

# HUMAN CENTERED ENGINEERING DESIGN

Human Centered Engineering Design (HCED) is concerned with the interactive, iterative, and creative problem solving and/or product and system development by building empathy with the customer to better understand their needs. The human centered design approach is widely being adopted by different industries, including automotive, aerospace, healthcare, information technology, software, consumer electronics, e-commerce, and digital marketing. These industries are actively looking for design professionals with the technical background who can research, identify, translate and document user needs; generate creative product/process design ideas that address user requirements; and implement and evaluate the usability of products or services in a scientific way. Human Centered Engineering Design is an interdisciplinary and inclusive field of study that bridges engineering design, art design, social sciences and business principles.

## Undergraduate Degree Program

The Bachelor of Science Engineering in Human Centered Engineering Design requires a total of 128 credit hours and provides first, a strong basis in the foundations of engineering: natural and physical sciences, mathematics, the behavioral sciences and the basic engineering sciences which begin the emphasis on creative problem solving. Then, the program develops strong foundation on which human centered design engineering work is founded. This includes studies in design process and creative problem solving, design communication, art design, qualitative and quantitative research methods in need finding, usability engineering, human factors engineering, and prototyping. Innovative problem solving, product/process design and prototyping skills are progressively developed and applied through a 4-year (freshman, sophomore, junior and senior year) individual and team based immersive design project experiences. The program creates an environment that inspires brainstorming for innovative and aesthetic solutions while emphasizing the theoretical, technological and design knowledge.

## Educational Objectives of the BSE (Human Centered Engineering Design) Program

Consistent with providing a strong academic foundation in the field of Human Centered Engineering Design, the program educational objectives for our graduates are:

- To remain gainfully employed in Human Centered Engineering Design related fields,
- To continue to develop professionally, and
- To serve in leadership roles.

## Student Outcomes

To achieve the educational objectives, the graduates of the program will have:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

## Major Requirements

Code	Title	Credit Hours
<b>Basic Preparation Requirements</b>		
COMP 105	Writing & Rhetoric I	3
COMP 106	Writing & Rhetoric II	3
	or COMP 270 Tech Writing for Engineers	
ANTH 101	Introduction to Anthropology	3
MATH 115	Calculus I	4
MATH 116	Calculus II	4
MATH 228	Diff Eqns with Linear Algebra	4
IMSE 317	Eng Probability and Statistics	3
CHEM 134	General Chemistry IA	4
BIOL 103	Anatomy and Physiology I	4
PHYS 150	General Physics I	4
PHYS 151	General Physics II	4
ENGR 100	Introduction to Engineering and Engineering Design	3
ECE 210	Circuits	4
ENGR 250	Principles of Eng Materials	3
ME 260	Design Stress Analyses	4
	or ME 265 Applied Mechanics	
<b>Engineering Design Core</b>		
HCED 220	Engineering Design Communication	2
ENGR 360	Design Thinking : Process, Method & Practice	4
HCED 370	Needfinding and Research Methods in Design	3
HCED 380	Product Prototyping: Tools and Methods	4
IMSE 382	Manufacturing Processes	4
IMSE 421	Eng Economy and Dec Anlys	3
IMSE 4425	Human Factors and Ergonomics	4
HCED 450	Product Realization: Design and Making	4
HCED 4951	Capstone Project in HCED: Needfinding and Conceptualization	2
HCED 4952	Capstone Project in HCED: Design and Implementation	2
ART 210	Beginning Digital Design	3
ART 410	Advanced Digital Design	3
Select 1 course from the following:		
ARTH 101	Understand Art-Ancient to 1400	3

ARTH 102	Understanding Art 1400 to Now	3
ARTH 103	Arts of Asia	3
ARTH 106	Architecture & Society in Western Civilization	3
ARTH 221	Ancient Monuments then and Now	3
ARTH 241	Encountering the Renaissance	3
ARTH 261	Art and Film	3
ARTH 305	The Arts & Culture of Detroit	4
ARTH 312	Art of Japan	4
ARTH 313	Chinese Painting	4
ARTH 315	Early Chinese Art and Culture	4
ARTH 327	Gods, Myth and Worship	4
ARTH 333	Late Medieval Art and Architecture	4
ARTH 335	Women in Medieval Art	4
ARTH 343	Renaissance & Reformation Art	4
ARTH 352	Baroque Art and Architecture	4
ARTH 362	Impressionism and Post-Impressionism	4
ARTH 363	Arts of the Twentieth Century	4
ARTH 367	Contemporary Art	4
ARTH 368	Global History of Photography	4
Select 2 courses from the following:		
MKT 352	Mktg Principles and Policies	3
MKT 382	Understanding Customers	3
OB 354	Behavior in Organizations	3
ENT 400	Entrepreneurial Thinking&Behav	3
BA 320	Project Management and Leadership Skills	3

