –Fundamentals of Data Science for Engineers • SIE 577(3) – Introduction to Biomedical Informatics • *Other courses may be added at the discretion of the faculty advisor with prior approval of the Graduate Studies Committee (GSC)*		
Research methods, data analysis, and methodology requirements (Yes/No). If yes, provide description.	If the student selects the Thesis Option, they are required to complete 6 units of research and thesis development in an area related to computer science and engineering. It is also recommended (but not required) that one of their technical electives	If the students selects the thesis option, they are required to take 6 units of research and thesis development.	Not required but approved courses may include: EECS 501: Probability and Random Processes (4) EECS 507: Intro to Embedded System Research (3-4)

	be CSE 507 – Computer Science and Engineering Research Methods.		EECS 568: Mobile Robotics: Methods and Algorithms (4)
Internship, practicum, applied course requirements (Yes/No). If yes, provide description.	No	No	No
Master thesis or dissertation required (Yes/No). If yes, provide description.	If the student selects the *Thesis Option*, they are required to complete 6 units of research in an area related to computer science and engineering. The thesis will capture the results of the research that was completed under the guidance of a faculty member. The thesis paper should demonstrate the students core knowledge, technical skills, and the ability to articulate and synthesize the findings of a project they were engaged in over multiple semesters.	If the student selects the *Thesis Option*, they are required to complete 6 units of research in an area related to computer science and engineering. The thesis will capture the results of the research that was completed under the guidance of a faculty member. The thesis paper should demonstrate the students core knowledge, technical skills, and the ability to articulate and synthesize the findings of a project they were engaged in over multiple semesters.	The option of writing a Master's thesis is available to master's students in good academic standing. A student wishing to exercise this option may initiate the process by taking the following two steps. They must: a) Find a CSE faculty member willing to serve as thesis advisor. b) Enroll under the master's thesis 6 course number (EECS 698) for one to six credit hours. (EECS 698 will not count for technical credit hours.) These credit hours may be spread over more than one term and are graded on an S/U basis.
Additional requirements (provide description)	A cumulative GPA of 3.0 / 4.0 or higher must be maintained on all coursework taken for graduate credit. A grade of C or higher is required for a course to be used to satisfy the degree requirements (A or B for transfer credits). Grade Replacement Option cannot be used for graduate courses.	According to Graduate School rules, students must maintain a 3.0 overall GPA, as well as a cumulative 3.0 GPA for all courses taken from CISE, to graduate. All Master's students are required to pass an examination within six months prior to graduation. Students must be appropriately registered in their final term (three credit hours for Fall and Spring semesters and two credit hours for summer semesters. Students with thesis option must register for three credits of CIS 6971 Master's Research in the	Students normally complete the master's degree in 1-2 years. The complete master's requirements can be found in the CSE Graduate Program Guide (Google Doc). View a list of courses that satisfy the different MS degree requirements (Google Sheet). The Program requires that the Grade Point Average received in CSE coursework must be at least 3.0 based on Rackham's 4.0 scale. An individual course grade of B- or better is required for the credit hours received in any course to be counted towards

		final term. A graduation workshop is held every semester for graduating students to review graduation requirements. Students with thesis option are examined primarily on their thesis topic. The scope of the thesis will be determined by the student's supervisory committee. Each student must request that the oral examination be scheduled, in concurrence with the Supervisory Committee Chair. The examination announcement must be posted by the Student Services Center a minimum two weeks prior to the examination. Committee members must be provided a copy of the thesis one week prior to the examination. Non-thesis option students are given a brief written examination after they have satisfied all course and grade requirements. The exam requires general computer science and engineering knowledge and may be administered in conjunction with the Exit Interview. Questions regarding the exam and/or Exit Interview should be directed to a graduate advisor. All requirements for the MS degree must be completed within 7 years after enrollment. Full time students are expected to complete in 3 years.	any master's degree requirement. A master's thesis is optional. Credit hours transferred may be applied to meet any master's degree requirement except the 15 credit hours of 500-level CSE coursework required. (Rackham specifies limitations to the circumstances under which credits may be transferred. See the Rackham Graduate School Academic Policies: rackham.umich.edu.)

*Note: comparison of additional relevant programs may be requested.

