



ME 490: Senior Mechanical Engineering Design I

Term: Fall 2026

Credits: 3.0

Seminar Times & Location: Tuesday & Thursday 11:00 a.m.–12:15 p.m., Lovell Hall 310

Modality: In-Person Seminar

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Instructor Information

- **Instructor:** Dr. Inés Romero (Assistant Professor of Mechanical Engineering)
- **Email:** iromero@university.alkimi.ai
- **Office:** Rowan Engineering Center 226
- **Office Hours:**
 - Wednesday & Thursday: 1:00–2:30 p.m. (In person, Rowan Engineering Center 226)
 - Friday: 3:00–4:00 p.m. (Virtual via Zoom; link posted in Canvas)
 - Also available by appointment.

Course Description

First semester of the capstone design sequence: client needs, specifications, concept generation and selection, engineering analysis, and a preliminary design review. ME 490 is the first half of the mechanical engineering senior capstone design sequence, transitioning students from theoretical coursework into professional engineering practice. Working in multidisciplinary teams sponsored by industrial clients or research partners, students identify user needs, establish target specifications, generate and screen concepts, and conduct comprehensive engineering analyses. The course culminates in a formal Preliminary Design Review (PDR) and comprehensive engineering design package that sets the foundation for detailed fabrication, testing, and display at the spring Senior Design Showcase in ME 491.

Prerequisites

ME 340, ME 350, and senior standing.

Measurable Student Learning Outcomes

Upon successful completion of ME 490, students will be able to:

1. **Translate Client Needs to Specifications:** Elicit customer requirements, construct House of Quality matrices, and establish measurable, defensible engineering target specifications with realistic constraints.
2. **Execute Concept Generation and Selection:** Apply functional decomposition and systematic ideation techniques, evaluating competing design concepts using structured Pugh selection matrices.
3. **Conduct Rigorous Engineering Analysis:** Perform first-principles mechanical, thermal, and dynamic calculations supported by computer-aided engineering tools (CAD, FEA, MATLAB) to validate preliminary feasibility.

4. **Integrate Standards and Safety Codes:** Incorporate relevant professional standards (ASME, ASTM, ISO), regulatory guidelines, and failure mode and effects analysis (FMEA) into the mechanical system architecture.
5. **Present Professional Design Reviews:** Deliver oral preliminary design review presentations and comprehensive written engineering reports according to professional industry standards.

Required Course Materials & Approximate Costs

1. **Ulrich, Karl T., Steven D. Eppinger, and Maria C. Yang. *Product Design and Development*. 7th ed., McGraw-Hill, 2020.** Approx. \$70 digital rental (\$175 purchase; reserve copies available in Alkimi Library).
2. **SolidWorks and ANSYS Student Software Suites (available on university lab workstations and student download).** Free educational access provided by Alkimi University.
3. **Total estimated cost:** Approx. \$0 (library reserve & campus software) to \$70 (digital rental).

Generative AI Policy (AI Level 2: AI Permitted with Disclosure for Specified Tasks)

In accordance with Alkimi University Academic Policies (Student Handbook §5.8), ME 490 operates under **AI Level 2**.

- **What is permitted:** Students may use generative AI tools to assist in drafting documentation outlines, formatting tables, refining technical prose, and brainstorming broad concept variations during divergent design phases.
- **What is prohibited:** AI tools must not be used to fabricate engineering calculations, generate finite element or kinematic simulation results, or draft client requirements without direct stakeholder consultation. Submitting AI-generated engineering designs without rigorous mechanical analysis violates course ethics.
- **Disclosure:** All submitted project reports and design portfolios must include an AI disclosure statement identifying any tools used, specific prompts submitted, and the technical validation methods used to verify engineering calculations.

Grading Components and Weights

- **Team Charter & Project Scoping Document:** 10% (Due Friday, September 11 at 11:59 p.m.)
- **Customer Needs & Engineering Specifications Document:** 15% (Due Friday, October 2 at 11:59 p.m.)
- **Concept Generation & Selection Report:** 15% (Due Friday, October 23 at 11:59 p.m.)
- **Preliminary Design Review (PDR) Presentation:** 20% (In class, Thursday, December 3)
- **Team Standups, Client Engagement & Peer Evaluation:** 15% (Assessed via biweekly client updates, team meeting logs, and peer evaluations across the term)
- **Preliminary Design Package & Comprehensive Technical Report:** 25% (Due by the end of the final exam period, Wednesday, December 16, 2026, 1:30–3:30 p.m.)

Grading Scale (Alkimi University Standard)

- **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+:** 67–69% | **D:** 60–66% | **F:** Below 60%
- **Extra credit:** No extra credit assignments are offered in ME 490.

