PLTW Principles of Engineering
Course Framework

PLTW Framework - Overview

PLTW Frameworks are representations of the knowledge, skills, and understandings that empower students to thrive in an evolving world. The PLTW Frameworks define the scope of learning and instruction within the PLTW curricula. The framework structure is organized by four levels of understanding that build upon each other: Knowledge and Skills, Objectives, Domains, and Competencies.

The most fundamental level of learning is defined by course Knowledge and Skills statements. Each Knowledge and Skills statement reflects specifically what students will know and be able to do after they've had the opportunity to learn the course content. Students apply Knowledge and Skills to achieve learning Objectives, which are skills that directly relate to the workplace or applied academic settings. Objectives are organized by higher-level Domains.

Domains are areas of in-demand expertise that an employer in a specific field may seek; they are key understandings and long-term takeaways that go beyond factual knowledge into broader, conceptual comprehension.

At the highest level, Competencies are general characterizations of the transportable skills that benefit students in various professional and academic pursuits. As a whole, the PLTW Frameworks illustrate the deep and relevant learning opportunities students experience from PLTW courses and demonstrate how the courses prepare students for life, not just the next grade level.

To thrive in an evolving world, students need skills that will benefit them regardless of the career path they choose. PLTW Frameworks are organized to showcase alignment to in-demand, transportable skills. This alignment ensures that students learn skills that are increasingly important in the rapidly advancing, innovative workplace.

Essential Questions

0.1 - 1	How does a design team know what problem to solve?
0.1 - 2	Why is empathy an important skill in engineering design?
0.1 - 3	How do engineers communicate designs and solutions?
0.1 - 4	What is a decision matrix and why is it used?
0.2 - 1	What techniques do engineers use to visually present design ideas?
0.2 - 2	What advantages does Computer-Aided Design (CAD) provide over traditional paper and pencil design?
0.2 - 3	What advantages does paper and pencil design provide over CAD?
0.2 - 4	What would happen if engineers did not follow accepted dimensioning standards and guidelines, but instead, used their own individual dimensioning methods?
0.2 - 5	What are the differences between manufacturing processes?
0.3 - 1	What properties should be considered when evaluating material choice for a product?
0.3 - 2	What data should be collected in a testing process?
0.3 - 3	How is material testing data useful?
0.3 - 4	How does an engineer predict the performance and safety of a selected material?

0.3 - 5 What is the difference between the independent variable and the dependent variable in experimental design?

0.4 - 1 What are two possible ways that a team could come to a consensus in a disagreement over a solution to a problem?

0.4 - 2 Why is it important for the team to come to a consensus on the issues that arise? What are some reasons that the team leader should not dictate the direction of the group?

0.4 - 3 How can you design a product that meets the needs of a user?

1.1 - 1 How do engineers quantify the mechanical advantage of a system?

1.1 - 2 How do engineers apply their knowledge of simple machines to solve problems?

1.1 - 3 How do engineers quantify energy, work, and power?

1.1 - 4 How do engineers apply their knowledge of energy, work, and power to solve problems?

1.2 - 1 How are mechanisms used to convert one type of motion to another?

1.2 - 2 How do engineers manipulate motion to solve design problems?

1.3 - 1 How can you apply your understanding of machines and mechanisms to solve an authentic problem?

2.1 - 1 What characteristics define a robot?

2.2 - 1 What practices do programmers use to write effective code?

2.2 - 2 How do engineers use sensors to solve design problems?

2.3 - 1 What is artificial intelligence, and how do engineers use it to solve problems?

2.3 - 2 What are some of the ethical implications of artificial intelligence?

2.4 - 1 How can you apply your understanding of mechanics and programming to solve a design problem?

3.1 - 1 How do you differentiate between circuit types?

3.1 - 2 How do you model electrical circuits?

3.1 - 3 How do you test circuit parameters?

3.1 - 4 What are the mathematical relationships between circuit parameters?

