PLANNED INSTRUCTION

A PLANNED COURSE FOR:

Engineering 4: PLTW Capstone

Curriculum writing committee:
Robert Curtis

Grade Level:
12

Date of Board Approval: ____________________

Course Weighting: Engineering 4: PLTW Capstone

Major Assessments	**45%**
Skills Application	**30%**
Skills Practice	**20%**
Participation	**5%**
Total	**100%**

Curriculum Map

Overview:
PLTW Capstone is a capstone course for students who are completing any of PLTW's high school programs. It is an open-ended research course in which students work in teams to design and develop an original solution to a well-defined and justified open-ended problem.

Teams draw on the knowledge, skills, and interests of each member, as they perform research to select, define, and justify a problem. Given this collaboration, team members leave the course with a broadened skillset and an appreciation for learning from their peers. After carefully defining the design requirements and creating multiple solution approaches, student teams select an approach, create, and test or model their solution prototype. As they progress through the problem-solving process, students work closely with experts and continually hone their organizational, communication, and interpersonal skills, creative and problem-solving abilities, and their understanding of the integration of processes such as the design process, experimental design, and the software development process. At the conclusion of the course, teams present and defend their original solution to an outside panel.

PLTW Capstone is appropriate for 12th grade students who are interested in any technical career path because the projects students work on can vary with student interest, and the curriculum focuses on collaborative problem solving and project management. Students should take PLTW Capstone as the final PLTW course, because it requires application of the knowledge and skills introduced during the PLTW foundation courses. This course is not designed to teach additional content, but to empower students to find resources—mentors, subject matter experts, research articles, peers, and teachers—to meet their needs, bolster their skills, and solve the problem they have selected.

Time/Credit for the Course: One full year, meeting daily for ~46 minutes / 1 elective credit

Goals:

1. **Marking Period One: Over a 45-day period, students will aim to understand:**

   Component 1: The Capstone Journey
   - What is PLTW Capstone? (1 days)
   - Mini Design Project (5 days)

   Component 2: Problem Validation
   - Element A: Identification and Justification of the Problem (15 days)
     - A.1 Developing a Problem Statement
     - A.2 Brainstorming a Topic
     - A.3 Beginning Research
     - A.4 Choosing a Problem
     - A.5 Academic Research
     - A.6 Marketplace Research
   - Element B: Documentation and Analysis of Previous Solution Attempts (5 days)
     - B.1 Previous Solution Attempts
   - Element C: Presentation and Justification of Solution Requirements (19 days)
     - C.1 Design Specifications
     - C.2 Project Proposal

2. **Marking Period Two: Over a 45-day period, students will aim to understand:**

   Component 3: Solution Design
   - Element D: Design Concepts Generation, Analysis, and Selection (15 days)
     - D.1 Concept Development
     - D.2 Concept Analysis
     - D.3 Solution Selection
     - D.4 Design Documentation
   - Element E: Application of STEM Principles and Practices (2 days)
     - E.1 STEM Career Investigation
   - Element F: Consideration of Design Viability (8 days)
     - F.1 Design Viability
     - F.2 Preliminary Design Review

   Component 4: Prototyping and Testing
   - Element G: Construction of a Testable Prototype (25 days)
     - G.1 Prototype Materials Planning
     - G.2 Incremental Testing Planning

3. **Marking Period Three: Over a 45-day period, students will aim to understand:**

   Component 4: Prototyping and Testing (continued)
   - Element G: Construction of a Testable Prototype (continued) (20 days)
     - G.3 Build the Prototype
   - Element H: Prototype Testing and Data Collection Plan (20 days)
     - H.1 Testing Criteria
     - H.2 Testing Plan
   - Element I: Testing, Data Collection, and Analysis (5 days)
     - I.1 Test and Evaluate the Prototype
     - I.2 Critical Design Review
     - I.3 Refine the Design

4. **Marking Period Four: Over a 45-day period, students will aim to understand:**

   Component 5: Project and Process Evaluation
   - Element J: Documentation of External Evaluation (10 days)
     - J.1 External Evaluation
   - Element K: Reflection on the Design Project (10 days)
     - K.1 Personal Evaluation
   - Element L: Presentation of the Designer's Recommendation (10 days)
     - L.1 Recommendations

   Component 6: Design Presentation
   - Element M: Presentation of Project Portfolio (5 days)
     - M.1 Notebook and Portfolio Review
     - M.2 Presentation Preparation
     - M.3 Presentation and Evaluation
   - Element N: Technical Communication (10 days)
     - N.1 Final Portfolio Evaluation

Textbook and Supplemental Resources:

my.pltw.org website: the source for all elements and activities

Curriculum Plan

Please refer to the following Course Outline, Course Resume, and Unit Frameworks for the curriculum plan.

