Engineering Analysis and Applications II

8451 36 weeks

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Course Description

Suggested Grade Level: 10 or 11 or 12
Prerequisites: 8450

Engineering Analysis and Applications II is the second of a possible four-course sequence that will allow students to apply the engineering design process to areas of the designed world, explore ethics in a technological world, and examine engineering systems. Students will

participate in STEM-based, hands-on projects as they communicate information through team-based presentations, proposals, and technical reports.

Task Essentials Table

- Tasks/competencies designated by plus icons (⊕) in the left-hand column(s) are essential
- Tasks/competencies designated by empty-circle icons (○) are optional
- Tasks/competencies designated by minus icons (⊖) are omitted
- Tasks marked with an asterisk (*) are sensitive.

Task Number	8451	Tasks/Competencies
Exploring Engineering Systems as Applied to Areas of the Designed World		
39	⊕	Define *designed world*.
40	⊕	Describe major engineering disciplines.
41	⊕	Analyze the interdisciplinary nature of engineering projects.
42	⊕	Integrate the parts of a project.
43	⊕	Identify the impact of a design solution on industry, economy, society, and environment.
Applying the Engineering Design Process		
44	⊕	Identify the need for a product or system.
45	⊕	Explain the validity of designing alternative solutions to an engineering design problem.
46	⊕	Design an engineering solution to a real-world problem for each of the areas in the designed world.
47	⊕	Implement a design.
48	⊕	Iterate on the solution.
49	⊕	Maintain documentation (e.g., sketches, notes, reports).
50	⊕	Present a solution.
Using Logic and Problem-Solving Techniques		

51	⊕	Reverse-engineer a product, process, or idea.	
52	⊕	Define *algorithm*.	
53	⊕	Create an algorithm to solve an engineering problem.	
54	⊕	Explain the benefits of modeling and simulation.	
55	⊕	Create a model or simulation for an engineering product, process, or idea.	
Examining Engineering Materials and Manufacturing			
56	⊕	Demonstrate lab safety.	
57	⊕	Describe hazards associated with machines and tools.	
58	⊕	List common engineering materials and common applications of each.	
59	⊕	Describe properties of engineering materials in terms of their internal structures.	
60	⊕	Identify the correct engineering material for a specific function.	
761	⊕	List common causes of material failure.	
62	⊕	Demonstrate processes used with metal, wood, polymer, ceramic, and composite materials, including adhesives.	
63	⊕	Identify common hand tools and fasteners.	
Examining Engineering Systems			
64	⊕	Explore electrical systems.	
65	⊕	Explain primary concepts and components of a fluid power system.	
66	⊕	Identify the primary concepts and components of thermodynamic systems.	
67	⊕	Identify the primary concepts and components of mechanical systems.	
68	⊕	Demonstrate control of systems.	
69	⊕	Design a system that transforms energy from one type to another.	

Legend: ⊕Essential ○Non-essential ⊖Omitted

Curriculum Framework

Exploring Engineering Systems as Applied to Areas of the Designed World

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Task Number 39

Define *designed world*.

Definition

Definition should include

- manufacturing technologies
- construction technologies
- energy and power technologies
- information and communications technologies
- agriculture and related biotechnologies
- medical technologies
- transportation technologies.

Process/Skill Questions

- What problems in the world does engineering not address?
- What problems in the world does engineering address?
- How can engineering improve the lives of people in third-world countries?
- What are the major challenges for engineering?

Task Number 40

Describe major engineering disciplines.

Definition

Description should include

- aerospace
- biomedical

- bioengineering
- civil
- environmental
- computer engineering
- chemical
- materials engineering
- mechanical
- electrical
- systems
- fire protection and safety.

Process/Skill Questions

- What are some of the tasks that these engineers would perform in their daily work lives?
- What skills are common across all specializations?
- What specializations overlap?
- What kind of educational attainment should the engineers from these disciplines have?
- What are the trade organizations for these disciplines?
- To what principles or cannons do engineers adhere?
- What are the main ethical considerations of these disciplines?

Task Number 41

Analyze the interdisciplinary nature of engineering projects.

