PLTW Engineering
Digital Electronics | Course Outline

Open doors to understanding electronics and foundations in circuit design.

Digital electronics is the foundation of all modern electronic devices such as cellular phones, MP3 players, laptop computers, digital cameras, high definition televisions, etc. Students learn the digital circuit design process to create circuits and present solutions that can improve people's lives.

Learn how advancements in foundational electronic components and digital circuit design processes have transformed the world around you.

Digital electronics is the study of electronic circuits that are used to process and control digital signals. In contrast to analog electronics, where information is represented by a continuously varying voltage, digital signals are represented by two discrete voltages or logic levels. This distinction allows for greater signal speed and storage capabilities and has revolutionized the world of electronics.

The major focus of the DE course is to expose students to the design process of combinational and sequential logic design, teamwork, communication methods, engineering standards, and technical documentation.

Utilizing the activity-project-problem-based (APB) teaching and learning pedagogy, students will analyze, design, and build digital electronic circuits. While implementing these designs, students will continually hone their professional skills, creative abilities, and understanding of the circuit design process.

Digital Electronics (DE) is a high school level course that is appropriate for 10th or 11th grade students interested in exploring electronics. Other than their concurrent enrollment in college preparatory mathematics and science courses, this course assumes no previous knowledge.

The following is a summary of the units of study that are included in the course. Activities, projects, and problems are provided to the teacher in the form of student-ready handouts, teacher notes/lesson planning resources, and supplementary materials, including simulations, instructional videos, and online resources as appropriate.

While many students may have been exposed to basic circuits and electricity in a science course, Digital Electronics is typically a unique experience for students because of its focus on understanding and implementing circuit design skills. The course is planned for a rigorous pace, and it is likely to contain more material than a skilled teacher new to the course will be able to complete in the first iteration. Building enthusiasm for rigorous exploration of electronics and circuit design for students is a primary goal of the course.

DE Unit Summary

Unit 1	Foundations in Electronics
Unit 2	Combinational Logic
Unit 3	Sequential Logic
Unit 4	Controlling Real-World Systems

Unit 1: Foundations in Electronics

In Unit 1 Foundations in Electronics, students will explore the fundamental components, concepts, equipment, and skill sets associated with circuit design. They will learn an engineering design process that can be used to guide the creation of circuits based on a set of design requirements. Throughout the course students will learn about advancements in circuits and circuit design that have shaped the world of digital electronics.

Foundations in Electronics Lesson Summary

Lesson 1.1	Introduction to Electronics
Lesson 1.2	Introduction to Circuit Design

Lesson 1.1 Introduction to Electronics

In Lesson 1.1 Introduction to Electronics, students will learn to distinguish between analog and digital components. They will begin by exploring basic circuits and the measurement tools used to characterize and validate calculations that predict a circuit's behavior. Students will be able to clearly describe electrical circuits, voltage, current, resistance, series and parallel circuits, Ohm's law, and how to use a digital multimeter to measure voltage. Students will be introduced to common components such as resistors, capacitors, light emitting diodes (LEDs), seven-segment displays, combinational logic gates, and sequential logic gates.

Lesson 1.2 Introduction to Circuit Design

In Lesson 1.2 Introduction to Circuit Design, students will explore fundamental circuit designs, manipulate circuits to understand their function, and explore the examples that combine analog, digital combinational logic, and digital sequential logic.

This lesson is meant to serve as a broad overview of circuit design and to expose students to basic designs they will be exploring and incorporating into their own future designs.

Unit 2: Combinational Logic

How do you design a circuit to "do what you want it to do"? The goal of Unit 2 is for students to gain in-depth understanding of the combinational logic circuit design. Student will explore creation of circuits with discrete components and how to simplify these circuits to implement more efficient designs.