The knowledge and skills students acquire throughout PLTW high school courses in computer science, engineering, and biomedical science come together in PLTW Capstone as student teams pool resources to identify an issue or problem of interest and then research, design, and test a solution, ultimately presenting their solution to a panel of professionals. Students work with their team, drawing on the strengths and skills of each member, as they prepare themselves for the interdisciplinary collaboration required for success in college and career.

PLTW Capstone is a capstone course for students who are completing any of PLTW's high school programs. It is an open-ended research course in which students work in teams to design and develop an original solution to a well-defined and justified open-ended problem.

Teams draw on the knowledge, skills, and interests of each member, as they perform research to select, define, and justify a problem. Given this collaboration, team members leave the course with a broadened skillset and an appreciation for learning from their peers. After carefully defining the design requirements and creating multiple solution approaches, student teams select an approach, create, and test or model their solution prototype. As they progress through the problem-solving process, students work closely with experts and continually hone their organizational, communication, and interpersonal skills, creative and problem-solving abilities, and their understanding of the integration of processes such as the design process, experimental design, and the software development process. At the conclusion of the course, teams present and defend their original solution to an outside panel.

PLTW Capstone is appropriate for 12th grade students who are interested in any technical career path because the projects students work on can vary with student interest, and the curriculum focuses on collaborative problem solving and project management. Students should take PLTW Capstone as the final PLTW course, because it requires application of the knowledge and skills introduced during the PLTW foundation courses. This course is not designed to teach additional content, but to empower students to find resources—mentors, subject matter experts, research articles, peers, and teachers—to meet their needs, bolster their skills, and solve the problem they have selected.

Common Capstone Course Subjects/Subject Areas

Innovation and Problem-solving

- Design Process
- Experimental Design
- Software Development Process
- Project Management
- Professional Documentation
- Technical Writing
- Ethical Reasoning
- Teamwork and Collaboration

Independent Problem Design and Execution

- Problem Identification and Justification
- Research
- Identification of Design Requirements
- Project Proposal
- Design, Prototyping, and Testing
- Design Review
- Presentation of the Process and Results

PLTW Capstone Course Structure

The structure of PLTW Capstone is aligned to the Engineering Design Process Portfolio Rubric. Students in this course are encouraged to format their portfolio according to the Components and Elements defined within that rubric.

Component 1. The Capstone Journey
This component introduces the course, provides a brief overview of the process to identify and solve an open-ended problem, and highlights a wealth of resources students will refer to as they progress through the year. Students review the elements of design and processes that assist with problem-solving. They explore tools of project management and learn how to organize their work in a course binder and portfolio. Students discover resources to help them network with industry professionals regarding their research and design, as well as how to build and present a professional presentation. As the culmination of this component, students have a chance to get to know their peers and collaborate across disciplines as they complete a mini design project.

Component 2. Problem Validation
This component requires students to identify a problem for which they will design a solution during the rest of the course. In the first lesson, students write a clear problem statement and validate the problem by documenting credible sources that indicate that the problem exists. Validation is carried out through research and input from experts and mentors. After their work is defined, students justify the problem with additional research to confirm that the expense and effort involved with solving the problem are warranted. Students will explore and analyze previous solution attempts. Based on their research, students create a testable design requirement, which they will use to explore possible solutions. Students will present a project proposal to ensure that the project is justified and they have explored all prior solution attempts.

- Element A. Identification and Justification of the Problem
- Element B. Documentation and Analysis of Previous Solution Attempts
- Element C. Presentation and Justification of Solution Requirements

Component 3. Solution Design
Based on the design requirements identified through research, students develop multiple solution possibilities. Through an evaluation process that involves feedback from experts and stakeholders and the application of a decision matrix or data-driven process, students select the best potential solution to pursue. Students will refine the final solution path and provide evidence that the selected solution is viable.

