PLTW Computer Integrated Manufacturing 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

1.1 - 1 How is manufacturing made to be more efficient?

1.1 - 2 How does manufacturing affect the economy and society?

1.2 - 1 How can mechanical, electrical, and software systems be integrated to design a product?

1.2 - 2 How is your life affected by micocontrollers with inputs and outputs?

1.2 - 3 How does team diversificartion enhance a design process?

1.3 - 1 How do decisions related to cost, product quality, and safety interrelate?

1.3 - 2 How can a model be used to help design a full-scale system?

2.1 - 1 How is a product design enhanced by considering its manufacturability?

2.1 - 2 How do mathematical models improve manufacturing decision making?

2.1 - 3 Why do engineers use a code of ethics?

2.2 - 1 How do manufacturing processes affect product cost and quality?

2.2 - 2 How can the creation of a prototype be used in a design process?

2.3 - 1 How does manufacturability affect the design of a product?

2.3 - 2 How does a design and simulaiton software affect a product design process?

2.3 - 3 How does material selection affect a manufacturing process?

3.1 - 1 How is manufacturing affected by the use of a robot?

3.1 - 2 How can a simulation be used to plan a physical system?

3.2 - 1 How does the ability of power be transformed into other forms affect products that you use?

3.2 - 2 How can a system be optomized?

3.2 - 3 How can you use fluid power as part of the system that you deisng?

3.3 - 1 Why do systems need to communicate?

3.3 - 2 How can manufacturing be improved through the use of a robot?

3.3 - 3 How can a physical system be simulated as part of the design process?

4.1 - 1 How can a product be analyzed to suggest the manufacturing processes used to produce it?

4.1 - 2 How would you want to be remembered as a professional?

4.1 - 3 Who and what are credible sources for career advice?

4.2 - 1 How is computational thinking applied to solving a problem.

4.2 - 2 How can a design process be used to optimize a solution to a problem?

4.2 - 3 How the effectiveness of a presentation affects the acceptability of a solution?

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. Describe and distinguish among the different disciplines of engineering.

CAR-A.1 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	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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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).

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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COM-A.2 Follow acceptable formats for technical writing and professional presentations.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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COM-A.3 Properly cite references for all communication in an accepted format.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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COM-A.4 Clearly label tables and figures with units and explain the information presented in context.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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COM-A.5 Describe 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	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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Competencies, Domains, Objectives, Knowledge and Skills

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 Contribute individually to overall collaborative efforts.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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COL-B. Manage project timelines and resources as part of an engineering design process.

COL-B.1 Explain the process of project management and the importance of elements, such as timelines, schedules, task assignments, and identification and mitigation of potential risks, in the effort to complete a project on time.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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Ethical and Reasoning 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. Apply ethical consideration to engineering decision making.

ERM-A.1 Explain that engineers have a responsibility to serve the public interest, their clients, and the profession with a high degree of honesty, integrity, and accountability.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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ERM-B. Assess an engineering ethical dilemma.

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

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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ERM-B.2 Identify an ethical dilemma that has positive and negative consequence outcomes resulting from an engineering decision or series of decisions.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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Critical and Creative Problem-Solving (CCP):

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

CCP-A. Demonstrates independent thinking and self-direction in pursuit of accomplishing a goal.

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

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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CCP-A.2 Plan how to gain additional knowledge and learning to accomplish a goal.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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CCP-B. Demonstrate flexibility and adaptability to change.

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

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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CCP-C. Persevere to solve a problem or achieve a goal.

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

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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CCP-C.2 Reflect critically on past experiences to inform future progress.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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CCP-D. Explain and justify an engineering design process.

CCP-D.1 Explain that there are many versions of a design process that describe essentially the same process.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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CCP-D.2 Describe major steps of a design process and identify typical tasks involved in each step.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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CCP-D.3 Outline how iterative processes inform engineering decisions, improve solutions, and inspire new ideas.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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CCP-D.4 Document a design process in an engineering notebook according to best practices.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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CCP-E. Collect, analyze, and interpret information relevant to the problem or opportunity at hand to support engineering decisions.