3.1 - 5 Why are Kirchhoff's Laws important to engineers and designers of electrical circuits?

3.2 - 1 What impact does fluid power have on our everyday lives?

3.2 - 2 What devices or systems might be improved with the use of fluid power?

3.2 - 3 What are the similarities and differences of mechanical advantage in simple machines?

3.2 - 4 Why are Pascal's Law, the perfect gas laws, Bernoulli's Principle, and other similar rules important to engineers and designers of fluid power systems?

3.3 - 1 How do we graph and analyze motion?

3.3 - 2 What equations govern how objects move?

3.3 - 3 How do we predict where projectiles will land?

4.1 - 1 What factors impact beam deflection?

4.1 - 2 Why is the value of beam deflection useful?

4.1 - 3 What are the properties of structural members and why are they useful?

4.1 - 4 What is a centroid and how is it applied in structural members?

4.1 - 5 Why is it crucial for designers and engineers to construct accurate free body diagrams of the parts and structures that they design?

4.1 - 6 Why must designers and engineers calculate forces acting on bodies and structures?

4.1 - 7 What are the differences between stress and strain?

4.1 - 8 Why are stress and strain important factors to consider when designing?

4.1 - 9 How does the stress-strain curve help engineers during tensile testing?

4.1 - 7 What is a moment and how does it help solve problems in static structures?

4.1 - 8 When solving truss forces, why is it important to know that the structure is statically determinate?

4.1 - 9 How is the method of joints used to determine internal forces in trusses?

4.1 - 10 How do material properties affect structural stability, internal forces, and cost?

4.2 - 1 What are renewable and nonrenewable resources and how do humans use them?

4.2 - 2 In what innovative ways could the efficiency of electricity production using solar cells be maximized throughout the day?

4.3 - 1 What factors affect the rate of flow on a roadway?

4.3 - 2 How is the optimum speed limit determined for a roadway?

4.3 - 3 In your opinion, what type of intersection is prone to the most accidents? What can be done to maximize safety at this type of intersection?

4.4 - 1 What role does creativity have in the engineering design process?

4.4 - 2 What do engineers do to clearly document and communicate their work? Why is this important?

4.4 - 3 How are different elements of infrastructure related?

4.4 - 4 How do mass, friction, and gears

Competencies, Domains, Objectives, Knowledge and Skills

Transportable Knowledge and Skills

Core workplace skills that students and workers need to acquire, that can be used across all stages of a career, and that, because of their universal utility, are transportable from job to job, from employer to employer, across the economy.

Career Readiness (CAR):

Engineers use professional skills and knowledge to pursue opportunities and create sustainable solutions to improve and enhance the quality of life of individuals and society.

CAR-A. Identify engineering disciplines and engineering expertise that are critical to the solution of a specific problem.

CAR-A.1 Describe the historically traditional disciplines of engineering, including civil, electrical, mechanical, and chemical.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
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CAR-A.2 Explain that engineering disciplines continue to evolve and emerge as new interdisciplinary fields or sub-disciplines to better meet the needs of society. Examples include: Aerospace Engineering, Biomedical Engineering, Environmental Engineering, Computer Engineering, Structural Engineering, and Water Resource Engineering.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
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CAR-A.3 Describe a wide variety of career options and show each career option relates to Science, Technology, Engineering, and Mathematics.

Lesson:

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CAR-A.4 Match interests, aptitudes, and aspirations to career choices.

Lesson:

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CAR-A.5 Compare and contrast how education and training decisions may affect career choices.

Lesson:

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CAR-A.6 Identify necessary actions that bridge the gap between high school and postsecondary education.

Lesson:

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CAR-A.7 Reflect upon knowledge gained to monitor professional progress and individual growth.

Lesson:

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CAR-A.8 List financial considerations of postsecondary education pathways.

Lesson:

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Communication (COM):

Engineering practice requires effective communication with a variety of audiences using multiple modalities.

COM-A. Communicate effectively with an audience based on audience characteristics.