- Element D. Design Concept Generation, Analysis, and Selection
- Element E. Application of STEM Principles and Practices
- Element F. Consideration of Design Viability

Component 4. Prototyping and Testing
Students create a physical or virtual, testable prototype or model. To determine the effectiveness of the solution created, students devise an unbiased testing plan based on the defined design requirements.

- Element G. Construction of a Testable Prototype
- Element H. Prototype Testing and Data Collection Plan
- Element I. Testing, Data Collection, and Analysis

Component 5. Project and Process Evaluation
At this point in the design process, it is critical to seek and document feedback from all stakeholders. The student designers reflect on all design decisions and the analysis that was generated from the testing process. Then, the designers can begin to formulate next steps.

- Element J. Documentation of External Evaluation
- Element K. Reflection on the Design Project
- Element L. Presentation of Designers' Recommendations

Component 6. Design Presentation
At the conclusion of the design process, students present and defend their process and decision.

- Element M. Presentation of the Project and Project Portfolio
- Element N. Technical Communication

Component 7. Beyond Common Capstone
After completing design work, students explore resources related to college and career readiness and success. Student opportunities include competitions, scholarships, university admission, and interest from business representatives to further develop the ideas created in PLTW Capstone classrooms.

Course resumes showcase the technical skills students gain in PLTW courses. A resume outlines the computational skills, analytical skills, and knowledge that students acquire in a specific course. Course resumes also detail student experience with tools, software, lab work, and design. The detailed skills presented in course resumes illustrate the immediate contributions that students can make in a workplace as a result of their participation in the course.

This course resume highlights the PLTW Capstone course. The following lists detail knowledge and skills in computer science, engineering, and biomedical science, that each student experiences in the course. The innovation and problem-solving experience and course knowledge gained varies depending on the problem that each student (or team of students) chooses to address.

Problem-Solving Experience
Through designing a solution for an open-ended problem, students will can:

- Exhibit professional skills to successfully contribute to work in a team
- Determine how to proceed through possible alternate routes of design
- Solve a problem using a design process, experimental design, and/or a software development process
- Document in detail the process used to solve a problem or design a product
- Create a detailed and comprehensive design brief

Transportable Skills
Through design and innovation in teams with varying levels of knowledge and skills in engineering, biomedical science, and computer science, students practice:

- Team collaboration
- Project management
- Effective research
- Problem-solving
- Communication skills
- Presentation skills
- Technical writing
- Ethical reasoning

Tools and Software
Depending on the problem chosen and the solution paths explored, students may use:

- Microsoft® Office (Excel®, Word, PowerPoint®)
- 3D solid modeling software
- Variety of measuring devices
- Laboratory equipment
- Vernier® Graphical Analysis 4 data collection software and wireless sensors/probes
- MIT App Inventor
- Visual Studio Code
- Python
- Java

Course Knowledge

Through the problem-solving process, students gain an understanding of:

- Careers
- STEM careers
- Innovation and Design
- Defining a problem
- Completing effective research
- Developing and vetting solutions
- Constructing and testing a prototype or model
- Evaluating a solution
- Presenting design findings
- Application of STEM principles and practices
- Technical sketching and drawing
- Modeling
- Computational and analytical skills
- Experimental design
- Measurement

PLTW Capstone Framework

PLTW Framework - Overview

PLTW Component Frameworks provide an overview of the levels of understanding that each build upon the higher level: 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.

Component 1

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 employe

Design Process - A design process is an iterative, systematic approach to problem solving.

DPR.A Explain and justify a design process.

- DPR.A.1 Explain that there are many versions of a design process that describe essentially the same process.
- DPR.A.2 Describe major steps of a design process and identify typical tasks involved in each step.
- DPR.A.3 Identify the step in which a task would fit in a design process.
- DPR.A.4 Outline how iterative processes inform decisions, improve solutions, and inspire new ideas.
- DPR.A.5 Document a design process in a notebook according to best practices.

DPR.B Collect, analyze, and interpret information relevant to the problem or opportunity at hand to support scientific decisions.