**HCED students must choose a concentration in Mechanical Engineering Design, Electrical Engineering Design, Software Engineering and HCI Design, Systems Engineering Design or Individualized Design. Concentration requirements are listed below.**

### Mechanical Engineering Design Concentration - 21 credits

Code	Title	Credit Hours
Required		
ENGR 216	Computer Meth for Engineers	2
Select 4 courses from the following		
ENGR 350	Nanoscience and Nanotechnology	4
ME 345	Engineering Dynamics	4
ME 3601	Design and Analysis of Machine Elements	4
ME 4191	Structural Mech & Design	4
ME 460	Design for Manufacturing	3
ME 4981	Automotive Engineering	4
General Electives: 3-4 credits		

Code	Title	Credit Hours
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Recommended elective list: COMM 300 Communication Research Methods, COMM 340 Professional Communication, ESCI 275 Introduction to Environmental Sustainability, ENST 340 Remote Sensing, ESCI 490B Sustainable Cities, ANTH 460 Economic Anthropology, ENGR 399 Experiential Honors Prof. Prac, ENGR 492 Exper Honors Directed Research, ENGR 493 Exper Hnrs Dir Dsgn.

### Electrical Engineering Design Concentration - 21 credits

Code	Title	Credit Hours
Required		
ECE 270	Computer Methods in ECE I	4
Select 4 courses from the following		
ECE 273	Digital Systems	4
ECE 311	Electronic Circuits I	4
ECE 3171	Analog & Discrete Sig & Sys	4
ECE 329	Intro to Computer Music	4
ECE 3731	Microproc and Embedded Sys	4
ECE 413	Intro to VLSI Design	3
ECE 414	Electronic Systems Design	4
ECE 450	Analog and Digital Comm Sys	4
ECE 460	Automatic Control Systems	4
ECE 471	Comp Networks/Data Comm	4
ECE 473	Embedded System Design	4
ECE 4951	Sys Desgn and Microcontrollers	3
General Electives: 1-3 credits		

Code	Title	Credit Hours
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Recommended elective list: COMM 300 Communication Research Methods, COMM 340 Professional Communication, ESCI 275 Introduction to Environmental Sustainability, ENST 340 Remote Sensing, ESCI 490B Sustainable Cities, ANTH 460 Economic Anthropology, ENGR 399 Experiential Honors Prof. Prac, ENGR 492 Exper Honors Directed Research, ENGR 493 Exper Hnrs Dir Dsgn.

### Software Engineering and HCI Design Concentration - 21 credits

Code	Title	Credit Hours
Required		
CIS 150	Computer Science I	4
or CIS 1501	CS I for Data Scientists	
or ECE 270	Computer Methods in ECE I	
CIS 200	Computer Science II	4
or CIS 2001	CS II for Data Scientists	
CIS 350	Data Struc and Algorithm Anlys	4
or CIS 3501	Data Struc & Alg Anlys for SE	
Select once class from the following		
CIS 375	Software Engineering I	4
CIS 285	Software Engineering Tools	3
CIS 411	Introduction to Natural Language Processing	3
CIS 435	Web Technology	3
CIS 436	Mobile App Des & Impl	3
CIS 479	Intro to Artificial Intel	3
General Electives: 5-6 credits		

Code	Title	Credit Hours
Recommended elective list: COMM 300 Communication Research Methods, COMM 340 Professional Communication, ESCI 275 Introduction to Environmental Sustainability, ENST 340 Remote Sensing, ESCI 490B Sustainable Cities, ANTH 460 Economic Anthropology, ENGR 399 Experiential Honors Prof. Prac, ENGR 492 Exper Honors Directed Research, ENGR 493 Exper Hnrs Dir Dsgn.		

