Curriculum Framework – Principles of Engineering (2015-2016)
Unit 1 Energy and Power – Lesson 1.1 Mechanisms

Desired Results *(stage 1)*

ESTABLISHED GOALS
It is expected that students will…

- G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
- G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
- G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.
- G5 – Demonstrate an ability to

Transfer

TRANSFER: *Students will be able to independently use their learning to …*

- T1 – Explore career opportunities in engineering and interview a professional engineer to gain insight related to pathway to engineering and current state of engineering.
- T2 – Apply the engineering design process to design a system using mechanisms to redirect energy within a system by manipulating force, speed, and distance.
- T3 – Determine the mechanical advantage of a simple machine or system of simple machines and characterize the work done by and power of a mechanical system.

Meaning

UNDERSTANDINGS: *Students will understand that …*

- U1 – *(Career Exploration)* Engineers and engineering technologists apply math, science, and discipline-specific skills to solve problems.
- U2 – *(Career Exploration)* Engineering and engineering technology careers offer creative job opportunities for individuals with a wide variety of backgrounds and goals.
- U3 – Most mechanisms are composed of gears, sprockets, pulley systems, and simple machines.
- U4 – Mechanisms are used to redirect energy within a system by manipulating force, speed, and distance.
- U5 – Mechanical advantage ratios relate input forces to output forces in mechanisms; efficiency ratios relate input work to output work for those mechanisms.

ESSENTIAL QUESTIONS: *Students will keep considering …*

- Q1 – What are some different types of occupations within the engineering pathway?
- Q2 – What are some common responsibilities of engineers?
- Q3 – Identify a mechanism in your household. Why do you think that particular mechanism is designed the way it is?
- Q4 - What are some strategies that can be used to make everyday mechanisms more efficient?
- Q5 - Describe one situation in which an engineer would want to include a mechanism with a mechanical advantage greater than one? What is the advantage in this case?
- Q6 - How could designing a solution to a mechanical problem without regard to efficiency be problematic?

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

use the techniques, skills, and modern engineering tools necessary for engineering practice. • G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. • G7 – Demonstrate an understanding of professional and ethical responsibility. • G8 – Demonstrate an ability to function on multidisciplinary teams. • G9 – Demonstrate an ability to communicate effectively. • G10 – Gain knowledge of contemporary issues. • G11 – Recognize the need for, and develop an ability to engage in life-long learning.	• U6 – *(Design Process)* Technical communication can be accomplished in oral, written, and visual forms and must be organized in a clear and concise manner. • U7 – *(Design Process)* Working in a team requires effective communication, clear responsibilities, and attention to interpersonal relationships. (Same as U4 in Lesson 1.4.)	
	Acquisition	
	KNOWLEDGE: *Students will…* • K1 – Describe the job responsibilities of various types of engineers and engineering technicians. U1, U2 • K2 – Know the six simple machines, their attributes, and components. U4 • K3 – Know the equations to solve for mechanical advantage, work, and power. U6	***SKILLS:*** *Students will…* • S1 – *(Career Exploration)* Differentiate among the various types of engineering careers and engineering technicians. U1, U2 • S2 – Measure forces and distances related to mechanisms. U4, U5 • S3 – Distinguish among the six simple machines, their attributes, and components. U4 • S4 – Calculate mechanical advantage and drive ratios of mechanisms. U4 • S5 – Design, create, and test systems using simple machines and drive mechanisms. U3, U4, U5, U6 • S6 – Calculate work and power in mechanical systems. U5, U6 • S7 – Determine efficiency in a mechanical system. U6 • S8 – Design, create, test, and evaluate a compound machine design. U3, U4, U5, U6 • S9 – *(Design Process)* Communicate a design for a machine using annotated sketches and other documentation. U3 • S10 – *(Design Process)* Collaborate effectively with others in a design team. U7