COM-A.1 Adhere to established conventions of written, oral, and electronic communications (grammar, spelling, usage, and mechanics).

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COM-A.2 Follow acceptable formats for technical writing and professional presentations.

Lesson:	0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
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COM-A.3 Properly cite references for all communication in an accepted format.

Lesson:	0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
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COM-A.4 Clearly label tables and figures with units and explain the information presented in context.

Lesson:	0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
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COM-A.5 Use characteristics important to oral delivery of information (volume, tempo, eye contact, articulation, and energy). Vary these elements of delivery to convey and emphasize information and engage the audience.

Lesson:	0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
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Collaboration (COL):

Demonstrate an ability to function on multidisciplinary teams.

COL-A. Facilitate an effective team environment to promote successful goal attainment.

COL-A.1 Describe the various individual roles and interdependencies of a collaborative team.

Lesson:

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COL-A.2 Describe the importance of team norms and how to develop those norms for a team.

Lesson:

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COL-A.3 Solicit, negotiate, and balance diverse views and beliefs to reach workable solutions.

Lesson:

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COL-A.4 Identify basic conflict resolution strategies and employ those strategies as necessary and appropriate.

Lesson:

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COL-B. Contribute individually to overall collaborative efforts.

COL-B.1 Describe one’s individual role and expectations of performance within the team.

Lesson:

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Competencies, Domains, Objectives, Knowledge and Skills

Ethical Reasoning and Mindset (ERM):

Successful engineering professionals exhibit personal and professional characteristics and behaviors that involve considerations of the impact of their work on individuals, society, and the natural world.

ERM-A. Assess an engineering ethical dilemma.

ERM-A.1 Explain that engineering solutions can have significantly different impacts on an individual, society, and the natural world.

Lesson:

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Critical and Creative Problem-Solving (CCP):

The skills necessary for students to generate ideas and solutions to problems.

CCP-A. Explain and justify an engineering design process.

CCP-A.1 Identify the step in which an engineering task would fit in a design process.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
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CCP-A.2 Document a design process in an engineering notebook according to best practices.

Lesson:

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CCP-B. Collect, analyze, and interpret information relevant to the problem or opportunity at hand to support engineering decisions.

CCP-B.1 Explain the role of research in the process of design.

Lesson:

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CCP-C. Synthesize an ill-formed problem into a meaningful, well-defined problem.

CCP-C.1 Explain the importance of carefully and specifically defining a problem or opportunity, design criteria, and constraints, to develop successful design solutions.

Lesson:

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CCP-C.2 List potential constraints that may impact the success of a design solution. Examples include economic (cost), environmental, social, political, ethical, health and safety, manufacturability, technical feasibility, and sustainability.

Lesson:

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CCP-D. Generate multiple potential solution concepts.

CCP-D.1 Represent concepts using a variety of visual tools, such as sketches, graphs, and charts, to communicate details of an idea.

Lesson:

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CCP-E. Develop models to represent design alternatives and generate data to inform decision making, test alternatives, and demonstrate solutions.

CCP-E.1 Define various types of models that can be used to represent products, processes, or designs, such as physical prototypes, mathematical models, and virtual representations. Explain the purpose and appropriate use of each.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
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CCP-F. Select a solution path from many options to successfully address a problem or opportunity.

CCP-F.1 Explain that there are often multiple viable solutions and no obvious best solution. Trade-offs must be considered and evaluated consistently throughout an engineering design process.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
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CCP-F.2 Demonstrate understanding of how to use a decision matrix to select a solution.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
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CCP-G. Plan and execute an investigation to collect valid quantitative data to serve as a basis for evidence and to inform decisions.

CCP-G.1 Identify the data needed to answer a research question and the appropriate tools necessary to collect, record, analyze, and evaluate the data.

Lesson:

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CCP-H. Demonstrate independent thinking and self-direction in pursuit of accomplishing a goal.

CCP-H.1 Plan and use time in pursuit of accomplishing a goal without direct oversight.