Course Schedule (Fall 2026)

Week	Dates	Topics & Readings	Assignments & Deadlines
Week 1	Aug 27	Capstone Overview and Project Pitches: Introduction to senior capstone expectations, sponsor presentations of industry projects, multidisciplinary team forming protocols, and intellectual property agreements. <i>Reading: Ulrich et al. Ch. 1–2</i>	<i>First day of classes: Wed Aug 26.</i>
Week 2	Sep 1, 3	Team Organization and Project Planning: Team roles, leadership structures, Gantt charts, work breakdown structures (WBS), risk management matrices, and sponsor contact protocols. <i>Reading: Ulrich et al. Ch. 3</i>	<i>Wed Sep 2: Add/section change deadline.</i>
Week 3	Sep 8, 10	Customer Needs Discovery and Stakeholder Interviews: Conducting stakeholder interviews, identifying latent customer needs, organizing needs hierarchies, and formulating the team charter (due Friday). <i>Reading: Ulrich et al. Ch. 5</i>	<i>Mon Sep 7: Labor Day (no classes). Wed Sep 9: Census date (last day to drop without a W).</i> Team Charter & Project Scoping Document due Fri Sep 11 at 11:59 p.m.
Week 4	Sep 15, 17	Engineering Specifications and House of Quality: Establishing target specifications, Quality Function Deployment (QFD), competitive benchmarking, and setting verifiable engineering metrics. <i>Reading: Ulrich et al. Ch. 6</i>	—
Week 5	Sep 22, 24	Functional Decomposition and Subsystem Modeling: Functional diagramming, black-box modeling, energy/material/signal flow decomposition, and sub-problem formulation across mechanical domains. <i>Reading: Ulrich et al. Ch. 7.1–7.3</i>	—
Week 6	Sep 29, Oct 1	Concept Generation and Ideation Methods: Internal search methods, morphological charts, TRIZ principles, concept classification trees, and submission of the Specifications Document (due Friday). <i>Reading: Ulrich et al. Ch. 7.4–7.8</i>	Customer Needs & Engineering Specifications Document due Fri Oct 2 at 11:59 p.m.
Week 7	Oct 6, 8	Concept Selection and Pugh Screening: Structured decision matrices, concept screening vs. concept scoring (Pugh selection), sensitivity analysis, and multi-criteria evaluation. <i>Reading: Ulrich et al. Ch. 8</i>	—
Week 8	Oct 15	Engineering Ethics and Professional Responsibility: NSPE Code of Ethics for Engineers, case studies in engineering failures and whistleblowing, and public health, safety, and welfare responsibilities. <i>Reading: NSPE Code of Ethics and selected readings</i>	<i>Oct 12–Oct 13: Fall break (no classes).</i>
Week 9	Oct 20, 22	System Architecture and Subsystem Interfaces: Modular vs. integral architectures, chunking, mechanical interface definitions, geometric layout planning, and Concept Selection Report (due Friday). <i>Reading: Ulrich et al. Ch. 10</i>	Concept Generation & Selection Report due Fri Oct 23 at 11:59 p.m.
Week 10	Oct 27, 29	Engineering Analysis and First-Principles Modeling: Structural analysis, component sizing, thermodynamic balances, and preliminary FEA/CFD simulations to substantiate mechanical viability. <i>Reading: Ulrich et al. Ch. 14</i>	—
Week 11	Nov 3, 5	Design for Manufacturing and Assembly (DFMA): Design rules for machining, sheet metal, injection molding, and additive manufacturing; component count reduction and assembly efficiency. <i>Reading: Ulrich et al. Ch. 13</i>	<i>Fri Nov 6: Last day to withdraw (W) or elect Pass/No Pass.</i>
Week 12	Nov 10, 12	Industry Standards and Failure Mode Analysis: Applying ASME, ASTM, and ISO consensus standards; performing Failure Mode and Effects Analysis (FMEA) to identify safety hazards and risk priority numbers. <i>Reading: Selected standards guidelines</i>	—
Week 13	Nov 17, 19	Cost Estimation, Bill of Materials, and Vendor Sourcing: BOM formulation, unit manufacturing costs, tooling amortization,	—

