PURDUE UNIVERSITY | College of Engineering

Engineering Faculty Document
No.: 110-24
March 22, 2024

TO: The Engineering Faculty

FROM: The Faculty of the Elmore Family School of Electrical and Computer Engineering

RE: New Engineering Degree

The Faculty of the Elmore Family School of Electrical and Computer Engineering has approved the following new Major from the College of Engineering. This action is now submitted to the Engineering Faculty with a recommendation for approval.

TITLE:

Master of Science in Software Engineering

DESCRIPTION:

The Master of Science in Software Engineering will be a new degree offered by the Elmore Family School of Electrical and Computer Engineering and Purdue's Department of Computer Science. The curriculum requirements are similar to those of the existing course-only MSECE but will also allow students to take courses from Purdue's Department of Computer Science in addition to courses from ECE. See detailed curriculum requirements on the following pages.

This degree will be available both on-campus in West Lafayette and Indianapolis and fully online.

This collaboration between ECE and CS will allow us to leverage the strengths of each program and offer a diverse set of course offerings to students.

Current undergraduate software engineering offerings:

- BS in Computer Science (CS), software engineering track
- BS in Computer Engineering (ECE), software engineering concentration

Graduate Software Engineering Offerings:

- MS in Electrical and Computer Engineering (ECE), concentration in software engineering (expected to be available in Fall 2024)

No other master's level degree(s) or concentrations exist in software engineering.

RATIONALE:

The existing Master of Science in Electrical and Computer Engineering offered by the Elmore Family School of Electrical and Computer Engineering allows students to select coursework related to a wide variety of topics within ECE: from power and energy systems

to microelectronics to computer engineering. The School currently offers a number of courses related to software engineering, and this new Master of Science in Software Engineering will allow students to earn a targeted degree in this field. We anticipate that a minimal number of new courses will be required to support this degree.

Existing Infrastructure: ECE currently has more than 600 active students in the online MSECE and has built the needed infrastructure to administer this program successfully and efficiently. The software engineering degree will utilize this same infrastructure and be administered in a similar manner.

Need for the degree: Data provided by Purdue Online (Lightcast, 2023) indicate the following:

- Top skills listed in job postings requiring masters-level engineering degrees include computer science, Python, software engineering, and software development.
- Job openings in the field of software engineering are expected to grow by 25% between 2020 and 2028.
- Purdue's BS in Computer Engineering conferrals are up 4X between 2012 and 2021. Note that the BS in Computer engineering allows students to earn a concentration in Software Engineering.
- We expect an MS in Software Engineering will have similar performance to the MS in Electrical and Computer Engineering, with gross revenue as high as $3M/year within 5 years of start-up, generating residuals of $1.0-1.2M/year.

Additionally, according to the 2023 TechPoint Indiana Tech Workforce Report, software developers are in high demand throughout Indiana and this demand is expected to grow, but many of these positions are going unfilled due to talent shortages.

As such, we believe that many existing tech workers in Indiana and nationwide will be interested in the MS in Software Engineering to transition into the software engineering field or improve their existing computer engineering and software skills. Offering this degree residentially at Purdue University Indianapolis may be very attractive to the local area's many tech workers, especially if schedule allows for part-time study.

Competition: While many institutions throughout the US offer master's degrees in computer science, data science, and cybersecurity, few offer master's degrees in software engineering. Of the US News and World Report 2023-2024 Best Engineering Graduate Schools (of which Purdue is ranked #4), only two offer MS degrees in software engineering: Carnegie Mellon (residential only) and the University of Michigan-Dearborn (online and residential). The MS in software engineering will allow Purdue to offer another high-demand, high-quality degree.

Head/Director of the [school or committee]

Link to Curriculog entry:

To be completed

Purdue MS Software Engineering Curriculum Requirements

Total credits needed: 30

- Two core courses:
  - Select one:
    - ECE 60800, Computational Models and Methods (3 credits)
    - CS 58000, Algorithm Design, Analysis, and Implementation (3 credits)
  - ECE 59500, Advanced Software Engineering (3 credits)
- One math course (3 credits)
  - Course options will match those of current ECE students: ECE grad student math course options
- A total of 18 hours of ECE and CS coursework, includes core courses above

Curriculum Details

Required courses:

Course	Title	Offerings	Term offered	Credits
ECE 60800 OR CS 58000	Computational Models and Methods (core) Algorithm Design, Analysis, and Implementation	On campus & online	Fall (on-campus and online) and Spring (on-campus only)	3
ECE 59500	Advanced Software Engineering	On-campus and online	Fall, Spring	3

Recommended Course for Any Specialization

Course	Title	Course	Term offered	Credits
ECE 51220	Applied Algorithms	On-campus and online	Fall - odd years	3
CS 51000	Software Engineering	On-campus and online	Each Spring	3
ECE 66400	Formal Languages, Computability, and Parallelization	On-campus only	Fall - odd years	3
ECE 5XXXX	Introduction to Software Engineering	On-campus and online	TBD	3