Definition

Analysis should include

- identifying disciplines and skills necessary to complete a full project
- applying skills to real-world problems
- using suggested case studies.

Process/Skill Questions

- How do the different engineering disciplines work together?
- What does it mean to be multi-disciplinary or interdisciplinary?
- What non-engineering disciplines are used in engineering?
- How does one use case studies in engineering?
- What specific sub-disciplines or topics within the identified disciplines are involved?

Task Number 42

Integrate the parts of a project.

Definition

Integration should include

- resources (e.g., people, information, energy, capital, time, materials, tools)
- overall systems plan for efficient use of resources
- overall systems plan for effective communication between disciplines and customer.

Process/Skill Questions

- What is integration?
- Why is it important to integrate all parts of a project?
- How do different parts of a project work together?
- What is a visual representation of the design process that shows all aspects of the project (resources, efficiency, and communication)?

Task Number 43

Identify the impact of a design solution on industry, economy, society, and environment.

Definition

Identification should include a hypotheses of planned, unplanned, positive, and negative impacts and should be supported by documentation, data, and research.

Process/Skill Questions

- Who might be an unintended stakeholder in an engineering project?
- What are positive outcomes?
- What are negative outcomes?

Applying the Engineering Design Process

Task Number 44

Identify the need for a product or system.

Definition

Identification should include

- identifying the need or opportunity for an engineering solution
- defining an engineering design problem
- identifying the requirement and constraints of the design problem.

Process/Skill Questions

- Why is it important to have a clear definition of the problem before attempting to solve it?
- How can an engineering design problem be stated succinctly?
- How is an engineering design brief used in an engineering design process?
- How can a new product be designed to be functional, sustainable, and environmentally friendly?

Task Number 45

Explain the validity of designing alternative solutions to an engineering design problem.

Definition

Explanation should include the

- reason multiple solutions are possible and encouraged
- benefits of exploring alternative solutions (one correct answer/process vs. multiple answers/processes).

Process/Skill Questions

- What are the benefits of generating multiple solutions?
- What is brainstorming? What are its steps?
- How does one develop criteria and benchmarks for the engineering design problem?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Processes

13. Assess the Impact of Products and Systems

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Animatronics

Architectural Design

Biotechnology Design

Dragster Design

Engineering Design

Flight Endurance

System Control Technology

Transportation Modeling

Video Game Design

Task Number 46

Design an engineering solution to a real-world problem for each of the areas in the designed world.

Definition

Design should include

- researching potential solutions
- brainstorming multiple solutions
- sketching the solutions
- evaluating the design against the requirements and constraints
- justifying an optimal solution
- explaining some of the mathematical analysis that would need to be done for a realistic solution
- developing ergonomics for user interaction.

Process/Skill Questions

- How does one demonstrate collaborative performance in designing a solution?
- How does one create a visualization for the design process and maintain accurate records of follow-through?
- How does one demonstrate decision-making and iterative approach in designing the solution?
- What is one product in each area of the designed world that has had positive consequences?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Processes

15. Agricultural and Related Biotechnologies

16. Energy and Power Technologies

17. Information and Communication Technologies

18. Transportation Technologies

19. Manufacturing Technologies

20. Construction Technologies

TSA Competitive Events

Animatronics

Architectural Design

Biotechnology Design

Dragster Design

Engineering Design

System Control Technology

Transportation Modeling

Video Game Design

Webmaster

Task Number 47

Implement a design.

Definition

Implementation should include

- creating a model or prototype for the chosen solution to the design problem, using appropriate materials and processes
- determining the objectives for an engineering test of the solution to the design problem
- testing the solution to the design problem, using mathematical, conceptual, and/or physical modeling, simulating, and optimizing
- evaluating the test results.

Process/Skill Questions

- What factors contribute to selection of a model type?
- What constraints should one consider when selecting a model type?
- How does one determine which model type will produce the most robust solution?
- How can one create a mathematical model from the techniques available?
- Why is a plan for a model needed before one begins construction?
- What characteristics or properties of a material are desirable for product function (vary by project)?