THE UNIVERSITY OF ARIZONA

BUDGET PROJECTION FORM

Name of Proposed Program or Unit: Computer Science and Engineering MS

	Projected		
Budget Contact Person:	**1st Year** 2023- 2024	**2nd Year** 2024 - 2025	**3rd Year** 2025- 2026
METRICS			
Net increase in annual college enrollment UG	-		
Net increase in college SCH UG			
Net increase in annual college enrollment Grad On campus		5	15
Net increase in college SCH Grad On campus - 18 units per year		90	270
Net increase in annual college enrollment Grad Online		5	15
Net increase in college SCH Grad Online - 18 units per year		90	270
Number of enrollments being charged a Program Fee			
New Sponsored Activity (MTDC)			
Number of Faculty FTE			
FUNDING SOURCES			
Continuing Sources			
UG AIB Revenue - enrollment			
UG AIB On Campus Degree			
UG SCH			
Grad AIB Revenue SCH On campus - Used average of 368 per SCH		33,120	99,360
Grad AIB Revenue enrollment On campus - Used average of 1009 per enrollment		5,045	15,135
Grad AIB Revenue SCH Online - Used average of 675 per SCH		60,750	99,360
Grad AIB Revenue enrollment Online - Used average of 1109 per enrollment		5,545	15,135
Program Fee Revenue (net of revenue sharing)			
F and A AIB Revenues			106,666
Reallocation from existing College funds (attach description)			
Other Items (attach description)			
Total Continuing	**$ -**	**$ 104,460**	**$ 335,656**
One-time Sources			
College fund balances			
Institutional Strategic Investment			
Gift Funding			
Other Items (attach description)			
Total One-time	**$ -**	**$ -**	**$ -**
TOTAL SOURCES	**$ -**	**$ 104,460**	**$ 335,656**
EXPENDITURE ITEMS			
Continuing Expenditures			
Faculty	-	260,000	526,500
Other Personnel	-	140,000	228,500
Employee Related Expense	-	127,600	240,845
Graduate Assistantships	-	-	40,160
Other Graduate Aid	-	-	29,917
Operations (materials, supplies, phones, etc.) - Faculty recruitement, student travel, seminars		35,000	35,000
Additional Space Cost			
Other Items (attach description)			
Total Continuing	**$ -**	**$ 562,600**	**$ 1,100,922**
One-time Expenditures			
Construction or Renovation			
Start-up Equipment	-	266,666	533,332
Replace Equipment			
Library Resources			
Other Items (attach description)			
Total One-time	**$ -**	**$ 266,666**	**$ 533,332**
TOTAL EXPENDITURES	**$ -**	**$ 829,266**	**$ 1,634,254**
Net Projected Fiscal Effect	**$ -**	**$ (724,806)**	**$ (1,298,597)**

From:	Valerdi, Ricardo - (rvalerdi)
To:	ONeal, Sharon L - (sharononeal)
Cc:	Wu, Michael H. - (mhwu); Hahn, David W - (dwhahn)
Subject:	Re: Letter of Support - Computer Science and Engineering Degree Programs
Date:	Saturday, October 8, 2022 6:25:23 PM
Attachments:	image001.png image002.png

Sharon,
The SIE Department supports the proposed degree programs and commits to ongoing offerings of the courses listed below.

Regards,

-Ricardo

From: ONeal, Sharon L - (sharononeal) <sharononeal@arizona.edu>
Sent: Saturday, October 8, 2022 8:08:00 PM
To: Valerdi, Ricardo - (rvalerdi) <rvalerdi@arizona.edu>
Cc: Wu, Michael H. - (mhwu) <mhwu@arizona.edu>; Hahn, David W - (dwhahn) <dwhahn@arizona.edu>
Subject: Letter of Support - Computer Science and Engineering Degree Programs

Ricardo,
The College of Engineering and the Electrical and Computer Engineering Department are proposing a new BS undergraduate degree in Computer Science and Engineering (CSE) beginning in Fall 2023 to be taught in both the In-person and Online modalities. We are also planning to subsequently offer a MS and PhD program to begin in 2024/2025 academic year.

The CSE curriculum applies computer science theory and software development fundamentals to produce computing-based solutions. It includes substantial coverage of algorithms and complexity, computer science theory, concepts of multiple programming languages, software development, and engineering principles. The program has a firm engineering foundation that is ABET CAC / EAC compliant.

We have obtained very enthusiastic endorsements from Provost Folks, Vice-Provost Heileman and Dean Hahn (CoE) for this new degree.

The table below summarizes the full-time projected enrollments in the CSE program extrapolated out over the first 5 years, at which we believe we will achieve a steady enrollment number. These numbers were estimated based on actual enrollments[1] in other AAU universities that have dual computer science programs in the College of Engineering and a Computer Science program in another college.