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

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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CCP-E.2 Find relevant data in credible sources such as literature, databases, and policy documents.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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CCP-F. Synthesize an ill-formed problem into a meaningful, well-defined problem.

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

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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CCP-F.2 Identify and define visual, functional, and structural design requirements with realistic constraints, against which solution alternatives can be evaluated.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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CCP-F.3 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	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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CCP-G. Generate multiple potential solution concepts.

CCP-G.1 Describe multiple techniques and appropriate guidelines used to generate ideas.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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CCP-G.2 Represent concepts using a variety of visual tools, such as sketches, graphs, and charts, to communicate details of an idea.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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CCP-H. Develop models to represent design alternatives and generate data to inform decision making, test alternatives, and demonstrate solutions.

CCP-H.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	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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CCP-H.2 Produce a physical model using hand tools and simple construction techniques.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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CCP-I. Select a solution path from many options to successfully address a problem or opportunity.

CCP-I.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	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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CCP-I.2 Develop and carry out a justifiable scheme to compare and evaluate competing solution paths. A decision matrix is one tool used to compare and evaluate competing solutions based on design criteria.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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CCP-J. Make judgments and decisions based on evidence.

CCP-J.1 Explain that a conclusion is valid if the evidence supports the conclusion while acknowledging the limitations, opposing views, and biases.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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CCP-J.2 Evaluate evidence and arguments to identify deficiencies, limitations, and biases or appropriate next steps in the pursuit of a better solution.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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Competencies, Domains, Objectives, Knowledge and Skills

Technical Knowledge and Skills

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

Algorithms and Programming (AAP):

Manufacturing systems can include automated equipment and processes to improve their performance.

AAP-A. Design a manufacturing system.

AAP-A.1 Describe how a tool such as a flowchart or pseudocode is used to develop a control program.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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AAP-A.2 Describe open- and closed-loop systems.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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AAP-A.3 Explain how input and output devices are used in an open- and closed-loop system.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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AAP-A.4 Explain how separate control systems inter-communicate.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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AAP-A.5 Create a flowchart or pseudocode to perform a series of tasks.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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AAP-A.6 Given a sample of a control program, interpret the actions that will be performed.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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AAP-A.7 Interpret sensor input to the environment being measured.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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AAP-A.8 Create a program to control a manufacturing system.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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AAP-B. Create a program to control a robot.

AAP-B.1 Describe the effect of robot development on the manufacturing industry.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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AAP-B.2 Describe common robot types and applications used in the manufacturing industry.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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AAP-B.3 Describe accuracy and repeatability of a robot.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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AAP-B.4 Describe robot geometry characteristics such as work envelope.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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AAP-B.5 Calculate position information of a robotic arm based on actuator movement.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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AAP-B.6 Explain how separate robot control systems inter-communicate.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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AAP-B.7 Recognize symbols used to represent a series of robot movements.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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AAP-B.8 Construct a series of symbols which represent a series of robot movements.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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AAP-B.9 Interpret the actions that will be performed given a sample of a control program.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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AAP-B.10 Create a program for a robot to perform a series of tasks.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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AAP-C. Analyze the use of power in manufacturing systems.

AAP-C.1 Describe the application of energy and power in a manufacturing environment.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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AAP-C.2 Define torque, pressure, work, and power.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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AAP-C.3 Apply equations related to torque, pressure, work, and power to solve an engineering problem.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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AAP-C.4 Design a system to perform an operation using fluid power.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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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 that all measurements are an approximation of the true value of a quantity.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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ETT-A.2 Explain and differentiate between the accuracy and precision of a measurement or measuring device.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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ETT-A.3 Use dimensional analysis and unit conversions to transform data to consistent units or to units appropriate for a particular purpose or model.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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ETT-B. Use a spreadsheet application to help identify and/or solve a problem.