Task Number 48

Iterate on the solution.

Definition

Iteration should include

- formulating an alternative solution
- iterating on a design
- testing the alternative solution
- documenting the final project report
- identify areas needing improvement.

Process/Skill Questions

- Why should you revisit the solutions proposed in the brainstorming step when formulating an alternate solution to the problem?
- How might the data you acquired in the test impact the formulation of an alternate solution?
- What factors might help you to justify the alternate solution as optimal?
- What should be recorded in an engineering log or journal?

Task Number 49

Maintain documentation (e.g., sketches, notes, reports).

Definition

Maintenance should include

- collecting documents, files, and project data that contain information to record performance
- providing a record of progress and self-assessment
- keeping an up-to-date work log or journal
- maintaining a design notebook or portfolio project binder/project file.

Process/Skill Questions

- How does the role of documentation change depending on the engineering project?
- Why is a journal important for engineering projects?
- What makes for good documentation?
- Why is it important to document ideas that are not selected?

Task Number 50

Present a solution.

Definition

Presentation should use multimedia elements and include

- introduction, thorough presentation of points, and a conclusion
- persuasive tone and strategy
- realistic/practical approach to the solution
- display of proficient communications skills, professional demeanor, and confidence
- purpose of demonstration and simulations.

Process/Skill Questions

- What are the benefits of incorporating graphical and/or visual representations of one's solution into one's presentation?
- What makes a presentation effective and persuasive?
- How can the quality of one's presentation affect the acceptance of one's solution?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Processes

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Animatronics

Architectural Design

Dragster Design

Engineering Design

Flight Endurance

Geospatial Technology (Virginia only)

System Control Technology

Transportation Modeling

Video Game Design

Using Logic and Problem-Solving Techniques

Task Number 51

Reverse-engineer a product, process, or idea.

Definition

Reverse engineering should include

- analyzing the product (e.g., determining its intended application)
- working backward from the finished item (function)
- disassembling the product, process, or idea
- measuring parts and assembly, if applicable
- finding ways to improve the product, process, or idea.

Process/Skill Questions

- What does it mean to reverse-engineer something?
- What are some important ideas to help stay organized?
- How might one improve an existing product one owns?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Processes

12. Use and Maintain Technological Products and Systems

9. Engineering Design

TSA Competitive Events

Biotechnology Design

Engineering Design

Task Number 52

Define *algorithm*.

Definition

Definition should state that an algorithm is a procedure or formula for solving a problem.

Process/Skill Questions

- How can one create a flowchart that demonstrates an algorithm and engages another student to follow an algorithm to measure its success? Problem solving can use a simple process-oriented algorithm, such as making a peanut butter and jelly sandwich.

ITEEA National Standards

13. Assess the Impact of Products and Systems

TSA Competitive Events

System Control Technology

Video Game Design

Task Number 53

Create an algorithm to solve an engineering problem.

Definition

Creation of an algorithm should express a logical process for solving an engineering problem or a step-by-step thought process and should result in one or more of the following algorithm types:

- Visual—flow chart
- Written—pseudo code
- Mathematical—formula-based

Process/Skill Questions

- How can one conduct a trace using test cases?

ITEEA National Standards

11. Apply the Design Processes

TSA Competitive Events

System Control Technology

Video Game Design

Task Number 54

Explain the benefits of modeling and simulation.

Definition

Explanation should include the ways that modeling and simulation allows for

- ideas to be tested in a virtual environment that
    - is safer (e.g., simulates within a range of conditions and extremes without physical risk)
    - reveals ergonomic issues
    - is easier to control (e.g., confidence in predictability based on known inputs and effect of variables)
    - is easier to modify (e.g., variables of time, conditions, scale, materials, chemistry)
- improvements in cost-effectiveness over real-world testing
- identification of differences between model and prototype efficiency when creating a prototype
- errors in design/logic to emerge prior to implementation.

Process/Skill Questions

- What are the various ways in which one's project benefited from modeling and simulation?
- Why is it important to create, test, and analyze models? What is the difference between a model and a prototype?
- Why do manufacturers and designers use computer simulations instead of creating a physical model or prototype?