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

Evidence *(stage 2)*			Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems(B)	Assessment FOR Learning	Assessment OF Learning	Activities (A) Projects (P) Problems(B)	Knowledge and Skills
1.1.0 Career Professional Interview	• 1.0.A.RU Professional Interview Rubric • Essential Questions	• 1.0.A.RU Professional Interview Rubric	1.1.0 Career Professional Interview	K1, S1
1.1.1.A Simple Machines Investigation	• Essential Questions • Simple Machine Calculations • Student responses to presentation examples	• Conclusion Questions • Simple Machine Calculations	1.1.1.A Simple Machines Investigation	S2, S3, S4, S5, S9, S10
1.1.2.A Simple Machines Practice Problems	• Essential Questions	• Simple Machine Calculations	1.1.2.A Simple Machines Practice Problems	S3,S4,S7
1.1.3.A.VEX Gears	• Essential Questions • Gear Calculations • Student responses to presentation examples	• Gear Calculations	1.1.3.A.VEX Gears	S4, S5
1.1.4.A Pulleys, Drives, & Sprockets	• Essential Questions • A Pulleys, Drives, & Sprockets Calculations • Student responses to presentation examples	• Conclusion Questions • Pulley, Drives, & Sprockets Calculations	1.1.4.A Pulleys, Drives, & Sprockets	S4
1.1.5.A Gears, Pulleys, Drives, & Sprockets Practice Problems	• Essential Questions	• Gear, Pulley, Drives, & Sprockets Calculations	1.1.5.A Gears, Pulleys, Drives, & Sprockets Practice Problems	S3,S4
1.1.6.P.VEX Compound Machine Design	• Essential Questions • 1.1.6.P.RU Compound Machine Design Rubric	• 1.1.6.P.RU Compound Machine Design Rubric	1.1.6.P.VEX Compound Machine Design	S3,S4, S5, S6, S7, S8, S9, S10

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

Curriculum Framework – Principles of Engineering (2015-2016)
Unit 1 Energy and Power – Lesson 1.2 Energy Sources

Desired Results *(stage 1)*

ESTABLISHED GOALS
It is expected that students will…

- G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
- G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
- G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.
- G5 – Demonstrate an ability

Transfer

TRANSFER: *Students will be able to independently use their learning to …*

- T1 – Distinguish between nonrenewable, renewable, and inexhaustible energy sources and describe the process related in harnessing, storing, transporting, and converting energy.
- T2 – Design and characterize electrical circuits by calculating and describing the relationships between the current, voltage, and resistance in series circuits and parallel circuits.
- T3 – Identify the means of energy loss and calculate the efficiency of a system that converts electrical energy into mechanical energy.

Meaning

UNDERSTANDINGS: *Students will understand that …*

- U1 – Energy sources for consumption are varied, including nonrenewable, renewable, and inexhaustible sources.
- U2 – Energy sources for consumption are harnessed or mined, often stored and transported, and converted to other forms of energy.
- U3 – Energy often needs to be converted from one form to another to meet the needs of a given system.
- U4 – Energy can be transformed to do work.
- U5 – Efficiency describes how much energy or power is transformed in the manner desired.
- U6 – Power is the rate at which energy is transformed.
- U7 – The relationship among voltage, current, and resistance determines the behavior of electricity in a circuit.
- U8 – Electricity involves the motion of electrons and the electrical properties of a material (e.g., whether it is a

ESSENTIAL QUESTIONS: *Students will keep considering …*

- Q1 – Choose a specific energy production source. Explain why it is considered “clean.” In what ways may it not be so “clean?”
- Q2 – How might innovation of current technology involved with energy production provide energy more efficient?
- Q3 – What alternative energy source would be best implemented in your community? Explain why.
- Q4 – Choose a specific energy production source. What
- Q5 – What is one possible way that “lost” energy might be collected in your home or school and transformed for a useable purpose?
- Q6 – What are the advantages and disadvantages of wiring a house with either series or parallel circuits?