Combinational Logic Lesson Summary

Lesson 2.1 AOI Combinational Logic Circuit Design
Lesson 2.2 Alternative Design: Universal Gates and K-Mapping
Lesson 2.3 Specific Combinational Logic Designs
Lesson 2.4 Introduction to Programmable Logic Devices (PLDs)

Lesson 2.1 AOI Combinational Logic Circuit Design
Lesson 2.1 focuses on AND, OR, Inverter (AOI) combinational logic circuit design. Students will reinforce concepts that were introduced in the previous units, including binary number systems, truth tables, and Boolean expressions. They will then expand on these concepts by exploring how mathematics can be used to reduce circuit size, cost, and complexity. Using the systematic approaches of AOI simplification, AOI logic analysis, and AOI implementation, students will learn to take design specifications and translate them into the most efficient circuit possible.

Lesson 2.2 Alternative Design: Universal Gates and K-Mapping
In the first lesson of this unit, students learned how to use a design process to transform design specifications into functional AOI combinational logic. Though the result of this work was a functioning circuit, this process does not address a few issues.

First, Boolean algebra was required to simplify the logic expressions. Though Boolean algebra is an important mathematical process, applying its numerous theorems and laws is not always the easiest task to undertake in simplifying circuits.

Second, AOI circuit implementations are rarely the most cost-effective solutions for combinational logic designs.

After completing a series of guided foundational activities on Karnaugh maps, NAND only logic design, and NOR only logic design, the students will apply the combinational logic design process to develop a Fireplace Control Circuit. This process will walk the students through the steps required to transform a set of written design specifications into a functional combinational logic circuit implemented with either NAND only or NOR only logic.

Lesson 2.3 Specific Combinational Logic Designs
This lesson will address a few fundamental topics related to combinational logic. These topics include hexadecimal and octal number systems, XOR, XNOR, and binary adders, 2's complement arithmetic, and multiplexers/de-multiplexers.

These designs are commonly used in digital circuit designs related to adding/subtracting numbers, the use of seven segment displays in designs, and carrying multiple signals through the same pathway in a circuit.

Lesson 2.4 Introduction to Programmable Logic Devices (PLDs)
In the first three lessons of this unit, students learned how to use a design process to transform design specifications into functional AOI, NAND, and NOR combinational logic circuits. In this lesson students apply all that they have learned to design a circuit in which they define some of the design specifications themselves for the first time.

Students will design, simulate, and breadboard a circuit that displays their unique birthdate. Circuit implementation is then demonstrated at the next level by utilizing a programmable logic device called a Field Programmable Gate Array (FPGA). FPGA is a state-of-the-art programmable device capable of implementing large, sophisticated designs. In this course we have limited our designs to four inputs and circuits that are manageable for breadboarding. The PLD shows us the next evolution of circuit design, allowing us to design more complex circuits in a shorter period of time. Students quickly see the benefit of this new design tool and strategy over designing discrete logic gates.

Unit 3: Sequential Logic

How do you get a circuit to do what you want it to do, when you want it to do it? Sequential logic introduces students to event detection and memory. Sequential logic has two characteristics that distinguish it from combinational logic. First, sequential logic must have a signal that controls the sequencing of events. Second, sequential logic must have the ability to remember past events.
A keypad on a garage door opener is a classic example of an everyday device that utilizes sequential logic. On the keypad, the sequencing signal controls when a key can be pressed. The need to enter the passcode in a specific order necessitates memory of past events.
These characteristics are made possible by a simple device called a flip-flop. The flip-flop is a logic device that is capable of storing a logic level and allowing this stored value to change only at a specific time. For this reason the flip-flop is the fundamental building block for all sequential logic designs.

Sequential Logic Lesson Summary

Lesson 3.1 Sequential Logic Circuit Design
Lesson 3.2 Asynchronous Counters
Lesson 3.3 Synchronous Counters

Lesson 3.1 Sequential Logic Circuit Design

In this lesson students begin the study of sequential logic by examining the basic operation of the two most common flip-flop types, the D and J/K flip-flops. As part of this analysis, they will review the design of four typical flip-flop applications: event detector, data synchronizer, frequency divider, and shift register. In later lessons the application of flip-flops for asynchronous counters, synchronous counters, and state-machines will be studied.