Lesson:

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CCP-I. Demonstrate flexibility and adaptability to change.

CCP-I.1 Adapt to varied roles, job responsibilities, schedules, and contexts.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
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CCP-J. Persevere to solve a problem or achieve a goal.

CCP-J.1 Describe why persistence is important when identifying a problem and/or pursuing solutions.

Lesson:

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Competencies, Domains, Objectives, Knowledge and Skills

CCP-K. Design and carry out an experiment that investigates a research question.

CCP-K.1 Develop a testable hypothesis and design an experimental protocol that evaluates its validity.

Lesson:

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CCP-K.2 Distinguish between the independent and dependent variables.

Lesson:

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CCP-K.3 Identify and explain the purpose and importance of experimental controls.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
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3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

CCP-K.4 Maintain a detailed repeatable account of the experiment in a physical or digital laboratory notebook.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☑	☐	☑	☐	☑	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

CCP-K.5 Select and use appropriate equipment to conduct experiments.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

CCP-K.6 Identify possible source of errors, then redesign and repeat the experiment when appropriate.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☑	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

CCP-K.7 Communicate the findings of the experiment in oral and written (including digital) form.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☑	☐	☑	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

CCP-K.8 Describe why experimental design is a continual process.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☑	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

CCP-L. Collect and analyze experimental data to draw conclusions.

CCP-L.1 Demonstrates an ability to accurately follow a sequential protocol.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

CCP-L.2 Draw logical conclusions from experimental data.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☑	☐	☑	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

Technical Knowledge and Skills

Every career field requires technical literacy and career-specific knowledge and skills to support professional practice.

Engineering Tools and Technology (ETT):

The practice of engineering requires the application of mathematical principles and common engineering tools, techniques, and technologies.

ETT-A. Using a variety of measuring devices, measure and report quantities accurately and to a precision appropriate for the purpose.

ETT-A.1 Explain and differentiate between the accuracy and precision of a measurement or measuring device.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

ETT-B. Use a spreadsheet application to help identify and/or solve a problem.

ETT-B.1 Use dimensional analysis and unit conversions to transform data to consistent units or to units appropriate for a particular purpose or model.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☑	☐

ETT-B.2 Populate a spreadsheet application with data and organize the data to be useful in accomplishing a specific goal.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☑	☐

ETT-B.3 Use the functions and tools within a spreadsheet application to manipulate, analyze, and present data in a useful way, including regression analyses and descriptive statistical analyses.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☑	☐

ETT-C. Interpret and analyze data for a single count or measurement variable.

ETT-C.1 Represent data for a single count or measurement with plots on the real number line, such as dot plots, histograms, and box plots.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

ETT-C.2 Use statistics appropriate to the shape of the data distribution to determine the center (median, mean) and spread (interquartile range, standard deviation) of a data set and/or compare data sets.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

ETT-D. Apply system thinking to consider how an engineering problem and its solution fit into broader systems.

ETT-D.1 List realistic considerations that constrain solutions within the broader system. Examples include economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☑	☑	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☑	☑	☐

ETT-E. Construct physical objects using hand tools and shop tools.

ETT-E.1 Identify basic hand tools and shop tools and describe their function.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☑	☑	☑	☐	☑	☑	☑

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☑	☐	☐	☐	☑	☐	☐	☐

ETT-E.2 Demonstrate use of hand tools and shop tools.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☑	☑	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☑	☐	☐	☐	☑	☐	☐	☐

ETT-F. Apply computational thinking to generalize and solve a problem using a computer.

ETT-F.1 Interact with content-specific models and simulation to support learning and research.

Lesson:	0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐

	3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
	☐	☐	☐	☐	☑	☐	☑	☐

ETT-F.2 Use modeling and simulation to represent and understand natural phenomena.

Lesson:	0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐

	3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
	☐	☐	☐	☐	☑	☐	☑	☐

ETT-F.3 Develop an algorithm (step-by-step process) for solving a problem.