Computer Science and Engineering Projected Enrollments *(all programs)*					
Degree	Year 1 (2023 / 2024)	Year 2 (2024 / 2025)	Year 3 (2025 / 2026)	Year 4 (2026 / 2027)	Year 5 (2027 / 2028)
BS	60	140	300	425	500
MS	0	10	30	60	120
PhD	0	5	15	30	50

As part of the BS curriculum, the following course(s) from your Dept will be required for the degree:

SIE 305 – Introduction to Probability and Statistics
SFWE 302 – Software Architecture and Design *(co-owned with ECE)*
SFWE 402 – Software DevSecOps *(co-owned with ECE)*

As part of the graduate program, the following classes may be taken as electives by the MS / PhD CSE students:

SIE 533 –Fundamentals of Data Science for Engineers
SIE 578 –Artificial Intelligence for Health and Medicine

I'm writing to obtain your support for our plan to require these courses in our supporting coursework. Kindly respond with your acknowledgement and support for these new degree programs, so that it can be incorporated in the proposal that we are finalizing to submit for ABOR approval in early 2023.

If you have any questions, please feel free to reach out either via email or by cell at (520) 822-4040.

Sharon ONeal

Software Engineering

SOFTWARE ENGINEERING est. 2021

Sharon ONeal
Professor and
Director, Software Engineering

Phone: 520-621-2558
Mobile: 520-822-4040 *(preferred)*
Email: sharononeal@email.arizona.edu

[1] Enrollments derived from https://shinyapps.asee.org/apps/Profiles/

THE UNIVERSITY OF ARIZONA
Online, Distance & Continuing Education

October 2022

Prof. Sharon ONeal
Professor and Director, Software Engineering
College of Engineering
University of Arizona

Re: BS/MS Computer Science and Engineering online and distance degree programs – Letter of support

Dear Prof. ONeal,

On behalf of the University of Arizona's Online, Distance and Continuing Education (ODCE) division, I am pleased to offer this letter of support for your proposal to offer bachelor's and master's degrees in Computer Science and Engineering to online and distance students. Increased access to this critical field will provide our students, many of whom are adults with family and job responsibilities and cannot travel to Tucson, a great opportunity to achieve their educational goals.

As the university's in-house full-service enterprise for online and distance education we look forward to collaborating with you. Here is a snapshot of our services and support:

- Online curriculum planning and program development;
- Online course design;
- Marketing, student recruitment, and enrollment management; and,
- Student success coaching for increased retention and graduation.

Our ODCE team will work with you in efforts to help increase diversity, accessibility, and degree completion for students enrolled in these innovative STEM programs.

If you require more information about our support for this proposal, please feel free to contact Caleb Simmons (calebsimmons@arizona.edu), executive director for online education; and/or, Carla Holloway (carlaholloway@arizona.edu), executive director for distance education.

Sincerely,

Craig Wilson, JD, PhD
Vice Provost, Online, Distance and Continuing Education
Professor of Practice, College of Education

THE UNIVERSITY OF ARIZONA

01/20/2023

Prof. Greg Heileman
Vice Provost for Undergraduate Education

Re: Collaborations between COS and COE on BS-CSE degree

Dear Greg,

As you are aware, the College of Engineering (COE) is developing a **BS - Computer Science and Engineering** (CSE) program to be housed in the Department of Electrical and Computer Engineering (ECE). The proposed program has a firm engineering foundation that is ABET CAC/EAC compliant. It aims to broaden the University of Arizona's workforce development pipeline in direct response to industry needs and to provide a unique opportunity for students to develop knowledge of computer science and engineering by combining theory-based concepts with advanced engineering technologies and pedagogy to create solutions that address the grand challenges of the 21st century and beyond.

We are grateful to our colleagues, Prof. Christian Collberg serving as head of the department of Computer Science and Prof. Michael Wu serving as head of Electrical and Computer Engineering, for leading in depth discussions on how best we can maximize the synergy between the proposed new BS-CSE program in COE and the existing BS-Computer Science (BS-CS) program in the College of Science (COS). Below we summarize the planned collaborations and interactions between the two degree programs.

Introductory Programming
CSE students will be required to take two introductory programming classes. They can choose either:

(1) CSC 110 *Introduction to Computer Programming I* and CSC 120 *Introduction to Computer Programming II*, or,
(2) CSE 101 *Programming I* and CSE 201 *Programming II*.

A student can also choose to take CSC 110 and then CSE 201 or CSE 101 and then CSC 120, upon approval of the instructors.

Computer Organization
CS students are currently required to take CSC 252 *Computer Organization*. We plan to replace this with ECE 369 *Fundamentals of Computer Architecture*, or possibly a new course, CSE 303 *Fundamentals of Computer Architecture*, to minimize duplication.