ITEEA National Standards

11. Apply the Design Processes

TSA Competitive Events

Computer-Aided Design (CAD), Architecture

Computer-Aided Design (CAD), Engineering

Engineering Design

Scientific Visualization (SciVis)

System Control Technology

Video Game Design

Task Number 55

Create a model or simulation for an engineering product, process, or idea.

Definition

Creation of a model must include a description of a pattern, plan, or representation and be designed to show a main object or workings of an object, system, or concept. The process used for the creation of a model should be based on one of the following model types and procedures:

- Physical model type—design a model, determine the scale, choose and obtain materials, and assemble
- Conceptual model type—present a clearly communicated story or series of images of the phenomenon
- Mathematical model type—determine the relationship between variables or procedural steps and translate them into mathematical symbols

Process/Skill Questions

- What type of plan might one use for a physical model?
- How might a concept be modeled?
- How does one go about making a mathematical model?

ITEEA National Standards

10. The Role of Troubleshooting, Research and Development, Invention and Innovation, and Experimentation in Problem Solving

11. Apply the Design Processes

9. Engineering Design

TSA Competitive Events

Animatronics

Engineering Design

Video Game Design

Examining Engineering Materials and Manufacturing

Task Number 56

Demonstrate lab safety.

Definition

Demonstration should include class rules for each machine and tool.

Process/Skill Questions

- What is the first thing to put on when entering the lab?
- Which machines will a student be allowed to use?
- How close can students get to one another while using a machine?

ITEEA National Standards

12. Use and Maintain Technological Products and Systems

TSA Competitive Events

Principles of Technology (Virginia only)

Structural Design and Engineering

Technology Problem Solving

Task Number 57

Describe hazards associated with machines and tools.

Definition

Description should include specific accidents that may happen if a tool/machine is used improperly and examples of what actions are improper.

Process/Skill Questions

- How might an accident happen with a table saw?
- How might an accident happen when using a lathe?
- How can a drill press be a hazard?

Task Number 58

List common engineering materials and common applications of each.

Definition

Listing should include

- ceramics (e.g., shuttle tile, glass container)
- composites (e.g., PC board, surfboard)
- metals (including alloys) (e.g., light bulb filament, building materials)
- polymers (e.g., recyclable consumer products, PVC piping)
- forestry products (e.g., building materials, paper)
- emerging materials (e.g., nanotubes).

Process/Skill Questions

- What is the most important characteristic of a ceramic material? Why?
- What is a composite material? What makes composite materials superior for certain applications?
- What are the major types of plastics? How are they similar to each other? How are they different from each other?
- What is the difference between ferrous and non-ferrous material?
- What types of products would be composed of ferrous material? Why?
- What types of products would be composed of non-ferrous material? Why?

ITEEA National Standards

13. Assess the Impact of Products and Systems

TSA Competitive Events

Animatronics

Architectural Design

Biotechnology Design

Engineering Design

Structural Design and Engineering

Technology Problem Solving

Task Number 59

Describe properties of engineering materials in terms of their internal structures.

Definition

Description should include how internal structures of materials are related to the following properties:

- Physical
- Acoustical
- Electrical
- Magnetic

- Mechanical
- Optical
- Thermal
- Chemical

Process/Skill Questions

- What are the major properties of materials?
- Why are engineering materials identified by properties?
- To what degree is each property important in terms of a material's use as an engineering material?
- How can the properties of an engineering material be determined if it is not known?
- Why must an engineer have a thorough knowledge of the properties of materials?

ITEEA National Standards

13. Assess the Impact of Products and Systems

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

TSA Competitive Events

Principles of Technology (Virginia only)

Scientific Visualization (SciVis)

Technology Bowl

Task Number 60

Identify the correct engineering material for a specific function.

Definition

Identification should include

- material properties that are required for the function
- materials that have the required material property
- evaluation of which material is better suited.

Process/Skill Questions

- How does one determine which material is best for a given application?
- What material is best suited for a given application?
- What factors affect the material to be used?

