ENGINEERING FOR US ALL (e4usa)

Curriculum Summary

The Engineering for US All (e4usa) curriculum empowers, engages, and excites students to use what they know and find what they are passionate about to take control and boldly influence the world. Empowerment is built through an **awareness** of engineering in everyday life, the **variety** of engineers, and by **interrogating** and **emphasizing** how engineering is embedded in **society**. Engagement occurs as students practice engineering design at multiple scales, considering local and global engineering design challenges. *e4usa* generates excitement as students are provided opportunities to design and create solutions in authentic, student-centered product development challenges. *e4usa* invites all schools, teachers, and students to participate fully regardless of their technical background or preparation.

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e4usa+ Programming Course Description:

Empowerment

e4usa is an onramp for students to learn about engineering as a profession and a personal practice and increases student confidence to use engineering tools and thinking. Students will practice three systematic continuous improvement practices: consistent critical self-reflection, ethical action, and seeking feedback (e.g. performance data, mentoring, etc.). In the e4usa+Programming course, students will examine how programming plays a crucial role in developing solutions to problems which require engineering.

Engagement

Students will develop skills in using programming and algorithmic thinking in the engineering design of solutions to problems of importance to their community and society. Students will be equipped with valuable 21st century relevant programming knowledge and skills. Utilizing MATLAB, a programming and computing platform that is used by millions of engineers and many academic institutions, this course will reinforce the engineering design process and integrate computational thinking activities that align with Computer Science learning standards developed by the Computer Science Teacher Association. These standards are widely adopted in career and technical education programs across the country.

AP Computer Science “Big Ideas”

This course will cover content applicable to the Advanced Placement (AP) Computer Science “Big Ideas” including Creative Development, Data, Algorithms and Programming, Computer Systems and Networks, and the Impact of Computing. Students will practice both Computational Thinking and Engineering Design.

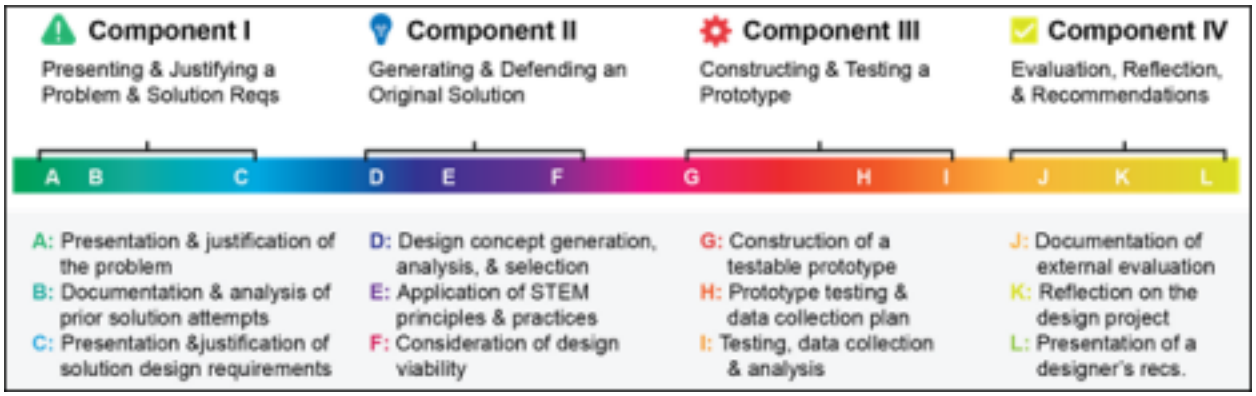
Design Portfolio

Engineering design as a process, or design within constraint, is scaffolded in terms of a learning progression that can be practiced in *any* discipline. *e4usa* students will create basic engineering design process portfolios that document their work.

MyDesign® and the MyDesign rubric

Engineering design process portfolios are assessed formatively and summatively using the MyDesign Rubric. The rubric is comprised of four main components, each in turn comprised of three elements, as detailed in the figure below. Each element is

broken down into a series of sub-elements that are scored on a scale of 0 (no evidence), 1 (novice), 2 (developing), 3 (proficient), 4 (advanced), and 5 (exemplary). With such a thorough focus on the details of the engineering design process, this rubric is useful in assessing student learning over the course of extended, complex projects. *e4usa* has moved MyDesign® into a classroom-ready tool. MyDesign® is an electronic engineering design process portfolio program, into which the MyDesign rubric described below is embedded, that integrates into local learning management systems and also functions as a stand-alone website.