ETT-B.1 Populate a spreadsheet application with data and organize the data to be useful in accomplishing a specific goal.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
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ETT-B.2 Use the functions and tools within a spreadsheet application to manipulate, analyze, and present data in a useful way.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☑

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

ETT-C.1 Explain that “systems thinking” is an approach to problem solving focused on understanding how interconnected system components, people, and societies influence one another.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☑	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐

ETT-C.2 List realistic considerations that constrain solutions within the broader system. Examples include: economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☑	☐	☐	☐	☐	☑	☐	☐	☑

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

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

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☑	☐	☐	☑	☐	☑	☐	☐	☑

ETT-D.2 Describe a process to build a physical object based on a conceptual communication, such as a drawing or description.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☑	☑	☐	☐	☑	☐	☑	☐	☐	☑

ETT-D.3 Demonstrate use of hand tools and shop tools.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☑	☐	☐	☑	☐	☑	☐	☐	☑

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

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

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☑	☑	☐	☑	☑	☐	☑	☐	☐

ETT-E.2 Develop an algorithm (step-by-step process) for solving a problem.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☑	☑	☐	☐	☑	☐	☑	☐	☐	☑

ETT-E.3 Identify, test, and implement possible solutions to a problem using a computer.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☑	☑	☐	☐	☑	☐	☑	☐	☐	☑

ETT-E.4 Automate a solution using algorithmic thinking.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☑	☑	☐	☐	☑	☐	☑	☐	☐	☑

ETT-F. Use spatial visualization to create and interpret graphical communication of two- and three-dimensional objects.

ETT-F.1 Match a set of orthographic projections of a 3D object with pictorial representations of the same object.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☐	☐	☑	☑	☐	☐	☐	☐

ETT-F.2 Identify the shapes of two-dimensional cross-sections of three-dimensional objects.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☐	☐	☑	☑	☐	☐	☐	☐

Manufacturing Processes (MPR):

A process is a step in a manufacturing sequence which changes the geometry or properties of material.

MPR-A. Analyze common material properties.

MPR-A.1 Describe properties of common materials.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐

MPR-A.2 Explain the effect that material selection has on a product function and manufacturing processes.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☑	☑	☐	☐	☐	☐	☐	☐

MPR-B. Analyze common manufacturing processes.

MPR-B.1 Explain the difference between additive and subtractive processes.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐

MPR-B.2 Explain the difference between primary and secondary processing.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐

MPR-B.3 Explain how a process can transform material geometry and its properties.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☐	☑	☑	☐	☐	☐	☐	☑

MPR-B.4 Describe common metallic transformative processes, such as casting, powder metallurgy, hot and cold working, heat treatment, shearing, and forming.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☑

MPR-B.5 Describe common non-metallic transformative processes involving materials such as plastic, ceramics, and composites.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☑

MPR-B.6 Describe common surface finishing processes.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☑

MPR-B.7 Describe common additive processes such as welding, fastening, and joining.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☑

MPR-B.8 Describe common subtractive processes, such as sawing, cutting, drilling, broaching, threading, grinding, turning, and milling.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☑

MPR-C. Design a process to manufacture a product.

MPR-C.1 Identify the process that a machine is designed to perform.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☐	☑	☑	☐	☐	☐	☑	☑

MPR-C.2 Analyze how a product can be produced through a series of processes.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☑	☐	☐	☐	☑	☑	☐	☐	☐	☑	☑

Manufacturing Systems (MSY):

Processes and components are organized into a system to efficiently produce products.

MSY-A. Analyze common manufacturing systems.