ITEEA National Standards

12. Use and Maintain Technological Products and Systems

TSA Competitive Events

Engineering Design

Future Technology Teacher

Principles of Technology (Virginia only)

Technology Bowl

Task Number 61

List common causes of material failure.

Definition

Listing should include

- fatigue, strain, stress
- vibrations
- necking
- corrosion
- human error (e.g., manufacturing error, misapplication)
- lack of maintenance.

Process/Skill Questions

- How can vibrations affect a structure?
- Why should an engineer consider all common causes of material failure in an engineering project?
- How can an engineer communicate to a client the need for maintenance to prevent future material failure?

- Among the causes of material failure, which are most commonly encountered?

ITEEA National Standards

12. Use and Maintain Technological Products and Systems

13. Assess the Impact of Products and Systems

TSA Competitive Events

Essays on Technology

Future Technology Teacher

Principles of Technology (Virginia only)

Technology Bowl

Task Number 62

Demonstrate processes used with metal, wood, polymer, ceramic, and composite materials, including adhesives.

Definition

Demonstration should include

- machining
- molding
- welding
- forming
- combining
- joining
- quality control.

Process/Skill Questions

- What are familiar characteristics that allow easy identification of a material as a metal, ceramic, or plastic?
- What properties are unique to each material classification?
- Which types of processes are commonly used with which materials?

- What is quality control? Why is it important?

ITEEA National Standards

13. Assess the Impact of Products and Systems

TSA Competitive Events

Architectural Design

Engineering Design

Future Technology Teacher

Technology Bowl

Task Number 63

Identify common hand tools and fasteners.

Definition

Identification should include

- hand tools (e.g., saws, screw drivers, drills, level)
- fastener (e.g., bolts, screw, nail)
- unified thread standard.

Process/Skill Questions

- What are common hand tools used by engineers? How are they used?
- What are common fasteners used by engineers?
- What is the purpose of the unified thread standard?

Examining Engineering Systems

Task Number 64

Explore electrical systems.

Definition

Exploration should include

- demonstrating the effect of resistance
- applying Ohm's Law, Watt's Law, Kirchhoff's Law and Coulomb's Law
- identifying series, parallel, and combination circuits
- applying knowledge of AC and DC systems
- identifying the uses and types of inductors and capacitors
- using appropriate electrical units to solve problems
- drawing a circuit diagram and layout the circuit
- identifying the difference between analog and digital signals
- identifying electrical components and their functions.

Process/Skill Questions

- Why is knowledge of the physics concepts related to voltage in an electrical energy system necessary for all engineers, not just electrical engineers?
- Why are both International System (SI) of units and U.S. customary units used in engineering?
- What are some innovative ways to demonstrate application of voltage?
- What resources are available to investigate application of voltage?
- What is a parallel circuit? What is a series circuit?
- What is Ohm's Law? What is Watt's Law? What is Kirchhoff's Law?

ITEEA National Standards

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

TSA Competitive Events

Animatronics

Engineering Design

Principles of Technology (Virginia only)

Scientific Visualization (SciVis)

Task Number 65

Explain primary concepts and components of a fluid power system.

Definition

Explanation should include

- identifying what causes resistance in a fluid system
- applying knowledge of hydraulic and pneumatic systems.

Process/Skill Questions

- Why is knowledge of the physics concepts related to pressure in a fluid energy system necessary for all engineers?
- Why are both SI units and U.S. customary units used in engineering?
- What are some innovative ways to demonstrate application of pressure?
- What resources are available to investigate application of pressure?
- How does a water filtration system work?

ITEEA National Standards

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

TSA Competitive Events

Animatronics

Engineering Design

Principles of Technology (Virginia only)

Scientific Visualization (SciVis)

Task Number 66

Identify the primary concepts and components of thermodynamic systems.

Definition

Identification should include

- identifying the three ways heat is transferred
- explaining the difference between Celsius and Fahrenheit scales
- describing heat conductors and insulators
- solving thermal problems using appropriate units
- identifying direction of heat flow given differences in temperature
- understanding the use of insulation to minimize heat flow.

