ME209 and Ed290C
ENGINEERING DESIGN AND PROTOTYPING: PEDAGOGY & ASSESSMENT
W 12:30-2:00 PM; F 1-2:30 PM
220 JACOBS HALL

Instructor
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Course Description
This graduate course explores contemporary research in engineering design and prototyping, as well as related cognitive issues in engineering curricular development, pedagogy, and assessment. One recurring theme throughout the course will be the duality between learning and design: design-based research, design as a pedagogy for integrative learning and the role of cognition and the learning sciences in the practice of engineering design. It has been motivated by several reforms: (1) National efforts to better train and educate engineers for the engineering workplace in the 21st Century: to better prepare engineers to face multidisciplinary problems and product design in competitive industries and improve their skills in teamwork and communication. (2) Efforts to improve how engineers build robust problem-solving, design and prototyping skills. (3) Advances in accessible prototyping technologies such as 3D printing and laser cutters and the popularity of the Maker movement. (4) Diversity Issues of ethnicity and gender in the engineering programs and practice. This course includes both qualitative and quantitative research methods in the pedagogy and assessment of engineering design and prototyping and coverage of key research findings. The theory will be applied to the students’ graduate research or capstone projects.

Course Objectives
This course has been developed to bridge student’s previous knowledge of disciplinary research in design and prototyping with engineering education research.

- Provide learners the opportunity to question (usually tacit) assumptions about what engineering is, what the purpose and process of engineering education is, and who gets to be an engineer.
- Understand design as a pedagogy for integrative learning and the role of cognition and the learning sciences in the practice of engineering design and prototyping.
- Provide the participants with an understanding of theories and practices in content, assessment, and pedagogy for teaching engineering design and prototyping.
• Familiarize learners with quantitative and qualitative methodologies for data analysis associated with the assessment of design and prototyping interventions.
• Promote critical thinking and a social construction of knowledge by having face-to-face and online discussions of readings from a variety of sources.

Student Learning Outcomes
Students will be able to:
• Identify their own role in shaping engineering and engineering education, and explore paths of connecting their disciplinary research to educational interests in design and prototyping;
• Think critically, reflectively and holistically about engineering and education;
• Become aware of the theoretical and practical issues of learning, instruction, and assessment as these concern the design of educational environments and technologies;
• Apply design research methods to inform and validate designs involving educational issues; and
• Articulate their own view of the design of educational tools and become more confident about their ability to work as an engineer and educational designer.

Topics Covered
1. Philosophy and epistemology of education and engineering
2. Learning Process: How people learn
3. Research methods: Qualitative and quantitative
4. Creativity and project-based learning
5. Motivation and diversity in learning strategies
6. Design thinking and learning
7. Constructivism and constructionism
8. Design, making and prototyping
9. Education, engineering and technology as an agents of emancipation
10. Assessment
11. K-12 education and recruitment
12. Diversity and equity in engineering: Women and underrepresented minorities

Credit
Units: 3.0 units
Credit: Letter Grade
Final Exam: No room required; project report in lieu of exam.

Assessment of Student Progress Toward Course Objectives
• 30% on assignments
• 40% on attendance and participation in class
• 30% on application to graduate research or capstone project
**Class Participation**

Students are considered co-producers of each class. They are encouraged to engage in deep, critical and respectful discussion to promote the social construction of knowledge. Learners are expected to actively participate in the discussions and share their ideas, as well as lead the discussions. At the beginning of the semester, each student is assigned to lead 1-2 topics with one other student partner, throughout the semester. Students are encouraged to discuss their assigned work with the instructor one week prior to their presentation to go over the reading material and approach to the discussion. Additionally, each week learners will post their reactions to at least one of the readings based on their own experiences.

**Individual Assignments**

Individual assignments will allow the students to reflect about some of the concepts being taught in the class. These are due at the start of each class, unless otherwise noted. Late assignments are discouraged but accepted. The penalization is 20% of the total score (20 points out of 100) for each day of delay. All individual assignments are to be submitted via the bcourse “assignments” tab under the appropriate heading prior to the start of class on the day they are due.

**bCOURSES Website**

We will make extensive use of the course website to both communicate information to you and to converse with you about your readings, homework and your projects.

**Schedule & Readings**

(All required readings will be available online)

**WEEK 1 (8-24/8-26): Philosophy and epistemology of education and engineering**


  **Optional:**


### WEEK 2 (8-31/9-2): Learning Process: How People Learn
- **Optional:**

### WEEK 3 (9-7/9-9): Research methods
- **Designing for Humans: an Ethnography Primer,” IDSA, 2010.**
- **Optional:**

### WEEK 4 (9-14/9-16): Creativity and project based learning
of the ACM SIGCHI conference on Creativity & Cognition, Washington, DC.


Optional:

**WEEK 5 (9-21/9-23):** Motivation and diversity in learning strategies

- Reis, Rick. Student Motivation: Problem Solved?
- Joi Ito’s blog posts: Formal vs Informal Education.

Optional:

**WEEK 6 (9-28/9-30):** Design thinking and learning


Optional:

**Week 7 (10-5/10-7): Constructivism and constructionism**

Optional:

**Week 8 (10/12/10/14): Design, making and prototyping**
- “Prototyping Is The Shorthand Of Design”, IDEO.
- **Sandhu, Jaspat S.** (Jan. 2013) “Measure early, measure often: rapid, real-time feedback in design for social innovation”.
- Scan: Build Methods on the Design Exchange

**Week 9 (10-19/10-21): Education, engineering and technology**
- **Kulkarni, C., M. S. Bernstein, and S.R. Klemmer** (2014). How do we harness the scale and diversity of an online class? In Learning with MOOCs, a Practitioner’s Workshop.

Optional:

**WEEK 10 (10-26/10-28): Assessment**
- (Video) Assessment: The Silent Killer of Learning / Eric Mazur (start at minute 8:30)
- ABET Accreditation Assessment Planning.

Optional:

**WEEK 11 (11-2/11-4): K-12 education and recruitment**

Optional:
- Next generation science standards: Science and Engineering Practices
- Next generation science standards: Three dimensional learning
**WEEK 12 (11-9/11-11):** Diversity and equity in engineering: Women and underrepresented minorities

  
  
- (Video) Thinking About Making - An examination of what we mean by making (MAKEing) these days. What gets made? Who makes? Why does making matter? - Leah Buechley


Optional:

- (Video) Young, Valierie, “Overcoming the Imposter Syndrome”

- Weinbaum, Sheldon, “Fulfilling the Dream: The Importance of Doing What You Believe and Being Taken Seriously”


**WEEK 13 & 14 (11-16/ 11-18 & 11/30-12-2):** Project presentations

Final presentations in class will be reviewed by peers and instructors.

**WEEK 15:** Reading, Review and Recitation

Students will also be invited to receive feedback through Jacobs’ Design Showcase.