- DPR.B.1 Explain the role of research in the process of design.
- DPR.B.2 Find relevant data in credible sources such as literature, databases, and policy documents.
- DPR.B.3 Explain the role of stakeholders and subject matter experts in the design process.
- DPR.B.4 Describe criteria for determining the reliability and credibility of information.

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

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

- DPR.C.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.

DPR.D Generate multiple potential solution concepts.

- DPR.D.1 Describe multiple techniques and appropriate guidelines used to generate ideas.

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

- DPR.E.1 Describe the use of a model to accurately represent the key aspects of a physical system. Include the identification of constraints, such as cost, time, or expertise that may influence the selection of a model.
- DPR.E.2 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.

DPR.F Select a solution path from many options to successfully address a problem or opportunity.

- DPR.F.1 Explain that there are often multiple viable solutions and no obvious best solution. Trade-offs must be considered and evaluated consistently throughout a design process.
- DPR.F.2 Develop and carry out a justifiable scheme to compare and evaluate competing solutions paths. A decision matrix is one tool used to compare and evaluate competing solutions based on design criteria.

DPR.G Make judgments and decisions based on evidence.

- DPR.G.2 Evaluate evidence and arguments to identify deficiencies, limitations, and biases or appropriate next steps in the pursuit of a better solution.

Innovative Mindset - Successful innovators typically exhibit specific personal and professional characteristics that lend themselves to the creative, collaborative, and solution-driven nature of the profession.

IMI.A Demonstrate independent thinking and self-direction in pursuit of accomplishing a goal.

- IMI.A.1 List and prioritize goals with tangible success criteria.
- IMI.A.2 Plan and use time in pursuit of accomplishing a goal without direct oversight.
- IMI.A.3 Plan how to gain additional knowledge and learning to accomplish a goal.

IMI.B Demonstrate flexibility and adaptability to change.

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

IMI.C Persevere to solve a problem or achieve a goal.

- IMI.C.1 Describe why persistence is important when identifying a problem and/or pursuing solutions.
- IMI.C.2 Accept failure as part of an evolution of individual growth and necessary to the expansion of a profession.

IMI.C.3 Reflect critically on past experiences to inform future progress.

Professional Practices and Communication - Professional practice is guided by professional ethics and standards and requires effective communication and collaboration.

Communication - 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).

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

COM.A.3 Describe how the size and characteristics of an audience will affect communication.

COM.A.4 Modify the content, format, level of technical detail, and length of communications to meet the needs of the audience.

COM.A.5 Properly cite references for all communication in an accepted format.

COM.A.6 Clearly label tables and figures with units and explain the information presented in context.

COM.A.7 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.

Collaboration - 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.

COL.B Contribute individually to overall collaborative efforts.

COL.B.1 Critically and realistically self-evaluate personal contributions and collaboration effectiveness within a team.

COL.C Analyze and evaluate the work of others to provide helpful and effective feedback.

COL.C.2 Describe the characteristics of effective feedback.

COL.D Manage project timelines and resources as part of a design process.

COL.D.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.

COL.D.3 Select and use a system of collaborative tools, such as cloud-based tools, document sharing, and video and text functions, to successfully complete a project.

PLTW Capstone Framework

PLTW

PLTW Framework - Overview

PLTW Component Frameworks provide an overview of the levels of understanding that each build upon the higher level: 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.

Component 2

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 employe

Design Process - A design process is an iterative, systematic approach to problem solving.

- DPR.A Explain and justify a design process.
  - DPR.A.4 Outline how iterative processes inform decisions, improve solutions, and inspire new ideas.
  - DPR.A.5 Document a design process in a notebook according to best practices.
- DPR.B Collect, analyze, and interpret information relevant to the problem or opportunity at hand to support scientific decisions.
  - DPR.B.1 Explain the role of research in the process of design.
  - DPR.B.2 Find relevant data in credible sources such as literature, databases, and policy documents.
  - DPR.B.4 Describe criteria for determining the reliability and credibility of information.
- DPR.C Synthesize an ill-formed problem into a meaningful, well-defined problem.
  - DPR.C.1 Explain the importance of carefully and specifically defining a problem or opportunity, design criteria, and constraints, to develop successful design solutions.
  - DPR.C.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.
- DPR.D Generate multiple potential solution concepts.
  - DPR.D.2 Represent concepts using a variety of visual tools, such as sketches, graphs, and charts, to communicate details of an idea.