### Systems Engineering Design Concentration - 21 credits

Code	Title	Credit Hours
Select one course from the Following		
IMSE 255	Computer Programming for Eng	3
CIS 150	Computer Science I	4
CIS 1501	CS I for Data Scientists	4
ECE 270	Computer Methods in ECE I	4
Select 4 courses from the following:		
IMSE 3005	Intro to Operations Research	4
IMSE 440	Applied stat models in engin	3
IMSE 4585	Simulation in Systems Design	4
IMSE 477	Human Computer Interaction for UI & UX Design	3
IMSE 4795	Prod, Inven Control & Lean Mfg	4
IMSE 4835	Comp.-Aided Prcs Design & Mfg	4
BA 320	Project Management and Leadership Skills	3
General Electives: 1-5 Credit hours		

Code	Title	Credit Hours
Recommended elective list: COMM 300 Communication Research Methods, COMM 340 Professional Communication, ESCI 275 Introduction to Environmental Sustainability, ENST 340 Remote Sensing, ESCI 490B Sustainable Cities, ANTH 460 Economic Anthropology, ENGR 399 Experiential Honors Prof. Prac, ENGR 492 Exper Honors Directed Research, ENGR 493 Exper Hnrs Dir Dsgn		

### Individualized Concentration - 21 credits

Code	Title	Credit Hours
Choose one of the following:		
CIS 150	Computer Science I	4
ECE 270	Computer Methods in ECE I	4
ENGR 216	Computer Meth for Engineers	2
IMSE 255	Computer Programming for Eng	3
Choose 3 courses in CIS,ECE, IMSE, or ME from the other concentrations (9-12 credits):		
Recommended/General Electives: 5-10 credits		

Code	Title	Credit Hours
Recommended elective list: COMM 300, COMM 340, ESCI 275, ENST 340, ESCI 490B, ANTH 460, ENGR 399, ENGR 492, ENGR 493		

## Learning Goals

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

#### HCED 220 Engineering Design Communication 2 Credit Hours

This course examines the fundamentals of researching, writing, and presenting technical information for diverse audiences and purposes. Students learn to plan, analyze and prepare for different types of communications; differentiate between audience types and their needs for information; conduct research, understand authority of sources, and provide citations; develop effective listening techniques in business and technical situations. Techniques for writing communication documents, developing and delivering effective presentations and design portfolio, along with the media and technologies commonly used for design communication is also covered in this class. (F).

**Prerequisite(s):** COMP 105

#### HCED 370 Needfinding and Research Methods in Design 3 Credit Hours

This course surveys qualitative and quantitative need finding and research methods in human-centered engineering design including usability engineering. Different data collection and measurement techniques are covered for different types of data, including subjective, behavioral, and physiological data. Human subject involved experiment design is also covered in this course. Students learn to formulate research questions and hypotheses, design and conduct a design related research study, and present research results through various case studies. (W).

**Prerequisite(s):** ENGR 360

#### HCED 380 Product Prototyping: Tools and Methods 4 Credit Hours

This course introduces the techniques and toolset necessary for developing low and medium fidelity prototypes to support the human-centered engineering design process. This includes CAD modeling, rapid prototyping, 3D printing, inventive problem solving techniques, sketching, storyboards, role-playing, visualization, virtual reality, and interaction prototyping techniques. Prototype testing techniques and tools are also covered in this course. Students work on individual and semester-long team based design projects in the Design Studio Lab by developing various product prototypes that fulfill customer needs using knowledge, methodology and skills obtained in the class. (W).

**Prerequisite(s):** ENGR 360 and (IMSE 255 or CIS 150 or CIS 1501 or ECE 270 or ENGR 216) and HCED 370\*

**HCED 450 Product Realization: Design and Making 4 Credit Hours**

Students will build on the foundation created in HCED 380 and will work on a single semester long project that executes the entire design process from conceptualization through presentation of a customer ready prototype, and creation of a project based portfolio. Different high fidelity engineering design and prototyping tools and techniques will also be covered in this class, including CAD/CAE, microcontrollers, process simulation, software platforms, risk analysis methods, virtual reality, data visualization, and 3D printing. (W).

**Prerequisite(s):** IMSE 4425 and HCED 380 and ENGR 250 and (ME 260 or ME 265) and ECE 210 and (CIS 150 or CIS 1501 or ECE 270 or IMSE 255 or ENGR 216)

**HCED 4951 Capstone Project in HCED: Needfinding and Conceptualization 2 Credit Hours**

Summary project using knowledge, methodology, and skills obtained in Human Centered Engineering Design major. Students implement an original design concept and present it to a professional jury. (F, W).

**Prerequisite(s):** HCED 450

**HCED 4952 Capstone Project in HCED: Design and Implementation 2 Credit Hours**

This course is a continuation of HCED 4951. Students will complete the development process to conceive a functional product. Students present their final design to a professional jury. (F, W).

**Prerequisite(s):** HCED 4951

\*An asterisk denotes that a course may be taken concurrently.

Frequency of Offering

The following abbreviations are used to denote the frequency of offering: (F) fall term; (W) winter term; (S) summer term; (F, W) fall and winter terms; (YR) once a year; (AY) alternating years; (OC) offered occasionally