Lesson:	0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

	3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
	☐	☐	☐	☐	☑	☐	☐	☐

ETT-F.4 Identify, test, and implement possible solutions to a problem using a computer.

Lesson:	0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐

	3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
	☐	☐	☐	☐	☑	☐	☐	☐

ETT-F.5 Automate a solution using algorithmic thinking.

Lesson:	0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☑

	3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
	☐	☐	☐	☐	☐	☐	☐	☐

ETT-G. Determine the traffic flow rate for roadways.

ETT-G.1 Calculate average flow rate.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☑	☑

ETT-G.2 Determine the optimal speed limit for a given roadway.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☑	☐

ETT-G.3 Calculate Critical Lane Volume (CLV) for an intersection.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☑	☐

ETT-G.4 Use data to redesign an intersection.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☑	☐

Foundations in Math and Engineering Science (FMS):

Engineering practice requires an understanding of mathematical principles and scientific phenomena to solve problems.

FMS-A. Identify appropriate applications and examples of each of the six simple machines.

FMS-A.1 Describe the attributes and components of each of the six simple machines.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☑	☐	☑	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

FMS-A.2 Distinguish between the six simple machines.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☑	☐	☑	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

FMS-A.3 Design a solution that incorporates several simple machines.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☑	☑	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

FMS-B. Measure forces and distances and calculate mechanical advantage, work, power, and efficiency in mechanical systems.

FMS-B.1 Identify the equations to solve for mechanical advantage, work, and power.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

FMS-B.2 Measure forces and distances related to mechanisms.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☑	☐	☑	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

FMS-B.3 Calculate mechanical advantage and drive ratios of mechanisms.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☑	☐	☑	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

FMS-B.4 Identify the equations for work and power.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

FMS-B.5 Calculate work and power in mechanical systems.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

FMS-B.6 Determine efficiency in a mechanical system.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

FMS-B.7 Identify the equation for calculating the efficiency of a system.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

FMS-B.8 Calculate the mechanical power developed when lifting an object.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

FMS-B.9 Design, build, and test a machine that efficiently channels mechanical energy when friction and limited input energy are significant constraints.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☑	☐	☐

FMS-B.10 Differentiate between types of motion and design systems to convert types of motion.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☑	☑	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☑	☐	☐	☐	☐	☐	☐	☐

FMS-B.11 Apply knowledge of simple machines to construct complex mechanisms and machines.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☑	☑	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☑	☐	☐	☐	☐	☐	☐	☐

FMS-C. Analyze parallel and series circuits resistance, current, and voltage using Ohm's law.

FMS-C.1 Identify the equations to calculate the resistance, current, and voltage of simple circuits.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☑	☐	☐	☐	☐	☐	☐	☐

FMS-C.2 Calculate electrical power developed in a circuit.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☑	☐	☐	☑	☐	☐	☐	☐

FMS-C.3 Calculate circuit resistance, current, and voltage using Ohm's law, including circuits with elements in series and/or parallel.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☑	☐	☐	☑	☐	☐	☐	☐

FMS-C.4 Compare and contrast the behavior of electrical circuits with parallel and series circuit designs.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☑	☐	☐	☐	☐	☐	☐	☐

FMS-D. Apply statistical analysis to determine central tendency, mean, median, and mode.

FMS-D.1 Calculate the variation in a set of data, including range, standard deviation, and variance.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

FMS-D.2 Name measures of central tendency and variation and describe their meaning.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

FMS-D.3 Calculate the central tendency of a data set, including mean, median, and mode.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

FMS-D.4 Produce a frequency distribution to describe experimental results and create a histogram to communicate these results.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

FMS-D.5 Distinguish between sample statistics and population statistics and know appropriate applications of each.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

FMS-E. Apply the tolerance analysis process to an engineering design problem.

