Quick Links

Course Information

- **Course number and title:** ECE 50874 Advanced Software Engineering (West Lafayette)| ECE 59595 Advanced Software Engineering (Indy)
- **Modality:** This course will be delivered in two modes as follows:
  - Face-to-face synchronous lecture (in-person graduate and undergraduate students)
  - Asynchronous section (typically online-MSc students)
- **Meeting days and times:** MWF, 2:30-3:20 PM. All lectures will be recorded for use by the asynchronous section.
- **Course credit hours**: 3
- **Prerequisites (if any**)
  - *Undergraduates*: ECE 461 (Software Engineering); or commensurate experience with instructor approval.
  - *Graduate students*: Graduate standing and an interest in software engineering. Students will be best equipped for success if they have prior experience developing non-trivial software projects, whether professionally or through pertinent

coursework. Please consult the course catalog of ECE 461 for an understanding of the topics and experiences that will be helpful. Contact instructor with questions.

Instructor Contact Information

- **Name of the instructor**: Assistant Professor James C. Davis
- **Office Location**: BHEE 334D
- **Office Phone Number**: 765-494-3133
- **Purdue Email address**: davisjam@purdue.edu
- **Office/Consultation hours, times, and location**: To be determined

- **Name of the instructor**: Assistant Professor Santiago Torres-Arias
- **Office Location**: BHEE 324B
- **Office Phone Number**: 765-496-6610
- **Purdue Email address**: santiagotorres@purdue.edu
- **Office/Consultation hours, times, and location**: To be determined

Other course staff: There is a Graduate Teaching Assistant, Alexander Avilez, aavilezb@purdue.edu

Teaching Philosophy

We teach courses about material that we find interesting and societally impactful. We strive to communicate this passion to our students.

There seems to be no end to the knowledge of humankind. We have not mastered it all and do not pretend to have done so. We may know more about some topics than some of my students. Sometimes, students may know more than the instructors do. As a class, we will proceed down the road of learning together.

We keep busywork to a minimum. We will assign meaningful assignments, exams, and projects. In return, we expect students to submit good work. If you feel that some aspect of the course is busywork, please let us know.

The relationship between teacher and student is two-way. We will do our part to the best of our ability. But we cannot force you to learn. You will get out of this course what you put into it.

Course Description

Software engineering is a difficult endeavor. Software engineers work in diverse teams to create and comprehend complex information, such as: code structure, implementation rationale, dynamic software behavior, change implications, and team dynamics. In this class, we will study principles of software engineering and discuss state-of-the-art research. In their course project, students will work to understand and extend the state-of-the-art in software engineering, or to apply the concepts to an existing open-source project.

This is a graduate-level course. It briefly reviews, but largely builds upon, the kind of material presented in a typical undergraduate software engineering course such as ECE 461.

This course follows a project-based learning (PBL) approach – much of the grade is obtained through the completion of a team-based project.

The primary audiences for this course are:

- Students whose research interests lie in software engineering and adjacent areas (*e.g.*, cybersecurity, systems, or human factors).
- Students who intend to develop computer-based systems, either as software engineers or working alongside them, and wish to have a more rigorous basis for their systems than "it seems to work".

Learning Resources, Technology & Texts

- **Required texts**:
  - Readings will be assigned from these works.
    - *IEC 61508: Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems*
    - *Software Engineering.* Sommerville, Pearson, 2016. The text has undergone major revisions over the years. References are to the 10th edition. The 9th edition has a similar table of contents and should be comparable.
    - *Software Engineering at Google*. O'Reilly, 2020. Check the Purdue library for access to e-edition.
- **Recommended references:** Never miss a chance to share book recommendations! Here are some favorites.
  - To improve your knowledge of Software Engineering
    - *The Mythical Man-Month: Essays on Software Engineering*. Brooks.
    - *Design Patterns*. Gamma, Holm, Johnsson, and Vlissides.
    - *Accelerate*. Forsgren, Humble, and Kim.
  - To improve your technical writing
    - *Style: Toward Clarity and Grace*. Williams.
- **Additional readings:**
  - Online resources and research papers may be referenced. Links or PDFs will be available on Brightspace.
- **Software/web resources**
  - Brightspace (for assignments, feedback, course discussions, and recordings)
  - Software for presentation and text processing (MS Office is free for all students)
  - Zoom or MS Teams can be used for e-meetings
  - If you need access to a Linux machine, you should have access to the Linux servers run by ECN (currently known as ECEProg) using your Purdue credentials. Most cloud providers also have a "free tier" or credits you can make use of.
- **Hardware requirements (e.g., webcam for exam proctoring)**
  - N/A
- **Tutoring support**
  - N/A
- **Brightspace learning management system**

- ○ Yes, accessible through the Brightspace Home.