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

DPR.E.1 Describe the use of a model to accurately represent the key aspects of a physical system. Include the identification of constraints, such as cost, time, or expertise that may influence the selection of a model.

DPR.E.2 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.

DPR.F Select a solution path from many options to successfully address a problem or opportunity.

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

DPR.F.2 Develop and carry out a justifiable scheme to compare and evaluate competing solutions paths. A decision matrix is one tool used to compare and evaluate competing solutions based on design criteria.

Innovative Mindset - Successful innovators typically exhibit specific personal and professional characteristics that lend themselves to the creative, collaborative, and solution-driven nature of the profession.

IMI.A Demonstrate independent thinking and self-direction in pursuit of accomplishing a goal.

IMI.A.1 List and prioritize goals with tangible success criteria.

IMI.A.2 Plan and use time in pursuit of accomplishing a goal without direct oversight.

IMI.C Persevere to solve a problem or achieve a goal.

IMI.C.2 Accept failure as part of an evolution of individual growth and necessary to the expansion of a profession.

IMI.C.3 Reflect critically on past experiences to inform future progress.

Professional Practices and Communication - Professional practice is guided by professional ethics and standards and requires effective communication and collaboration.

Communication - 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).

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

COM.A.3 Describe how the size and characteristics of an audience will affect communication.

COM.A.4 Modify the content, format, level of technical detail, and length of communications to meet the needs of the audience.

COM.A.5 Properly cite references for all communication in an accepted format.

COM.A.6 Clearly label tables and figures with units and explain the information presented in context.

COM.A.7 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.

Collaboration - Demonstrate an ability to function on multidisciplinary teams.

COL.D Manage project timelines and resources as part of a design process.

COL.D.3 Select and use a system of collaborative tools, such as cloud-based tools, document sharing, and video and text functions, to successfully complete a project.

PLTW Capstone Framework

PLTW Framework - Overview

PLTW Component Frameworks provide an overview of the levels of understanding that each build upon the higher level: 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.

Component 3

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 employe

Design Process - A design process is an iterative, systematic approach to problem solving.

- DPR.A Explain and justify a design process.
  - DPR.A.4 Outline how iterative processes inform decisions, improve solutions, and inspire new ideas.
  - DPR.A.5 Document a design process in a notebook according to best practices.
- DPR.C Synthesize an ill-formed problem into a meaningful, well-defined problem.
  - DPR.C.1 Explain the importance of carefully and specifically defining a problem or opportunity, design criteria, and constraints, to develop successful design solutions.
  - DPR.C.2 Identify and define visual, functional, and structural design requirements with realistic constraints, against which solution alternatives can be evaluated.
- DPR.D Generate multiple potential solution concepts.
  - DPR.D.2 Represent concepts using a variety of visual tools, such as sketches, graphs, and charts, to communicate details of an idea.
- DPR.E Develop models to represent design alternatives and generate data to inform decision making, test alternatives, and demonstrate solutions.
  - DPR.E.1 Describe the use of a model to accurately represent the key aspects of a physical system. Include the identification of constraints, such as cost, time, or expertise that may influence the selection of a model.
  - DPR.E.2 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.

DPR.F Select a solution path from many options to successfully address a problem or opportunity.

DPR.F.2 Develop and carry out a justifiable scheme to compare and evaluate competing solutions paths. A decision matrix is one tool used to compare and evaluate competing solutions based on design criteria.

DPR.G Make judgments and decisions based on evidence.

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

DPR.G.2 Evaluate evidence and arguments to identify deficiencies, limitations, and biases or appropriate next steps in the pursuit of a better solution.

Innovative Mindset - Successful innovators typically exhibit specific personal and professional characteristics that lend themselves to the creative, collaborative, and solution-driven nature of the profession.

IMI.A Demonstrate independent thinking and self-direction in pursuit of accomplishing a goal.

IMI.A.1 List and prioritize goals with tangible success criteria.

IMI.A.2 Plan and use time in pursuit of accomplishing a goal without direct oversight.