FMS-E.1 Define a tolerance stack and tolerance loop for a given set of components.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

FMS-E.2 Determine Nominal, Worst Case, and RSS Maximum values for component specifications.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

FMS-E.3 Interpret the results of a tolerance analysis and know the appropriate use case for each type of calculated component specification.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

FMS-F. Describe free-fall motion.

FMS-F.1 Describe free-fall motion of a projectile as having constant velocity in the horizontal direction and uniformly accelerating motion in the vertical direction.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☑	☑	☐	☐	☐	☐

FMS-G. Calculate distance, displacement, speed, velocity, and acceleration from data.

FMS-G.1 Calculate acceleration due to gravity given data from a free-fall trajectory.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☑	☑	☐	☐	☐	☐

FMS-G.2 Determine the angle needed to launch a projectile a specific range given vthe projectile’s initial velocity.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☑	☑	☐	☐	☐	☐

FMS-G.3 Calculate distance, displacement, speed, velocity, and acceleration from data.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☑	☑	☐	☐	☐	☐

FMS-H. Describe the location of a projectile in motion as a function of time.

FMS-H.1 Identify formulas related to motion of a projectile.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☑	☑	☐	☐	☐	☐

FMS-H.2 Calculate the location of a projectile at a specified time.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☑	☑	☐	☐	☐	☐

Materials and Structures (MAS):

The integrity of physical systems is dependent on their material properties and structural design.

MAS-A. Draw free body diagrams of objects, identifying all forces acting on the object.

MAS-A.1 Differentiate between scalar and vector quantities.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

MAS-A.2 Identify the magnitude, direction, and sense of a vector.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

MAS-A.4 Understand how Newton’s Laws are applied to determine the forces acting on an object.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

MAS-A.5 Create free body diagrams of objects, identifying all forces acting on the object.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☑

MAS-A.6 Calculate the x and y components of a given vector.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

MAS-B. Calculate moment of inertia, beam deflection, and moments or torques.

MAS-B.1 Define a cantilver as a projecting beam fixed at only one end.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

MAS-B.2 Define moment as the tendency to cause an object to rotate.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

MAS-B.3 Calculate moment given force and distance.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

MAS-B.4 Know that beam deflection is related to cross-sectional geometry and material properties.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

MAS-B.5 Know that the moment of inertia is related to cross-sectional geometry.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

MAS-B.6 Know that the modulus of elasticity defines the stiffness of an object related to material and chemical properties.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

MAS-B.7 Mathematically locate the centroid of structural members.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

MAS-B.8 Calculate the area moment of inertia of structural members.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

MAS-B.9 Calculate the deflection of a center-loaded beam from the beam’s geometry and material properties.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

MAS-B.10 Calculate moments or torques given a force and a point of application relative to a specified axis.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

MAS-C. Analyze and solve for the external and internal forces on a truss.

MAS-C.1 Use equations of equilibrium to calculate unknown external forces on a truss.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☑

MAS-C.2 Use the method of joints to calculate tension and compression forces in the members of a statically determinate truss.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☑

MAS-C.3 Construct and destructively test a truss, and relate observations to calculated predictions.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

MAS-D. Conduct non-destructive tests for material properties.

MAS-D.1 Conduct non-destructive tests for material properties on selected common household products, including tests for thermal conductivity, elasticity, wear resistance, impact resistance, and density.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

MAS-D.2 List material properties that are important to design, including mechanical, chemical, and electrical properties.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

MAS-E. Describe how the formulas are applied to material loaded with a tensile force.

MAS-E.1 Describe how formulas for stress and strain are applied to a material loaded with a tensile force.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

MAS-E.2 Describe how elastic and plastic deformation occurs in a material loaded with a tensile force.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

MAS-E.3 Describe the modulus of elasticity.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

MAS-F. Use axial force experiments to create a stress-strain curve describing intrinsic material properties.

MAS-F.1 Measure axial force and elongation data of material samples and create stress-strain diagrams describing the intrinsic properties of the materials.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

MAS-F.2 Calculate minimum or maximum design parameters to ensure a safe or reliable product using material strength properties.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

MAS-F.3 Identify and calculate test sample material properties using a stress-strain curve.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☑	☐	☐	☐

Control Systems (CSY):

A control system is integrated into a larger system as a means to coordinate input and output devices.