Learning Outcomes

The following table indicates the course learning outcomes, their correspondence to ABET criteria (see ABET criteria), and the planned assessment instruments.

Outcome	Primary Instruments
1. Understand mathematical bases for software engineering (*e.g.*, formal methods in software design and software verification) [ABET 1].	• Homework
2. Formulate, conduct, and report on a team-based research-oriented project in software engineering [ABET 1,5,6,7]	• Team Project
3. Consider the ethical implications of software engineering failures and successes [ABET 4]	• Homework • Class participation • Individual project
4. Summarize and analyze scholarly findings, both verbally and in writing [ABET 3]	• Homework • Class participation • Team Project

See the **Assignments** section of the Syllabus for more information about the assessment instruments.

Course Schedulej

The course will proceed in three main sections.

1. Course introduction and overview of IEC 61508
2. Walk-through of IEC 61508's software engineering-related components, structured as
    a. Mondays: Professor lecture on the topic
    b. Wednesdays: Student presentation on relevant research papers, selecting from set recommended by instructor.
    c. Fridays: Student presentation of relevant tool, with in-class lab and a take-home report to complete.
3. Prior to Spring Break, we will have been examining "traditional" software engineering methods for high-assurance software development. After Spring Break, we will switch to the Agentic paradigm, testing whether and how Agentic SE is compatible with IEC 61508.

Each topic is examined through the lenses of standards, research evidence, and practical tooling.

The following is an approximate course calendar. Subject to change – the course learning management system will have the latest information.

Week	Topics	Readings	Homework	Project Timeline
Week 1: 1/12/26	• Course overview • Project description, options, and	Sommerville chapter on process	Reading/Syllabus quiz	Project interest survey

	previous examples • Project team formation			
Week 2: 1/19/26 *1/19 is a university holiday*	• Introduction to standards • IEC 61508 Part 1 (Overview)	SWEng at Google chapter Mythical man month chapter (cloud castles)	SafeScrum	• Team composition • Final report: Plan v1 (activities, timeline, etc)
Week 3: 1/26/26	• IEC 61508 Part 3 (Overview)	IEC 61508 Part 1 (selected) Agile manifesto		
Week 4: 2/2/26	Specification • LTL • SPIN	LTL material from Holzmann's SPIN book		• Biweekly update 1 • Final report: (1) Description and justification of selected project; (2) Plan v2 (activities, timeline, etc)
Week 5: 2/9/26	Design and Impl •	IEEE design standard	Project peer critique 1	
Week 6: 2/16/26	Validation 1: Fuzzing			• Biweekly update 2 • Final report: Background (selected technique, related research works, related engineering works)
Week 7: 2/23/26	Validation 2: Formal methods		Case study: Regex differential testing with RE2	• Mid-semester update • Final report: Evaluation plan (metrics and subjects to measure)
Week 8: 3/2/26	Monitoring			
Week 9: 3/9/26	Failure knowledge management		Design doc for the studied project	
Week 10: 3/16/26				

SPRING BREAK				
Week 11: 3/23/26	Cybersecurity			
Week 12: 3/30/26	IEC 61508 vs. Speed? Agentic SE 1			• Biweekly update 4 • Final report: Implementation
Week 13: 4/6/26	IEC 61508 vs. Speed? Agentic SE 2			
Week 14: 4/13/26	Special topics			• Biweekly update 5: • Final report: Results section and Conclusions section
Week 15: 4/20/26	Project presentations 1		Project presentation critique 1	
Week 16: 4/27/26	Project presentations 2		Project presentation critique 2	• Final report: First draft (Wed.)
Week 17: Finals week: 5/4/26			Project peer critique 2 (Fri.)	• Final report (Wed.)

Assignments

Your learning will be assessed through a combination of homework, class participation, a team-based course project, and an individual project. The primary assignments for the course, *i.e.*, those with the greatest weight, are:

1. Research paper presentation (recorded or in-person presentation)
    a. Research paper presentations are intended to expose tensions between standards, research evidence, and engineering practice.
2. Tool lab preparation and walkthrough (recorded or in-person presentation)
    a. Tool demonstrations and labs are intended to translate standards requirements and research ideas into hands-on engineering practice, revealing where tools support, approximate, or fall short of their theoretical goals.
3. Semester-long **team** project (research or practice)
    a. This project will give you a lengthy team experience in either (1) discovering new knowledge or software engineering, or (2) applying state of the art software engineering knowledge to a substantial real world project.
4. Semester-long **individual** project (failure analysis)
    a. The failure analysis project will help you examine the root causes and opportunities for mitigation and real world software failures. You will map your analysis back to IEC 61508 and the research papers that we've discussed.