Lesson 3.2 Asynchronous Counters

The ability to count in a digital design application is a fundamental need in most circuits. These counting applications range from the simple Now Serving sign at the neighborhood deli counter to the countdown display used by NASA to launch rockets. A number of techniques are used to design counters, but they all fall into two general categories, each with their own advantages and disadvantages. These two categories are called asynchronous counters and synchronous counters.

The primary design characteristic of asynchronous counters that distinguish them from synchronous counters is that the flip-flop of each stage is clocked by the flip-flop output of the prior stage. Thus, rather than all the flip-flops changing simultaneously, the clock ripples its way from the first flip-flop to the last. This is why asynchronous counters are sometimes referred to as ripple counters.

After completing a series of activities on the process for designing Small Scale Integration (SSI) and Medium Scale Integration (MSI) asynchronous counters, this lesson will conclude with a design problem that requires the students to design, simulate, and create a Now Serving display circuit.

Lesson 3.3 Synchronous Counters
As discussed in the previous lesson of this unit, the two categories of digital counters are asynchronous and synchronous. The analysis and design of synchronous counters is the topic of study of this lesson. The primary design characteristic of synchronous counters is that all of the flip-flops are clocked simultaneously. This simultaneous clocking avoids the rippling effect that is present in asynchronous counters.

After completing a series of activities on the process for designing SSI and MSI synchronous counters, this lesson will conclude with a project that requires the students to design and simulate a Sixty Second Timer circuit.

Unit 4: Controlling Real-World Systems

In Unit 4 students make a final transition to the use of single-board computers used widely today. State machines and computers allow students to integrate sensors and motors. This allows us to create circuits that exist in the world around us.

Controlling Real-World Systems Lesson Summary

Lesson 4.1 Introduction to State Machines
Lesson 4.2 Application of State Machines

Lesson 4.1 Introduction to State Machines
State machines, sometimes called Finite State Machines (FSM), are a form of sequential logic that can be used to electronically control common everyday devices such as traffic lights, electronic keypads, and automatic door openers.

In this lesson students will learn and apply the state machine design process. This design process will be used to implement state machines utilizing the pi-top platform, which is based on the Raspberry Pi.

After completing a foundational activity on state machine design, the lesson introduces students to algorithmic thinking and the use of digital and analog devices to solve a problem. The lesson concludes with a project where students design and build a preemptive traffic light using the pi-top and the Python programming language.

Lesson 4.2 Application of State Machines

This lesson introduces students to more algorithms and programming concepts as they learn to use servo motors and remote communication across pi-top devices. The lesson concludes with a problem in which students use all the knowledge and skills they have learned in the unit to design and implement an escape room using multiple pi-tops.

State machines, the design process, planning, and documentation are threaded throughout the unit as students work in teams and practice transportable skills including communication and collaboration.

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PLTW Engineering Standards Connection
Digital Electronics

Connections to Standards in Engineering

PLTW curriculum is designed to empower students to thrive in an evolving world. As a part of the design process when developing and updating our curriculum, we focus on connections to a variety of standards. PLTW Digital Electronics connects to standards in the following:

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Common Core State Standards for English Language Arts Anchor Standards

Reading

Key Ideas and Details

CCSS.ELA-LITERACY.CCRA.R.1

Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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Craft and Structure

CCSS.ELA-LITERACY.CCRA.R.4

Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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Integration of Knowledge and Ideas

CCSS.ELA-LITERACY.CCRA.R.7

Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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Range of Reading and Level of Text Complexity

CCSS.ELA-LITERACY.CCRA.R.10

Read and comprehend complex literary and informational texts independently and proficiently.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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Writing

Text Types and Purposes

CCSS.ELA-LITERACY.CCRA.W.2

Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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Common Core State Standards for English Language Arts Anchor Standards

CCSS.ELA-LITERACY.CCRA.W.3

Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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Production and Distribution of Writing

CCSS.ELA-LITERACY.CCRA.W.4

Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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CCSS.ELA-LITERACY.CCRA.W.6

Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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Research to Build and Present Knowledge