CSY-A. Distinguish between digital and analog data, and the inputs and outputs of a computational system.

CSY-A.1 Distinguish between digital and analog data, and between the inputs and outputs of a computational system.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

CSY-B. Describe differences and advantages of open- and closed-loop systems.

CSY-B.1 Distinguish between open- and closed-loop systems based on whether decisions are made using time delays or sensor feedback.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

CSY-B.2 Identify the relative advantage of an open-loop or closed-loop control system for a given technological problem.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

CSY-C. Create a flowchart, pseudocode, and computer program to implement an algorithm.

CSY-C.4 Create a computer program to implement an algorithm, including conditional statements and iterations.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☑	☑	☑

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

CSY-D. Predict the behavior of a control system and use a variety of methods for finding, identifying, and correcting bugs in a program.

CSY-D.1 Based on given needs and constraints, design and create a control system, including the inputs, computer program, and outputs.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☑	☑	☑

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

CSY-D.2 Predict the behavior of a control system by examining the program it is going to execute.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

CSY-D.3 Evaluate algebraic and logical expressions involving programming variables.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

CSY-E. Describe the advantages of hydraulic and pneumatic systems relative to each other.

CSY-E.1 Identify devices that use hydraulic and pneumatic power.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☑	☐	☐	☐	☐	☐	☐

CSY-E.2 Distinguish between hydrodynamic and hydrostatic systems.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☑	☐	☐	☐	☐	☐	☐

CSY-E.3 Identify the advantages of hydraulic and pneumatic systems relative to each other.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☑	☐	☐	☐	☐	☐	☐

CSY-F. Design a hydraulic and pneumatic device, calculating design parameters using Pascal's Law.

CSY-F.1 Design, create, and test a fluid powered device.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☑	☐	☑	☐	☐	☐	☐

CSY-F.2 Calculate flow rate, flow velocity, power, and mechanical advantage in a fluid power system.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☑	☐	☐	☐	☐	☐	☐

CSY-F.3 Identify and explain basic components and functions of fluid power devices.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☑	☐	☐	☐	☐	☐	☐

CSY-F.4 Calculate values in a pneumatic system using the ideal gas laws.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☑	☐	☐	☐	☐	☐	☐

CSY-F.5 Calculate design parameters in a fluid power system utilizing Pascal's Law.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☑	☐	☐	☐	☐	☐	☐

CSY-F.6 Distinguish between pressure and absolute pressure.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☑	☐	☐	☐	☐	☐	☐

CSY-F.7 Distinguish between temperature and absolute temperature.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☑	☐	☐	☐	☐	☐	☐

Energy Sources (ESO):

Energy sources are used to generate power for humanity. Non-renewable sources include coal, oil, and natural gas, while renewable sources include wind, solar, hydroelectric, and geothermal.

ESO-A. Explore and document different energy sources and their uses.

ESO-A.1 Describe different energy sources.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☑	☐	☑

ESO-A.2 Explain positive and negative effects of different energy sources.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☑	☐	☐

Algorithms and Programing (AAP):

Algorithms are used to develop and express solutions to computational problems. Algorithms are fundamental to even the most basic everyday task.

AAP-A. Apply problem decomposition skills to break down data, problems, and processes into manageable parts.

AAP-A.1 Separate a complex process into multiple subprocesses that can be implemented in an organized way to complete the larger process.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☐	☑	☑	☑

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

AAP-B. Use algorithms to create a solution with or without the use of a computer program.

AAP-B.1 Write a set of ordered instructions (with or without a computer) involving multiple discrete steps to accomplish a complex task or achieve a desired result.

Lesson:	0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
	☐	☐	☐	☐	☐	☐	☐	☐	☑	☑	☑

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

AAP-B.2 Implement and analyze algorithms using conditional logic.