Details on these assignments are posted on Brightspace. The following table gives the general breakdown of activities, weights, and expected amount of effort.

Type of assessment	Planned activities and time estimates	Total points
Homework (50 hours)	1. Lab report: Report on in-class lab activities (8-10x, 2-3 hours each) 2. Reading responses: Assigned for four research papers (4x, 4-6 hours each) 3. Project peer critique: Read and give feedback on another team's work (2x, 3-4 hours each)	20
Class participation (10-20 hours)	1. Class discussions: Weekly posts. Posing good questions, formulating good answers (tracked via discussion board) 2. Research paper presentation (asynchronous students may record this for viewing in class, or join synchronously to present) 3. Attendance (enforced as needed)	15
Team Project (80 hours)	1. Proposal sketch (written) 2. Proposal (oral and written) 3. Response to proposal critiques (written) 4. Peer assessment 1 5. Project updates (biweekly) 6. Final report rough draft 7. Final report 8. Peer assessment 2	50
Individual Project (20 hours)	1. Three project ideas and feasibility checks (Week 3) 2. Initial analysis (Week 7) 3. Refined analysis (Week 12) 4. Final analysis (Finals Week)	15
150-165 hours (16 week course, 9-11 hours/week, consistent with Purdue's guidance)		***Total: 100***

Grading Scale

Your grades in this course are intended to assess how well you have met the learning outcomes for which the course is designed. Your grades reflect the sum of your achievement throughout the semester. You will accumulate points as described in the assignments portion above, with each assignment graded according to a rubric. At the end of the semester, final grades will be calculated by applying the appropriate weight to each assignment and translating the result into the following letters. A standard rounding, as defined by Excel's ROUND function, will be applied.

A+: An A, with exemplary performance
A: 93-100
A-: 90-92
B+: 87-89
B: 83-86

B-: 80-82
C+: 77-79
C: 73-76
C-: 70-72
D: 60-69
F: Below 60

Attendance and Deadline Policy

To succeed in the course, stay engaged.

If you are enrolled in the face-to-face version:

- You are expected to come to class unless there are mitigating circumstances (illness, travel, job interviews, etc.).
- A portion of your grade may be derived from in-class participation (or the asynchronous equivalent). Currently there is not a mandatory attendance policy for in-person students. If this policy is abused, the instructors reserve the right to enforce in-person attendance.

If you are enrolled in the asynchronous version:

- You are expected to view the lecture recordings within 1 week of their availability on Brightspace.
- If there is an in-class activity (beyond the lab days), you are expected to complete it, adapting as needed to your circumstances.

The assignments in this course have deadlines. However, the course staff am not so naïve as to believe you have no other demands on your time. This is a graduate-level course, and we will treat you as professionals. **If you need an extension or accommodation, contact your instructor to request it**. A professional strives to manage their time and completes assignments in a timely manner. However, surprises and emergencies of many kinds – including health, finances, and family matters – are all excellent reasons to retroactively request an accommodation. As needed, you or your representative should contact the Office of the Dean of Students via email or phone.

The course staff reserve the right to assess a late penalty, or to refuse to grant an extension.

Academic Integrity

General policy

Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breaches of this value by either emailing integrity@purdue.edu or by calling 765-494-8778. While information may be submitted anonymously, the more information is submitted the greater the opportunity for the university to investigate the concern.

If the course staff find evidence that you have engaged in academic dishonesty, we will contact you to discuss it. If we conclude that there is a preponderance of evidence that you have behaved dishonestly, then at our discretion one of the following outcomes will occur:

- You may receive a 0 on the assignment and can re-submit it following honest conduct.

- You may receive a failing grade in the course and have your behavior reported to the Office of the Dean of Students.
- Based on the Office of the Dean of Students' analysis of your behavior, further penalties may be considered, including removal from the university.

What does academic dishonesty mean in this course?

The Purdue Honor Pledge is "**As a Boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. Accountable together – We are Purdue.**" Here we clarify what it means to be "honest and true" on the different assignments in this course.