Recommended Courses: Machine Learning and Data Science

Course	Title	Offerings	Term offered	Credits
ECE 50024	Machine Learning	On-campus and online	Each Spring	3
ECE 56200	Introduction to Data Management	On-campus only	Fall - odd years	3
ECE 57000	Artificial Intelligence	On-campus and online	Each Fall, Spring	3
ECE 59500	Deep Learning for Computer Vision	On-campus only	Each Fall	3
ECE 59500	Intro to Data Mining	On-campus and online	Each Fall	3
ECE 59500	Introduction to Deep Learning	On-campus and online	Each Fall	3
ECE 59500	Natural Language Processing	On-campus only	Each Spring	3
ECE 59500	Reinforcement Learning	On-campus and online	Each Fall	3
ECE 60146	Deep Learning	On-campus only	Each Spring	3
ECE 62900	Intro to Neural Networks	On-campus and online	Each Fall	3
ECE 66100	Computer Vision	On-campus only	Fall - even years	3
ECE 69500	Inference and Learning in Generative Models	On-campus only	Each Spring	3
ECE 69500	Machine Learning for Bioinformatics and Healthcare	On-campus and online	Each Spring	3
ECE 69500	Optimization for Deep Learning	On-campus and online	Each Fall	3
ECE 69500	Big Data for Reliability and Security	On-campus and online	Each Fall	1
CS 57300	Data Mining Prerequisite = STAT 51600, Basic Probability and Applications	On-campus and online		3

Recommended math course: MA 511, Linear Algebra

Recommended Courses: Embedded Software, Robotics, and Controls

Course	Title	Offerings	Term offered	Credits
ECE 56800	Embedded Systems	On-campus and online	Each Spring	3
ECE 58000	Optimization Methods for Systems and Control (Prerequisite = MA 511)	On-campus and online	Each Spring	3
ECE 60872	Fault-Tolerant Computer System Design	On-campus only	Each Spring	3
ECE 66100	Computer Vision	On-campus only	Fall - even years	3
ECE 69500	Advanced Internet of Things Design and Applications	On-campus and online	Each Spring	3

Recommended math courses:

- MA 511-Linear Algebra
- MA 518-Advanced Discrete Math
- MA 521-Intro to Optimization
- STAT 511-Statistical Methods
- STAT 516-Probability and applications

Recommended Courses: Systems Software

Course	Title	Offerings	Term offered	Credits
ECE 50863	Computer Network Systems	On-campus and online	Each Spring	3
ECE 56300	Programming Parallel Machines	On-campus and online	Spring - odd years	3
ECE 57300	Compilers and Translator Writing Systems	On-campus only	Each Fall	3
ECE 59500*	Introduction to Compilers I: Compiler Basics	Online only	Each Fall	1
ECE 59500*	Introduction to Compilers II: Code Generation	Online only	Each Fall	1
ECE 59500*	Introduction to Compilers III: Optimization	Online only	Each Fall	1
ECE 62400	Multimedia Systems	On-campus only	Fall - even years	3
ECE 66300	Compiler Code Generation, Optimization, and Parallelization	On-campus only	Spring - even years	3
ECE 67300	Distributed Computing Systems	On-campus only	Each Spring	3
ECE 69500	Datacenter and Cloud Networks (Prerequisite: ECE 50863, Computer Network Systems)	On-campus only	Each Spring	3
ECE 69500	Introduction to Operating Systems	On-campus and online	Each Fall	3

*Together, these three modules are the same course as ECE 57300.

Recommended math courses:

- MA 518-Advanced Discrete Math
- STAT 511-Statistical Methods
- STAT 516-Probability and applications
- STAT 527-Intro to computing for statistics
- STAT 545-Intro to computational statistics

Recommended Courses: Cybersecurity

Course	Title	Offerings	Term offered	Credits
ECE 59500	Introduction to Game Theory	On-campus and online	Each Fall	3
ECE 69500	Hardware and Software Security	On-campus only	Each Fall	3
ECE 69500	Holistic Software Security	On-campus only	Each Fall	3
ECE 69500	Introduction to Applied Cryptography	On-campus only	Each Fall	3
CS 52600	Information Security Prerequisite = CS 50300, Operating Systems	On-campus and online	Each Fall	3
CS 52700	Software Security Prerequisite – CS 52600, Information Security	On-campus and online	Each Spring	3
CS 52800	Network Security Prerequisite – CS 52600, Information Security	On-campus only	Each Spring	3

Recommended math courses:

- MA 518-Advanced Discrete Math
- STAT 511-Statistical Methods
- STAT 516-Probability and Applications
- STAT 527-Intro to Computing for Statistics

Program Learning Outcomes

1. Identify, formulate, and solve complex software engineering problems by applying principles of engineering, science, and mathematics.
2. Develop expertise in machine learning and data science; embedded software, robotics, and controls; systems software; and/or cybersecurity.
3. Recognize and articulate specific software engineering needs with consideration of public health, safety and welfare as well as global, cultural, and social, environmental, and economic factors.
4. Effectively communicate software design and development decisions.
5. Work effectively as a member of a team solving software engineering problems.

Admissions Criteria

A bachelor's degree in computer science or computer engineering preferred. Students with other related undergraduate degrees who have 2-3 years of work experience in the field may be admitted if their credentials collectively indicate an ability to succeed in the coursework.

While the program includes some introductory courses to bridge the gaps for students with other undergraduate degrees, the program does not broadly teach undergraduate-level foundational courses. Students should have a working knowledge of relevant topics, such as algorithms, data structures, microprocessors, operating systems, programming languages, compilers, calculus, linear algebra, discrete mathematics, and probability and statistics.