Lesson:	0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☑

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

AAP-C. Formulate solutions that use automation and programming to solve a problem.

AAP-C.1 Interpret simple computer code within various applications to describe the intended function of the code.

Lesson:	0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
	☐	☐	☐	☐	☐	☐	☐	☐	☑	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

AAP-C.2 Create, interpret, and/or modify a program to manage inputs and outputs of a microcontroller.

Lesson:	0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
	☐	☐	☐	☐	☑	☐	☐	☐	☑	☑	☑

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

AAP-C.3 Create programs by writing and testing code in a modular, incremental approach.

Lesson:	0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☑

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

AAP-D. Apply abstraction to generalize problems and solutions.

AAP-D.1 Identify what has been made more general by an abstraction and what details have been hidden or removed.

Lesson:	0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

Robotics and Automation (RA):

The interaction and use of mechanical systems, energy transfer, machine automation, and computer control systems to solve problems.

RA-A. Design a robotic system that solves an engineering design problem and meets required constraints and criteria.

RA-A.1 Identify and explain basic components and functions of a robot

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☑	☐	☐	☑

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

RA-A.2 Program a robot to execute a desired behavior using inputs and outputs

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☑	☑	☑	☑

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

RA-A.3 Construct a robot that meets design requirements.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☑	☐	☐	☑	☑	☑	☑

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

RA-B. Describe the purpose of automation and robotics and its effect on society.

RA-B.1 Summarize ways that robots are used in today's world and the impact of their use on society.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☑	☐	☑	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

RA-B.2 Describe positive and negative effects of automation and robotics on humans in terms of safety, economics, and ethics

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☐	☐	☑	☐	☑	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

Product Design (PD):

The process of identifying a market opportunity, imagining a product that meets the market's needs, and working to create a valid solution.

PD-A. Develop models and simulations to represent information, processes, and/or objects to an appropriate level of abstraction for the intended purpose.

PD-A.1 Develop a model to accurately represent information or important characteristics of an object, data, process, or design idea for an intended purpose.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☑	☐	☑	☐	☑	☑	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☑	☐	☐	☐	☐	☐	☐	☐

PD-B. Use spatial visualization to interpret graphical representations of physical objects.

PD-B.1 Build a physical representation of an object, system, or environment. (Includes building solid objects, electrical circuits, mechanical devices, and complex systems according to technical drawings.)

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☑	☐	☐	☐	☐	☐	☐	☐

PD-C. Create technical drawings.

PD-C.1 Hand sketch isometric views of a simple object or part at a given scale using the actual object, a detailed verbal description of the object, pictorial view of the object, or set of orthographic projections.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☑	☐	☑	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☑

PD-D. Create and interpret a computer model or simulation of simple objects, assemblies, or systems to inform engineering decisions and solve problems.

PD-D.1 Correctly build and constrain a three-dimensional solid computer model to accurately represent the physical characteristics and behaviors of a design idea or real object. [Scope: This could include the appropriate application of geometric (horizontal, vertical, parallel, perpendicular, tangent, concentric) and dimensional constraints, as well as modeling other physical properties (i.e., density, color, texture, and so on)]

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☑	☑	☑	☐	☑	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

PD-F. Design a product with consideration to how it will be manufactured.

PD-F.1 Create a prototype.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☐	☐	☑	☐	☐	☑	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☑	☐	☐	☐	☐	☐	☐	☐

PD-F.2 Differentiate between basic manufacturing processes.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

PD-F.3 Determine what manufacturing processes are best suited for a given scenario.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐

PD-F.4 Describe how a product changes over time.

Lesson:

0.1	0.2	0.3	0.4	1.1	1.2	1.3	2.1	2.2	2.3	2.4
☐	☐	☑	☐	☐	☐	☐	☑	☐	☐	☐

3.1	3.2	3.3	3.4	4.1	4.2	4.3	4.4
☐	☐	☐	☐	☐	☐	☐	☐