CCSS.ELA-LITERACY.CCRA.W.9

Draw evidence from literary or informational texts to support analysis, reflection, and research.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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CCSS.ELA-LITERACY.CCRA.W.7

Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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Range of Writing

CCSS.ELA-LITERACY.CCRA.W.10

Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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Common Core State Standards for English Language Arts Anchor Standards

Speaking and Listening

Comprehension and Collaboration

CCSS.ELA-LITERACY.CCRA.SL.1

Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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CCSS.ELA-LITERACY.CCRA.SL.2

Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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Presentation of Knowledge and Ideas

CCSS.ELA-LITERACY.CCRA.SL.4

Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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CCSS.ELA-LITERACY.CCRA.SL.5

Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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CCSS.ELA-LITERACY.CCRA.SL.6

Adapt speech to a variety of contexts and communicative tasks, demonstrating command of formal English when indicated or appropriate.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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Language

Conventions of Standard English

CCSS.ELA-LITERACY.CCRA.L.1

Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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Common Core State Standards for English Language Arts Anchor Standards

CCSS.ELA-LITERACY.CCRA.L.2

Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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Knowledge of Language

CCSS.ELA-LITERACY.CCRA.L.3

Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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Vocabulary Acquisition and Use

CCSS.ELA-LITERACY.CCRA.L.4

Determine or clarify the meaning of unknown and multiple-meaning words and phrases by using context clues, analyzing meaningful word parts, and consulting general and specialized reference materials, as appropriate.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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CCSS.ELA-LITERACY.CCRA.L.5

Demonstrate understanding of word relationships and nuances in word meanings.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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CCSS.ELA-LITERACY.CCRA.L.6

Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when encountering an unknown term important to comprehension or expression.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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Common Core Standards for Mathematics

The Real Number System

Extend the Properties of Exponents to Rational Exponents

CCSS.MATH.CONTENT.HSN.RN.A.1

Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. For example, we define 51/3 to be the cube root of 5 because we want [5^(1/3)^3 = 5^(1/3*3) to hold, so (5^1/3)^3 must equal 5.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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CCSS.MATH.CONTENT.HSN.RN.A.2

Rewrite expressions involving radicals and rational exponents using the properties of exponents.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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Quantities

Reason Quantitatively and Use Units to Solve Problems

CCSS.MATH.CONTENT.HSN.Q.A.1

Use units as a way to understand problems and to guide the solution of multistep problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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CCSS.MATH.CONTENT.HSN.Q.A.2

Define appropriate quantities for the purpose of descriptive modeling.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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CCSS.MATH.CONTENT.HSN.Q.A.3

Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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Common Core Standards for Mathematics

Seeing Structure in Expressions

Interpret the Structure of Expressions

CCSS.MATH.CONTENT.HSA.SSE.A.1

Interpret expressions that represent a quantity in terms of its context.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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CCSS.MATH.CONTENT.HSA.A.1.A

Interpret parts of an expression, such as terms, factors, and coefficients.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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CCSS.MATH.CONTENT.HSA.SSA.1.B

Interpret complicated expressions by viewing one or more of their parts as a single entity. For example, interpret P(1+r)^n as the product of P and a factor not depending on P.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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CCSS.MATH.CONTENT.HSA.SSE.A.2

Use the structure of an expression to identify ways to rewrite it. For example, see x^4 – y^4 as (x^2)^2 – (y2)^2, thus recognizing it as a difference of squares that can be factored as (x^2 – y^2)(x^2 + y^2).

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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Write Expressions in Equivalent Forms to Solve Problems

CCSS.MATH.CONTENT.HSA.SSE.B.3

Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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Reasoning with Equations and Inequalities

Understand Solving Equations as a Process of Reasoning and Explain the Reasoning

CCSS.MATH.CONTENT.HSA.REI.A.1

Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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CCSS.MATH.CONTENT.HSA.REI.A.2

Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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Solve Equations and Inequalities in One Variable

CCSS.MATH.CONTENT.HSA.REI.B.3

Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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Solve Systems of Equations

CCSS.MATH.CONTENT.HSA.REI.C.5

Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
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Arithmetic with Polynomials and Rational Expressions

Perform Arithmetic Operations on Polynomials

CCSS.MATH.CONTENT.HSA.APR.A.1

Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☑	☑	☑	☑	☐	☐	☑	☐	☐

Understand the Relationship Between Zeros and Factors of Polynomials

CCSS.MATH.CONTENT.HSA.APR.B.2

Know and apply the Remainder theorem: For a polynomial p(x) and a number a, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x).