Week	Dates	Topics & Readings	Assignments & Deadlines
		supplier lead-time analysis, and procurement preparation for spring prototyping. <i>Reading: Ulrich et al. Ch. 13.5–13.8</i>	
Week 14	Nov 24	Prototyping Strategy and ME 491 Implementation Roadmap: Physical vs. analytical prototypes, comprehensive testing plans, design freeze criteria, and planning for the spring Senior Design Showcase. <i>Reading: Ulrich et al. Ch. 15</i>	<i>Nov 25–Nov 27: Thanksgiving break (no classes).</i>
Week 15	Dec 1, 3	Formal Preliminary Design Review (PDR) Presentations: In-class preliminary design review presentations before client sponsors, faculty evaluators, and peer teams with structured Q&A defenses. <i>Reading: Review presentation rubrics</i>	Preliminary Design Review (PDR) Presentation (in class).
Week 16	Dec 8	Design Review Revisions and Capstone Archival: Addressing faculty critique feedback, finalizing client sign-offs, updating the detailed design repository, and archiving the preliminary design package. <i>Reading: Review PDR feedback</i>	<i>Wed Dec 9: Last day of classes. Thu Dec 10: Reading Day.</i>
Finals	Dec 16	Preliminary Design Package & Comprehensive Technical Report due by the end of the scheduled final exam period, Wednesday, December 16, 2026, 1:30–3:30 p.m.	No final examination.

Course Policies

Attendance Policy

Attendance at all senior design seminar sessions, team coordination meetings, and sponsor briefings is mandatory. Engineering design is inherently collaborative; unexcused absences directly impede team progress and reflect unprofessional conduct. If an absence is unavoidable due to illness or approved job interview travel, notify Dr. Romero and your team members in advance. Students who miss the first two class meetings without notifying the instructor may be dropped. Students may miss class for religious observance without penalty if they notify the instructor in writing within the first two weeks of the semester (by Wednesday, September 9, 2026). Absences for university-sponsored activities (athletics, performances, conferences) are excused with a letter from the sponsoring office at least one week in advance.

Late Work Policy

Design milestones must be delivered on schedule to protect team momentum. Late team submissions will receive a 10% penalty per 24 hours up to 48 hours late, after which submissions are not accepted without prior approval. Preliminary Design Review presentations must occur during scheduled class slots and cannot be rescheduled.

Final Exam Policy

ME 490 has no final examination. The preliminary design package & comprehensive technical report takes its place. Nothing is due on Reading Day (Thursday, December 10, 2026).

Academic Integrity

Alkimi University is an academic community devoted to rigorous scholarship, open intellectual inquiry, and uncompromising ethical conduct. All students are subject to the regulations of the Alkimi University Academic Integrity Policy. Academic dishonesty—including plagiarism, cheating on examinations, unauthorized collaboration, fabrication of empirical data, and unauthorized submission of academic work generated by artificial intelligence—undermines the integrity of the university and carries severe disciplinary sanctions. Sanctions range from a failing grade on an assignment or exam to an administrative course failure recorded as an 'XF' on the official transcript, academic suspension, or expulsion. Suspected violations are formally investigated and resolved through the Office of Academic Integrity in accordance with Faculty Handbook §6. For detailed information, consult the Office of Academic Integrity, Lovell Hall 315, (555) 555-0163, integrity@university.alkimi.ai.

Accessibility Services

Alkimi University is committed to providing equitable educational access and reasonable accommodations for all students with documented disabilities, including physical, sensory, psychological, learning, and chronic health conditions. Students requesting academic accommodations must formally register with the Office of Accessibility Services, Harlan Hall 204, (555) 555-0155, access@university.alkimi.ai. Once approved, students will receive an official Faculty Accommodation Letter detailing approved accommodations. Students should present this letter to the instructor as early in the semester as possible, and at least one week prior to any exam or assignment requiring accommodation. Accommodations cannot be applied retroactively.

Student Wellness and Mental Health

Your physical health, psychological well-being, and mental health are essential to your academic success. If you experience heightened stress, anxiety, depressive symptoms, personal trauma, or academic burnout, free, confidential counseling and medical care are available through the Hollis Health & Counseling Center, located in the Hollis Center. Routine appointments are available Monday–Friday 8:00 a.m.–6:00 p.m. and Saturday 10:00 a.m.–2:00 p.m. during the semester by calling (555) 555-0190 or emailing health@university.alkimi.ai. Urgent, 24/7 crisis psychological counseling is accessible immediately at (555) 555-0199.

Campus Student Support Services

- **Academic Advising Center:** Lovell Hall 101 | (555) 555-0158 | advising@university.alkimi.ai
- **Writing Center:** Whitcombe Library 3rd Floor | Free consultations on papers, reports, and research projects at any stage.
- **Whitcombe Library:** Whitcombe Library, Main Floor | (555) 555-0170 | askalibrarian@university.alkimi.ai
- **Hollis Health & Counseling Center:** Hollis Center | (555) 555-0190 | 24/7 Counseling Line: (555) 555-0199 | health@university.alkimi.ai
- **Mechanical Engineering Capstone Studio:** Rowan Engineering Center 150 | Team meeting spaces, CAD workstations, and design review whiteboards available weekdays 8:00 a.m.–9:00 p.m.