Data Structures
We plan to collaborate to develop new upper-division data structures courses, CSC 345 *Analysis of Discrete Structures* (for CS students) and CSC 355 *Analysis of Discrete Structures* (for CSE students). The primary difference between these courses will be the coding language prerequisites: CSC 345 assumes Java (from CSC 210), while CSC 355 assumes C (from ECE 275). It may be preferable to have two sections of a single course since this could make it simpler to keep their course contents synced.

Ethics
We will require CS students to take ECE 311 *Engineering Ethics*. Currently, this is a 1-unit course. We aim to explore the possibility of expanding this into a 3-unit course.

400-level Electives
Open the following CS classes to ECE students:

- CSC 452 *Principles of Operating Systems*
- CSC 453 *Compilers and System Software*
- CSC 445 *Algorithms*
- CSC 473 *Automata, Grammars, and Languages*

Web Development and Internet of Things
We believe it would be valuable for CS students to be exposed to topics on embedded systems. The nearest course for this is ECE 413 *Web Development and the Internet of Things*. However, the content of this course is divided between Web Development and Embedded Systems, and we share a concern is that there may not be enough time to go into depth on either topic. To address these issues, we aim to explore the possibility of opening CSC 337 *Web Programming*, to ECE students, and focusing ECE 413 on embedded systems topics.

Future course development
CS and ECE agree to discuss the development of new courses open to both sets of students. Depending on faculty interest, these courses could be owned either by ECE or CS. Examples of topics that would be of high interest and value to both sets of students, including, but not limited to:

- Cryptography
- Robotics
- Software testing
- Program verification
- Functional programming
- Quantum computation
- High-performance computing
- Information privacy
- Computer algebra

Thank you also for your guidance and leadership as we have developed this proposal. We ask that you circulate this summary to all and any committees who are interested, as the proposal is advanced for review and approval.

Regards,

Carmela Garzione

Dean Garzione

Jan. 31, 2023

Date

Dean Hahn

Jan. 22, 2023

Date

Cc: Michael, Christian, Assoc deans, Liesl, etc.

THE UNIVERSITY OF ARIZONA

College of Science
Office of the Dean

1040 E. Fourth Street
Gould Simpson Bldg. Room 1025
PO Box 210077
Tucson, AZ 85721-0077
T: (520) 621-4090
F: (520) 621-8389
cos.arizona.edu

November 28, 2023

To: Dean David Hahn, College of Engineering

From: Carmie Garzione, Dean, College of Science

The College of Science and the Department of Computer Science are supportive of the College of Engineering's proposed M.S. and Ph.D. programs in Computer Science and Engineering. We look forward to working with Engineering to highlight our complementary strengths in computing disciplines and helping students identify the degree pathways that best meet their goals.

COLLEGE OF ENGINEERING
Office of the Dean
1209 E. 2nd Street, Room 100
Tucson, AZ 85721-0072

Office: 520-621-6595
engineering.arizona.edu

THE UNIVERSITY OF ARIZONA
College of Engineering

November 24, 2023

To: University of Arizona Faculty Senate

From: David W. Hahn, Craig M. Berge Dean, College of Engineering

Subject: Computer Science and Engineering MS and PhD degrees

This memo is submitted as an addendum to our current proposals for new MS and PhD degrees in Computer Science and Engineering (CSE) and is intended to provide clarity on the financial aspects of both degrees. A related new degree was approved and implemented for the Fall 2023 term, namely the new BS in Computer Science and Engineering. A plan is currently in place to hire 10 additional faculty members at the ranks of assistant professor, associate professor, full professor, and professor of practice over the next 3 years. The exact distribution will be determined through the search processes.

The additional 10 faculty, along with existing faculty in Electrical and Computer Engineering (ECE), the academic home of the new two proposed degrees, and leveraging some faculty from Systems and Industrial Engineering (SIE) from the existing Software Engineering program, are sufficient to teach the existing BS CSE and the new MS and PhD CSE degrees, as outlined in detail in the two proposals before the Faculty Senate.

The College of Engineering has committed $3M to hire the new faculty over a three-year period. This money, with concurrence of senior campus leadership, was redirected from a previous ENGR commitment to support the new Computer Science and Engineering program. As such this represents a new and fully dedicated revenue source to establish the CSE program, including the two new proposed degrees.

By the 5th program year (1st year is 2023-24 AY), a projected total cohort size of 450 undergraduate students and 50 graduate students will generate revenue estimated in excess of $2.5M per current AIB metrics, with a new faculty payroll estimated under $2M (salary and fringe). Additional faculty will be added in consideration of total enrollment and revenue models, all in the context of program financial sustainability. I add that there is considerable financial savings by using the existing infrastructure (leadership, faculty and staff) of the existing ECE department, avoiding unnecessary administrative growth.

I appreciate your consideration and am happy to provide any additional information.