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐

Use Polynomial Identities to Solve Problems

CCSS.MATH.CONTENT.HSA.APR.C.4

Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity $(x^2 + y^2)^2 = (x^2 – y^2)^2 + (2xy)^2$ can be used to generate Pythagorean triples.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☐	☐	☐	☑	☑	☐	☐	☐	☐	☐

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CCSS.MATH.CONTENT.HSA.APR.C.5

(+) Know and apply the Binomial theorem for the expansion of (x + y)^n in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☐	☐	☑	☑	☑	☐	☐	☐	☐	☐

Rewrite Rational Expressions

CCSS.MATH.CONTENT.HSA.APR.D.6

Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☑	☐	☑	☑	☐	☐	☐	☐	☐

CCSS.MATH.CONTENT.HSA.APR.D.7

(+) Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☑	☐	☑	☑	☐	☐	☐	☐	☐

Creating Equations

Create Equations That Describe Numbers Or Relationships

CCSS.MATH.CONTENT.HSA.CED.A.1

Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☐	☐	☑	☐	☐	☐	☐	☐	☐

CCSS.MATH.CONTENT.HSA.CED.A.3

Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐

CCSS.MATH.CONTENT.HSA.CED.A.4

Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law V = IR to highlight resistance R.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☑	☐	☐	☐	☐	☐	☐	☐	☐

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Common Core Standards for Mathematics

Interpreting Functions

Interpret Functions That Arise in Applications in Terms of the Context

CCSS.MATH.CONTENT.HSF.IF.B.4

For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐

CCSS.MATH.CONTENT.HSF.IF.B.5

Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐

CCSS.MATH.CONTENT.HSF.IF.B.6

Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐

Building Functions

Build New Functions From Existing Functions

CCSS.MATH.CONTENT.HSF.BF.B.4

Find inverse functions.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐

Linear, Quadratic, and Exponential Models

Construct and Compare Linear, Quadratic, and Exponential Models and Solve Problems

CCSS.MATH.CONTENT.HSF.LE.A.1

Distinguish between situations that can be modeled with linear functions and with exponential functions.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐

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Common Core Standards for Mathematics

CCSS.MATH.CONTENT.HSF.LE.A.1.B

Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐

CCSS.MATH.CONTENT.HSF.LE.A.2

Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐

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Writing

Text Types and Purposes

CCSS.ELA-LITERACY.W.11-12.1.E

Provide a concluding statement or section that follows from or supports the argument presented.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☐	☐	☐	☐	☑	☐	☐	☑	☐	☑

CCSS.ELA-LITERACY.W.11-12.2

Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☐	☐	☐	☐	☑	☐	☐	☑	☐	☑

CCSS.ELA-LITERACY.W.11-12.2.E

Provide a concluding statement or section that follows from and supports the information or explanation provided (e.g., articulating implications or the significance of the topic).

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☐	☐	☐	☐	☑	☐	☐	☑	☐	☑

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Next Generation Science Standards

Motion and Stability: Forces and Interactions

HS.PS2.6

Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Energy

HS.PS3.2

Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as either motions of particles or energy stored in fields.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

HS.PS3.3

Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☑	☑	☑	☑	☑	☑	☑	☑	☑	☐	☐

Waves and their Applications in Technologies for Information Transfer

HS.PS4.1

Use mathematical representations to support a claim regarding relationships among the frequency, wavelength, and speed of waves traveling in various media.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐

Engineering Design

HS.ETS1.2

Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☐	☑	☑	☑	☑	☑	☑	☑	☑	☑

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HS.ETS1.3

Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

HS.ETS1.4

Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

Disciplinary Core Ideas

ETS1.B Engineering Design - Developing Possible Solutions

- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (HS-ETS1-3)

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☑

Science and Engineering Practices

Practice 1 Asking questions and defining problems in 9-12 builds on K-8 experiences and progresses to formulating, refining, and evaluating empirically testable questions and design problems using models and simulations.

- Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

Practice 2 Developing and Using Models
Modeling in 9-12 builds on K-8 experiences and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed worlds.

- Develop a complex model that allows for manipulation and testing of a proposed process or system.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

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- Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

Practice 3 Planning and Carrying Out Investigations
Planning and carrying out investigations in 9-12 builds on K-8 experiences and progresses to include investigations that provide evidence for and test conceptual, mathematical, physical, and empirical models.

- Plan an investigation or test a design individually and collaboratively to produce data to serve as the basis for evidence as part of building and revising models, supporting explanations for phenomena, or testing solutions to problems. Consider possible variables or effects and evaluate the confounding investigation's design to ensure variables are controlled.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

- Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

Practice 4 Analyzing and Interpreting Data
Analyzing data in 9-12 builds on K-8 experiences and progresses to introducing more detailed statistical analysis, the comparison of data sets for consistency, and the use of models to generate and analyze data.

- Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

Practice 5 Using Mathematics and Computational Thinking
Mathematical and computational thinking in 9- 12 builds on K-8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

- Create and/or revise a computational model or simulation of a phenomenon, designed device, process, or system.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

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Next Generation Science Standards

Practice 6 Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 9-12 builds on K-8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

- Apply scientific ideas, principles, and/or evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

- Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

Practice 7 Engaging in Argument from Evidence
Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about the natural and designed world(s). Arguments may also come from current scientific or historical episodes in science.

- Compare and evaluate competing arguments or design solutions in light of currently accepted explanations, new evidence, limitations (e.g., trade-offs), constraints, and ethical issues.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☐	☑	☑	☑	☑	☑	☑	☑	☑	☑

- Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and/or logical arguments regarding relevant factors (e.g. economic, societal, environmental, ethical considerations).

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

Practice 8 Obtaining, Evaluating, and Communicating Information
Obtaining, evaluating, and communicating information in 9-12 builds on K-8 experiences and progresses to evaluating the validity and reliability of the claims, methods, and designs.

- Evaluate the validity and reliability of and/or synthesize multiple claims, methods, and/or designs that appear in scientific and technical texts or media reports, verifying the data when possible.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

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Crosscutting Concepts

Patterns

- Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐

- Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

Cause and Effect: Mechanism and Prediction

- Systems can be designed to cause a desired effect.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☑	☑	☑	☑	☑	☑	☑	☑	☑	☑	☐

Scale, Proportion, and Quantity

- In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐

- Algebraic thinking is used to examine scientific data and predict the effect of a change in one variable on another (e.g., linear growth vs. exponential growth).

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☑	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐

Systems and System Models

- A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐

- When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☐	☐	☐	☐	☐	☐	☐	☐	☐

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- Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

Structure and Function

- Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

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Standards for Technological and Engineering Literacy

STEL 1 Nature and Characteristics of Technology and Engineering

STEL-1N

Explain how the world around them guides technological development and engineering design.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☑	☑	☐	☐	☐	☐	☐	☐	☐

STEL-1O

Assess how similarities and differences among scientific, mathematics, engineering, and technological knowledge and skills contributed to the design of a product or system.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☐	☐	☐	☑	☐	☐	☐	☐	☐	☐

STEL-1R

Develop a plan that incorporates knowledge from science, mathematics, and other disciplines to design or improve a technological product or system.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☑	☑	☑	☐	☐	☐	☑	☐	☐

STEL 2 Core Concepts of Technology and Engineering

STEL-2T

Demonstrate the use of conceptual, graphical, virtual, mathematical, and physical modeling to identify conflicting considerations before the entire system is developed and to aid in design decision making.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☑	☑	☑	☑	☑	☐	☐	☑	☑	☐	☐