Process/Skill Questions

- Why is knowledge of the physics concepts related to temperature difference in a thermal energy system necessary for all engineers?
- Why are both SI units and U.S. customary units used in engineering?
- What are some innovative ways to demonstrate application of temperature difference?
- What resources are available to investigate application of temperature difference?
- What are some common endothermic processes?
- What are some common exothermic processes?

ITEEA National Standards

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

TSA Competitive Events

Animatronics

Engineering Design

Principles of Technology (Virginia only)

Scientific Visualization (SciVis)

Task Number 67

Identify the primary concepts and components of mechanical systems.

Definition

Identification should include

- identifying the six simple machines and their applications explaining force
- using SI units and U.S. customary units, including formulas
- demonstrating application of force
- identifying how friction affects mechanical systems.

Process/Skill Questions

- Why is knowledge of the physics concepts related to force in a mechanical energy system necessary for all engineers, not just mechanical engineers?
- Why are both SI units and U.S. customary units used in engineering?
- What are some innovative ways to demonstrate application of force?
- What resources are available to investigate application of force?
- What is friction? How does it affect systems?

ITEEA National Standards

3. The Relationships Among Technologies and the Connections Between Technology and Other Fields

TSA Competitive Events

Animatronics

Engineering Design

Principles of Technology (Virginia only)

Scientific Visualization (SciVis)

Task Number 68

Demonstrate control of systems.

Definition

Demonstration should include fluid, mechanical, electrical systems, and microcontrollers.

Process/Skill Questions

- What generates pressure in a pneumatic system?
- How does a microcontroller control a mechanical system?
- How are electrical systems interfaced with microcontrollers?

Task Number 69

Design a system that transforms energy from one type to another.

Definition

Design should include

- at least two of the systems changing power from one system to another
- include transforming mechanical power to electrical
- include transforming fluid power to mechanical.

Process/Skill Questions

- What is a common way for mechanical power to be converted to electrical power?
- How is electrical power converted to mechanical power?
- What does fluid power do to convert power to mechanical systems?

SOL Correlation by Task

39	Define *designed world*.	English: 10.3, 10.5, 11.3, 11.5, 12.3, 12.5
0	Describe major engineering disciplines.	English: 10.5, 11.5, 12.5
41	Analyze the interdisciplinary nature of engineering projects.	English: 10.5, 11.5, 12.5
42	Integrate the parts of a project.	English: 10.1, 11.1, 12.1
43	Identify the impact of a design solution on industry, economy, society, and environment.	English: 10.5, 11.5, 12.5
44	Identify the need for a product or system.	English: 10.3, 10.5, 11.3, 11.5, 12.3, 12.5
45	Explain the validity of designing alternative solutions to an engineering design problem.	English: 10.5, 11.5, 12.5 Science: PH.1

46	Design an engineering solution to a real-world problem for each of the areas in the designed world.	English: 10.1, 10.5, 10.8, 11.1, 11.5, 11.8, 12.1, 12.5, 12.8 Science: PH.1
47	Implement a design.	English: 10.1, 10.5, 11.1, 11.5, 12.1, 12.5 Mathematics: COM.1
48	Iterate on the solution.	English: 10.1, 11.1, 12.1
49	Maintain documentation (e.g., sketches, notes, reports).	English: 10.1, 10.6, 10.7, 11.1, 11.6, 11.7, 12.1, 12.6, 12.7 History and Social Science: GOVT.1, VUS.1, WHII.1
50	Present a solution.	English: 10.1, 10.5, 11.1, 11.5, 12.1, 12.5 History and Social Science: GOVT.1, GOVT.16 Science: PH.1, PH.4
51	Reverse-engineer a product, process, or idea.	English: 10.1, 11.1, 12.1
52	Define *algorithm*.	English: 10.3, 11.3, 12.3 Mathematics: COM.4
53	Create an algorithm to solve an engineering problem.	English: 10.1, 10.6, 10.7, 11.1, 11.6, 11.7, 12.1, 12.6, 12.7 Mathematics: AFDA.1, AFDA.3, AFDA.4, AII.6, AII.7, AII.9, AII.10, COM.4, COM.5, COM.6, COM.8, COM.9, COM.13, COM.14, COM.15, DM.8, DM.10, DM.5*, MA.2, MA.3, MA.7, MA.10, MA.11, MA.14
54	Explain the benefits of modeling and simulation.	English: 10.5, 11.5, 12.5 Mathematics: COM.1, COM.3, COM.5, COM.8, COM.10, COM.17, COM.18
55	Create a model or simulation for an engineering product, process, or idea.	English: 10.1, 11.1, 12.1 Mathematics: AFDA.1, AFDA.2, AFDA.3, AFDA.4, AII.3, AII.6, AII.7, AII.8, AII.9, AII.10, COM.1, COM.4, COM.6, COM.8, COM.14, COM.15, MA.2, MA.3, MA.7, MA.10, MA.11
56	Demonstrate lab safety.	English: 10.5, 11.5, 12.5 Science: PH.1
57	Describe hazards associated with machines and tools.	