IMI.A.3 Plan how to gain additional knowledge and learning to accomplish a goal.

IMI.C Persevere to solve a problem or achieve a goal.

IMI.C.3 Reflect critically on past experiences to inform future progress.

Professional Practices and Communication - Professional practice is guided by professional ethics and standards and requires effective communication and collaboration.

Communication - 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).

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

COM.A.3 Describe how the size and characteristics of an audience will affect communication.

COM.A.4 Modify the content, format, level of technical detail, and length of communications to meet the needs of the audience.

COM.A.5 Properly cite references for all communication in an accepted format.

COM.A.6 Clearly label tables and figures with units and explain the information presented in context.

COM.A.7 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.

Competencies, Domains, Objectives, Knowledge and Skills

Collaboration - Demonstrate an ability to function on multidisciplinary teams.

COL.D Manage project timelines and resources as part of a design process.

COL.D.3 Select and use a system of collaborative tools, such as cloud-based tools, document sharing, and video and text functions, to successfully complete a project.

PLTW Capstone Framework

PLTW Framework - Overview

PLTW Component Frameworks provide an overview of the levels of understanding that each build upon the higher level: 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.

Component 4

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 employe

Engineering Tools and Technology - 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.
  - ETT.A.2 Explain and differentiate between the accuracy and precision of a measurement or measuring device.
  - 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.
- ETT.B Interpret and analyze data for a single count or measurement variable.
  - ETT.B.1 Represent data for a single count or measurement with plots on the real number line, for example dot plots, histograms, and box plots.
  - ETT.B.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.
  - ETT.B.3 Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate.
- ETT.C Apply mathematical (including graphical) models and interpret the output of models to test ideas or make predictions.
  - ETT.C.1 Represent data for two quantitative variables on a scatter plot, and describe how the variables are related.
  - ETT.C.2 Fit a function to the data; use functions fitted to data to solve problems in the context of the data, especially linear, quadratic, and exponential functions.

ETT.C.3 In linear models, interpret the rate of change (slope) and the intercept (constant term) in the context of the data.

ETT.C.4 Distinguish between sample statistics and population statistics and know appropriate applications of each.

Design Process - A design process is an iterative, systematic approach to problem solving.

DPR.A Explain and justify a design process.

DPR.A.4 Outline how iterative processes inform decisions, improve solutions, and inspire new ideas.

DPR.A.5 Document a design process in a notebook according to best practices.

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

DPR.E.1 Describe the use of a model to accurately represent the key aspects of a physical system. Include the identification of constraints, such as cost, time, or expertise that may influence the selection of a model.

DPR.E.2 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.

Innovative Mindset - Successful innovators typically exhibit specific personal and professional characteristics that lend themselves to the creative, collaborative, and solution-driven nature of the profession.

IMI.A Demonstrate independent thinking and self-direction in pursuit of accomplishing a goal.

IMI.A.2 Plan and use time in pursuit of accomplishing a goal without direct oversight.

IMI.B Demonstrate flexibility and adaptability to change.

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

IMI.C Persevere to solve a problem or achieve a goal.

IMI.C.2 Accept failure as part of an evolution of individual growth and necessary to the expansion of a profession.

IMI.C.3 Reflect critically on past experiences to inform future progress.

Professional Practices and Communication - Professional practice is guided by professional ethics and standards and requires effective communication and collaboration.

Communication - 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).

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

COM.A.5 Properly cite references for all communication in an accepted format.

COM.A.6 Clearly label tables and figures with units and explain the information presented in context.

COM.A.7 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.

Collaboration - Demonstrate an ability to function on multidisciplinary teams.

COL.D Manage project timelines and resources as part of a design process.

COL.D.3 Select and use a system of collaborative tools, such as cloud-based tools, document sharing, and video and text functions, to successfully complete a project.

PLTW Capstone Framework

PLTW Framework - Overview

PLTW Component Frameworks provide an overview of the levels of understanding that each build upon the higher level: 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.

Component 5

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 employe

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

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

ETT.B.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.

Design Process - A design process is an iterative, systematic approach to problem solving.

DPR.A Explain and justify a design process.

DPR.A.1 Explain that there are many versions of a design process that describe essentially the same process.