MSY-A.1 Explain how a manufacturing system is used to organize many components, such as customer need, finance, and processes.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

MSY-A.2 Describe manufacturing systems, such as handmade production, mass production , Lean Manufacturing, Flexible Manufacturing System, Just-in-Time Manufacturing, and Small-scale Manufacturing.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

MSY-A.3 Explain the advantages and disadvantages of manufacturing techniques and processes.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☑	☐	☐	☐	☑	☐	☐	☐	☐	☐	☑

MSY-A.4 Describe the use of manufacturing system support functions, such as Automated Storage/Retrieval System and Automated Guided Vehicle.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐

MSY-B. Design a manufacturing system to produce a product.

MSY-B.1 Recognize symbols used to represent a series of manufacturing processes.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑

MSY-B.2 Construct a series of symbols to represent manufacturing processes that create a part.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☑

MSY-C. Analyze economic factors of a manufacturing system.

MSY-C.1 Explain how physical properties of a part affect manufacturing financial decisions.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐

MSY-C.2 Calculate physical properties of a part, such as volume, mass, and surface area.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐

MSY-C.3 Explain how costs of manufacturing a product are categorized, such as fixed, variable, direct, indirect, long-term, and short-term.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐

MSY-C.4 Compare the efficiency of multiple manufacturing systems using factors such as time, material use, labor, and safety.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐

MSY-D. Analyze ethical considerations of a manufacturing system.

MSY-D.1 Describe how ethics, environmental health, and safety considerations affect manufacturing systems.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐

Competencies, Domains, Objectives, Knowledge and Skills

Product Design for Manufacturability (PDM):

A product can be produced more efficiently by considering how it will be manufactured as part of the design criteria.

PDM-A. Design a product with consideration to how it will be manufactured.

PDM-A.1 Explain how product decisions, such as geometry, material, and specialized and standardized components, have an effect on a manufacturing system.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☑	☐	☑	☐	☐	☐	☑	☐

PDM-A.2 Explain how a part design can be altered to improve its manufacturability.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☑	☐	☑	☐	☐	☐	☐	☐

PDM-A.3 Describe a process of using Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) software to transform a concept into a physical part.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐

PDM-A.4 Describe common prototyping techniques.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐

PDM-A.5 Explain the use a prototype to evaluate and improve a design.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐	☐

PDM-A.6 Create a prototype.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☑	☐	☐	☑	☐	☐	☐	☑	☐

PDM-B. Create a product using a Computer Numerical Control (CNC) milling machine.

PDM-B.1 Describe the parts of and function of common CNC milling machines.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐

PDM-B.2 Describe common milling tools and their application.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐

PDM-B.3 Describe how machines use Computer Numerical Control (CNC) to operate autonomously.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐

PDM-B.4 Calculate settings needed for a milling machine.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐

PDM-B.5 Describe common G & M Codes.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐

PDM-B.6 Describe a procedure to operate a milling machine.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐

PDM-B.7 Manually create machine code required to manufacture a product.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐

PDM-B.8 Interpret the actions that will be performed given a sample of machine code.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐

PDM-B.9 Create machine code to manufacture a part using Computer Aided Manufacturing (CAM) software.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐

PDM-B.10 Verify machine code accuracy using simulation software.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐

PDM-B.11 Describe the use of work-holding devices, such as jigs and fixtures, to maintain consistency and quality control.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐	☐

Role of Manufacturing (ROM):

Manufacturing efficiently transforms ideas into products.

ROM-A. Interpret how developments in manufacturing impact society and address future manufacturing needs.

ROM-A.1 Describe the impact of manufacturing on society.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

ROM-A.2 Describe the cause-and-effect relationship that led to developments in the manufacturing industry.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Competencies, Domains, Objectives, Knowledge and Skills

ROM-A.3 Describe future manufacturing industry needs.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

ROM-B. Analyze the cause-and-effect relationship of advancements in manufacturing processes and systems.

ROM-B.1 Identify the correct sequence and approximate dates of major advancements in manufacturing processes and systems.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

ROM-B.2 Describe the cause-and-effect relationship that led to advances in manufacturing processes and systems.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

ROM-B.3 Describe how advances in techniques and technology impact modern manufacturing.

Lesson	1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3	4.1	4.2
	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