58	List common engineering materials and common applications of each.	English: 10.5, 10.7, 11.5, 11.7, 12.5, 12.7
59	Describe properties of engineering materials in terms of their internal structures.	English: 10.7, 11.7, 12.5 Science: PH.5, PH.8
60	Identify the correct engineering material for a specific function.	English: 10.5, 11.5, 12.5
61	List common causes of material failure.	English: 10.5, 10.6, 10.7, 11.5, 11.6, 11.7, 12.5, 12.6, 12.7
62	Demonstrate processes used with metal, wood, polymer, ceramic, and composite materials, including adhesives.	English: 10.5, 11.5, 12.5
63	Identify common hand tools and fasteners.	English: 10.5, 11.5, 12.5
64	Explore electrical systems.	English: 10.5, 10.8, 11.5, 11.8, 12.5, 12.8 Science: PH.11
65	Explain primary concepts and components of a fluid power system.	English: 10.5, 11.5, 12.5 Science: PH.7
66	Identify the primary concepts and components of thermodynamic systems.	English: 10.5, 10.8, 11.5, 11.8, 12.5, 12.8 Science: PH.7
67	Identify the primary concepts and components of mechanical systems.	English: 10.5, 10.8, 11.5, 11.8, 12.5, 12.8 Science: PH.5, PH.7
68	Demonstrate control of systems.	
69	Design a system that transforms energy from one type to another.	English: 10.1, 11.1, 12.1 Science: PH.5, PH.7

Entrepreneurship Infusion Units

Entrepreneurship Infusion Units may be used to help students achieve additional, focused competencies and enhance the validated tasks/competencies related to identifying and starting a new business venture. Because the unit is a complement to certain designated courses and is not mandatory, all tasks/competencies are marked “optional.”

Appendix: Credentials, Course Sequences, and Career Cluster Information

Industry Credentials: Only apply to 36-week courses

- Autodesk Certified User Examinations
- Certified SOLIDWORKS Associate (CSWA) Examination
- College and Work Readiness Assessment (CWRA+)
- Manufacturing Technician Level I Certification Examination
- National Career Readiness Certificate Assessment
- Pre-Engineering Certification Examinations
- Stratasys Additive Manufacturing Certification – Level 1 Examination
- Workplace Readiness Skills for the Commonwealth Examination

Concentration sequences: *A combination of this course and those below, equivalent to two 36-week courses, is a concentration sequence. Students wishing to complete a specialization may take additional courses based on their career pathways. A program completer is a student who has met the requirements for a CTE concentration sequence and all other requirements for high school graduation or an approved alternative education program.*

- Engineering Concepts and Processes III (8452/36 weeks)
- Engineering Explorations I (8450/36 weeks)
- Engineering Practicum IV (8453/36 weeks)

Career Cluster: Science, Technology, Engineering and Mathematics	
Pathway	**Occupations**
Engineering and Technology	**Aerospace Engineer** **Civil Engineer** **Environmental Engineer** **Human Factors Engineer** **Manufacturing Systems Engineer**