DPR.A.4 Outline how iterative processes inform decisions, improve solutions, and inspire new ideas.

DPR.A.5 Document a design process in a notebook according to best practices.

DPR.G Make judgments and decisions based on evidence.

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

Innovative Mindset - Successful innovators typically exhibit specific personal and professional characteristics that lend themselves to the creative, collaborative, and solution-driven nature of the profession.

IMI.A Demonstrate independent thinking and self-direction in pursuit of accomplishing a goal.

IMI.A.2 Plan and use time in pursuit of accomplishing a goal without direct oversight.

IMI.A.3 Plan how to gain additional knowledge and learning to accomplish a goal.

IMI.B Demonstrate flexibility and adaptability to change.

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

IMI.C Persevere to solve a problem or achieve a goal.

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

IMI.C.2 Accept failure as part of an evolution of individual growth and necessary to the expansion of a profession.

IMI.C.3 Reflect critically on past experiences to inform future progress.

Professional Practices and Communication - Professional practice is guided by professional ethics and standards and requires effective communication and collaboration.

Communication - 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).

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

COM.A.3 Describe how the size and characteristics of an audience will affect communication.

COM.A.4 Modify the content, format, level of technical detail, and length of communications to meet the needs of the audience.

COM.A.5 Properly cite references for all communication in an accepted format.

COM.A.6 Clearly label tables and figures with units and explain the information presented in context.

COM.A.7 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.

Collaboration - Demonstrate an ability to function on multidisciplinary teams.

COL.B Contribute individually to overall collaborative efforts.

COL.B.1 Critically and realistically self-evaluate personal contributions and collaboration effectiveness within a team.

COL.C Analyze and evaluate the work of others to provide helpful and effective feedback.

COL.C.1 Describe the purpose and positive outcomes of a peer review process.

COL.C.2 Describe the characteristics of effective feedback.

COL.D Manage project timelines and resources as part of a design process.

COL.D.2 Develop a project plan using a project planning tool such as a Gantt chart.

COL.D.3 Select and use a system of collaborative tools, such as cloud-based tools, document sharing, and video and text functions, to successfully complete a project.

PLTW Capstone Framework

PLTW Framework - Overview

PLTW Component Frameworks provide an overview of the levels of understanding that each build upon the higher level: 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.

Component 6

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 employe

Design Process - A design process is an iterative, systematic approach to problem solving.

DPR.A Explain and justify a design process.

DPR.A.4 Outline how iterative processes inform decisions, improve solutions, and inspire new ideas.

DPR.A.5 Document a design process in a notebook according to best practices.

DPR.G Make judgments and decisions based on evidence.

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

DPR.G.2 Evaluate evidence and arguments to identify deficiencies, limitations, and biases or appropriate next steps in the pursuit of a better solution.

Innovative Mindset - Successful innovators typically exhibit specific personal and professional characteristics that lend themselves to the creative, collaborative, and solution-driven nature of the profession.

IMI.A Demonstrate independent thinking and self-direction in pursuit of accomplishing a goal.

IMI.A.2 Plan and use time in pursuit of accomplishing a goal without direct oversight.

IMI.A.3 Plan how to gain additional knowledge and learning to accomplish a goal.

IMI.C Persevere to solve a problem or achieve a goal.

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

IMI.C.3 Reflect critically on past experiences to inform future progress.

Competencies, Domains, Objectives, Knowledge and Skills

Professional Practices and Communication - Professional practice is guided by professional ethics and standards and requires effective communication and collaboration.

Communication - 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).

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

COM.A.5 Properly cite references for all communication in an accepted format.

COM.A.7 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.

Collaboration - Demonstrate an ability to function on multidisciplinary teams.

COL.B Contribute individually to overall collaborative efforts.

COL.B.1 Critically and realistically self-evaluate personal contributions and collaboration effectiveness within a team.

COL.C Analyze and evaluate the work of others to provide helpful and effective feedback.

COL.C.1 Describe the purpose and positive outcomes of a peer review process.

COL.C.2 Describe the characteristics of effective feedback.

COL.D Manage project timelines and resources as part of a design process.

COL.D.3 Select and use a system of collaborative tools, such as cloud-based tools, document sharing, and video and text functions, to successfully complete a project.