In each kind of assignment, the primary consideration is that you clearly indicate which parts of your submission are your own work, which parts are communicating someone else's work. A failure to make this distinction is commonly called **plagiarism**. To avoid plagiarism, follow scholarly norms:

- Use quotation marks when making a direct quote, and include a citation in the text and a reference in your bibliography.
- If you are describing someone else's work, include a citation and a reference in your bibliography. When we say "someone else's work" we mean this broadly; that might include their study design, methodology, analysis technique, or research findings; a blog post they wrote; a talk they gave; personal communication; and so on.
- Use traditional document structure to make it easy to distinguish between your own work and someone else's work based on section title.
- Cite high-quality material. There are an abundance of research papers and "grey literature" (blog posts, Stack Overflow posts, Wikipedia pages, etc.). They are of varying quality. Do you trust the author?
- Honor the copyright of any images you use.

Here are some additional requirements for the main kinds of assignments in this course.

Homework: Paper summary

If you quote the manuscript, include the section number and/or page number as appropriate (this may be helpful to you in a class discussion).

Project: Project report

Structure your document so that your own work is in clearly noted sections. Here is a conventional outline for papers in the field of software engineering. The outline might look formulaic, but the convention has a purpose. It helps readers understand where the new material is.

Section	Description	Has citations?
Abstract	Describes what you did. You can refer to facts (e.g. "Current techniques fail to…") without citation, but only if you expand on that claim in the body of your document and include citations there.	Unusual in this field
Introductions	Contextualizes and summarizes your work.	Yes (many)

Background and/or Motivation	Provides the concepts, key terms, and related work that a reader must know to understand your contribution. May include a motivating example	Yes (many)
Research Questions / Study Design / Methodology (Usually 1-3 sections)	Explain what you want to know, why you want to know it, and how you intend to find it out.	Often (e.g. to explain your experimental design)
Results	What did you find?	Unusual
Analysis	What do your findings mean?	Sometimes (e.g. to justify a choice of analysis)
Related work	Contextualizes your work in more detail. Lines of research that you described in the Background may be omitted, but work that is similar to yours in spirit should be considered. Sometimes combined with “Background”.	Yes (many)

Class participation: Discussion

If you share your own thought, use phrases like “I think that…” or “Based on my experience, …” or “Based on my understanding of Zimmermann’s work, …”

If you share someone else’s thought, prefer phrases like “Zimmermann’s work showed that …”

Class participation: Presenting a paper

Distinguish between summarizing a paper and sharing your own thoughts on a work. Use signpost slides that say things like “My Analysis”, and verbalize transition phrases like “Now let me share my analysis of this work”.

If you include a figure from someone else’s work, indicate that you have done so through a citation at the bottom of the slide.

If you are re-using someone else’s slides, indicate that at the beginning of your talk.

Project: Software

Understand and honor the license(s) associated with other code that you incorporate into your project.

You may rely on external dependencies, so long as they do not impose restrictions that are incompatible with your use.

On the use of generative AI

All engineering judgment must be done by you. You may use generative AI tools (*e.g.,* ChatGPT, Gemini) as editors and tools for generation, but not as the final arbiters of ideas nor content. This policy applies to all deliverables for this course – reports and code.

Nondiscrimination Statement

Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life. For further reading on this theme, see: *Purdue's Nondiscrimination Policy Statement*

Accessibility

All course material will be available through Brightspace.

Purdue University strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let me know so that we can discuss options. You are also welcome to contact Purdue's Disability Resource Center.

Mental Health/Wellness Statement

If you need support and information about options and resources, please contact or see the Office of the Dean of Students. They can share many resources with you, including virtual tools and in-person or virtual mentoring and counseling sessions.

If you're struggling and need mental health services: Purdue University is committed to advancing the mental health and well-being of its students. If you or someone you know is feeling overwhelmed, depressed, and/or in need of mental health support, services are available. For help, such individuals should contact Counseling and Psychological Services (CAPS) at 765-494-6995 during and after hours, on weekends and holidays, or by going to the CAPS office on the second floor of the Purdue University Student Health Center (PUSH) during business hours.

If you need additional academic resources: Check out Purdue's Academic Success Center.

Basic Needs Security

Any student who faces challenges securing their **food** or **housing** and believes this may affect their performance in the course is urged to contact the Dean of Students for support. There is no appointment needed and Student Support Services is available to serve students

8 a.m.-5 p.m. Monday through Friday. Students may also submit requests for emergency assistance from the Critical Need Fund.

Emergency Preparation

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor’s control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. You are expected to read your @purdue.edu email on a frequent basis.