STEL-2V

Analyze the stability of a technological system and how it is influenced by all of the components in the system, especially those in the feedback loop.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☑	☑	☑	☑	☑	☑	☑	☑	☑

STEL-2W

Select resources that involve tradeoffs between competing values, such as availability, cost, desirability, and waste while solving problems.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☐	☐	☐	☐	☐	☐	☐	☐	☑	☑

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Standards for Technological and Engineering Literacy

STEL-2X

Cite examples of the criteria and constraints of a product or system and how they affect final design.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☐	☑	☑	☐	☑	☐	☑	☑	☑	☑

STEL-2Y

Implement quality control as a planned process to ensure that a product, service, or system meets established criteria.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☐	☑	☑	☐	☑	☐	☑	☑	☑	☑

STEL 3 Integration of Knowledge, Technologies, and Practices

STEL-3H

Analyze how technology transfer occurs when a user applies an existing innovation developed for one function for a different purpose.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☐	☐	☐	☐	☐	☑	☐	☐	☐	☐

STEL 4 Impacts of Technology

STEL-4P

Evaluate ways that technology can impact individuals, society, and the environment.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐

STEL-4S

Develop a solution to a technological problem that has the least negative environmental and social impact.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐

STEL 5 Influence of Society on Technological Development

STEL-5H

Evaluate a technological innovation that arose from a specific society's unique need or want.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☐	☑	☐	☐	☐	☐	☐	☐	☑	☑

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STEL-5I

Evaluate a technological innovation that was met with societal resistance impacting its development.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☐	☑	☐	☐	☐	☐	☐	☐	☐	☐

STEL 6 History of Technology

STEL-6F

Relate how technological development has been evolutionary, often the result of a series of refinements to basic inventions or technological knowledge.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☑	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

STEL 7 Design in Technology and Engineering Education

STEL-7W

Determine the best approach by evaluating the purpose of the design.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☑	☐	☑	☐	☑	☐	☐	☑	☑	☑

STEL-7X

Document trade-offs in the technology and engineering design process to produce the optimal design.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☐	☐	☑	☐	☑	☐	☐	☐	☑	☑

STEL-7Y

Optimize a design by addressing desired qualities within criteria and constraints.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☐	☑	☑	☐	☑	☐	☐	☐	☑	☑

STEL-7BB

Implement the best possible solution to a design.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☐	☐	☑	☐	☑	☐	☐	☑	☑	☑

STEL-7CC

Apply a broad range of design skills to their design process.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☐	☐	☑	☐	☑	☐	☑	☑	☑	☑

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STEL-7DD

Apply a broad range of making skills to their design process.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☑	☐	☑	☑	☐	☑	☐	☑	☑	☑	☑

STEL 8 Applying, Maintaining, and Assessing Technological Products and Systems

STEL-8N

Use various approaches to communicate processes and procedures for using, maintaining, and assessing technological products and systems.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☐	☑	☑	☐	☑	☐	☑	☑	☑	☑

STEL-8O

Develop a device or system for the marketplace.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☐	☐	☑	☑	☐	☐	☑	☑	☑	☑	☑

STEL-8P

Apply appropriate methods to diagnose, adjust and repair systems to ensure precise, safe and proper functionality.

1.1	1.2	2.1	2.2	2.3	2.4	3.1	3.2	3.3	4.1	4.2
☑	☑	☑	☑	☐	☑	☑	☑	☑	☑	☑

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References

International Technology and Engineering Educators Association. (2020). *Standards for technological and engineering literacy: The role of technology and engineering in STEM education*. Retrieved from https://www.iteea.org/STEL.aspx

National Governors Association Center for Best Practices, & Council of Chief State School Officers. (2010). *Common Core State Standards*. Washington, DC: National Governors Association Center for Best Practices, Council of Chief State School Officers. Retrieved from http://www.corestandards.org/read-the-standards/

Next Generation Science Standards: For States, By States. (2019). *Read the Standards*. Retrieved from https://www.nextgenscience.org/search-standards

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