Engineering Design Practices

The purpose of e4usa+Programming is not only to provide high school students and teachers additional resources to further their understanding of engineering and what it means to be an engineer, but additionally, how programming supports engineers and engineering solutions. This course will explore the use of programming as a problem-solving tool in engineering, especially problems whose solutions will affect and improve society, and the positive and negative impacts of engineering. In multidisciplinary teams and individually, students will explore various expert roles including both humanities and STEM-field experts as they grapple with humanity's grand challenges. Students will develop an appreciation for programming and algorithmic thinking within engineering solutions.

Benefits and Requirements for Teachers

Curriculum and Support

The *e4usa* curriculum is holistic. The curriculum is a scaffold to teach engineering awareness, engineering in society, and engineering design practices through iterative design challenges, yet it invites teachers to incorporate their students' interests, local needs, community partners, and personal expectations. The

e4usa+Programming curriculum scaffolds and builds upon the e4usa framework, tools, knowledge, and skill. It is, at its core, a set of rubrics and activities designed to promote engineering learning progressions.

Teacher Professional Development and Community of Practice

Professional Learning (PL) is a critical piece of *e4usa*. Over the summer, teachers participate in either a synchronous virtual workshop or an in-person workshop with asynchronous assignments that provide teachers with meaningful opportunities to experience the course and also enhance both pedagogical and assessment skills. To ensure continued support, teachers will also receive a series of timely and responsive PLs throughout the academic year to further help with the implementation of the *e4usa* curriculum.

e4usa has established Communities of Practice, actively managed networks for teachers. These include local faculty members and students from institutions of higher education, leaders in corporations and professional organizations, and *e4usa* team members. These Communities of Practice allow teachers to ask questions of other engineers, collaboratively plan classroom activities, and provide high school students with mentorship and support.

Course Learning Outcomes

Connect With Engineering

CE.A	Iterate and evolve the definition of what it means to engineer and be an engineer.	
CE.C	Explain and apply ethical & societal considerations when exploring an engineering problem.	

Engineering in Society

ES.A	Explore the impacts of past engineering successes and failures on society as a whole.	
ES.B	Recognize the world's greatest challenges and the role that engineering plays in solving these challenges (e.g., Engineering Grand Challenges, UN sustainability goals, etc.).	

Engineering Professional Skills

PS.A	Use various engineering communication methods.	

Engineering Design

ED.A	Identify and describe a local problem that can be solved with a potentially new product or process.	
ED.C	Plan and conduct research by gathering relevant and credible data, facts, and information.	
ED.D	Explore appropriate STEM practices and principles in the design.	
ED.G	Create a testing plan to evaluate the performance of design solutions.	

ED.I	Reflect on how an engineering design process could be applied to solving a problem.	
ED.J	Use appropriate engineering tools.	

Technical Content

TC.A	Design and develop computational solutions to engineering problems using an iterative process.	
TC.B	Demonstrate knowledge of and skills related to data in engineering contexts.	
TC.C	Write MATLAB programs using knowledge of and skills related to algorithms and programming.	
TC.D	Demonstrate an understanding of computer systems and networks in engineering applications.	
TC.E	Evaluate the impacts of computing in engineering and society.	
TC.F	Collaborate effectively on computational engineering projects.	

e4usa + Programming Curriculum Overview

The e4usa + Programming curriculum is designed as a full-year course as detailed below. The expectation is for students to have approximately 200 minutes per week of instructional contact time. Schools working on block schedules should adjust the per week expectations accordingly.

Schools may require that their e4usa+Programming students take an Industry Recognized Credential exam in MATLAB through this course. Students may also take the assessments associated with the AP Computer Science Principles (AP CSP) following this course.

Introduction to Computer Science and MATLAB

Students will explore computing using MATLAB, and its use in manipulating and exploring data. Basic and advanced MATLAB will be explored.

Data

Students will explore the structure and nature of data, including number systems, how data is stored and used, and the use of MATLAB for data analysis.

Algorithm and Programming

Students will develop and implement algorithms with MATLAB. Students will use MATLAB in problem solving for problems requiring an engineering solution.

Computer Systems and Networks

Students will explore networking basics, the Internet, fault tolerance, and parallel and distributed computing.

Impacts of Computing

Computational thinking and problem-solving using computing are featured. Students will also explore the societal and ethical considerations of the use of computers and computing more deeply. Collaborative computing, privacy and security, and historical examples will be featured.

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