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

to use the techniques, skills, and modern engineering tools necessary for engineering practice. • G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. • G7 – Demonstrate an understanding of professional and ethical responsibility. • G8 – Demonstrate an ability to function on multidisciplinary teams. • G9 – Demonstrate an ability to communicate effectively. • G10 – Gain knowledge of contemporary issues. • G11 – Recognize the need for, and develop an ability to engage in life-long learning.	conductor, an insulator, or a semiconductor) are determined by its atomic structure. • U9 – *(Design Process)* Effective presentations are the result of preparation, are tailored to suit the purpose and audience, and are improved by attending to posture, gestures, appearance, eye contact, and time constraints. (Same as U6 of Lesson 1.4.)	
	Acquisition	
	***KNOWLEDGE**: Students will…* • K1 – Describe the characteristics of various sources of energy. U1, U2 • K2 – Know types of nonrenewable, renewable, and inexhaustible energy sources. U1, U2 • K3 – Know the equations for work and power. U4,U5,U6 • K4 – Know the equation for calculation the efficiency of a system. U5 • K5 – Know the equations related to describing the characteristics of simple circuits. U7	***SKILLS:** Students will…* • S1 – *(Design Process)* Prepare and deliver a brief summary based on research. U9 • S2 – Calculate work and power. U3, U4, U5, U6 • S3 – Correctly use a digital multimeter as a voltmeter, ohmmeter, or ammeter. U7 • S4 – Calculate electrical power developed in a circuit. U6, U7 • S5 – Calculate mechanical power developed when lifting an object. U4, U6 • S6 – Determine efficiency of a system that converts an electrical energy to a mechanical energy. U3, U4, U5, U6, U7 • S7 – Calculate circuit resistance, current, and voltage using Ohm's law, including circuits with elements in series and/or parallel. U7 • S8 – Compare and contrast the behavior of electrical circuits with parallel and series circuit designs. U7

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

Evidence *(stage 2)*		
Activities (A) Projects (P) Problems(B)	Assessment FOR Learning	Assessment OF Learning
A.1.2.1 Energy Sources	• 1.2.1.A.RU Energy sources Rubric • Essential Questions	• 1.2.1.A.RU Energy sources Rubric • Conclusion Questions
A.1.2.2 Energy Distribution	• Essential Questions	• Conclusion Questions
A.1.2.3 Electrical Circuits	• Essential Questions • Student responses to presentation examples.	• Demonstration of simulated circuits. • Demonstration of physical circuit. • Conclusion Questions
A.1.2.4 Circuit Calculations	• Essential Questions	• Calculations and Conclusion Questions
A.1.2.5 Mechanical System Efficiency	• Essential Questions • Student responses to presentation examples.	• Calculations and Conclusion Questions • Demonstration of mechanical system.

Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems(B)	Knowledge and Skills
A.1.2.1 Energy Sources	K1, S1
A.1.2.2 Energy Distribution	K1
A.1.2.3 Electrical Circuits	S3, S7
A.1.2.4 Circuit Calculations	S3, S7
A.1.2.5 Mechanical System Efficiency	S2, S3, S4, S5, S6

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

Curriculum Framework – Principles of Engineering (2015-2016)
Unit 1 Energy and Power– Lesson 1.3 Energy Applications

Desired Results *(stage 1)*

ESTABLISHED GOALS
It is expected that students will…

- G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
- G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
- G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.

Transfer

TRANSFER: *Students will be able to independently use their learning to …*

- T1 – Design a system to convert solar power to mechanical power using photovoltaic and fuel cells.
- T2 – Design, construct, and test insulation materials for reducing thermal energy transfer.
- T3 – Analyze system energy requirements to select the best energy sources for a system.
- T4 - Predict and manipulate the amount of heat energy transferred in a system resulting from the material properties and system design.

Meaning

UNDERSTANDINGS*: Students will understand that …*

- U1 – Selecting sources of energy for human consumption requires consideration of efficiency of energy transformations, of the quantities of energy needed and available, of the rates at which energy is needed and available, and of the accessibility of the power source to the point of consumption.
- U2 – Energy systems can include multiple energy sources that can be combined to convert energy into useful forms.
- U3 – Hydrogen fuel cells and solar cells are two of the many options for transforming energy to power human needs.
- U4 – The flow of heat energy in a system is related to material properties and system design, and by considering the thermodynamics of a system, an engineer can predict and manipulate the amount of energy transferred.
- U5 – *(Design Process)* Engineers use a design process to

ESSENTIAL QUESTIONS: *Students will keep considering …*

- Q1 – In what innovative ways could the efficiency of electricity production using solar cells be maximized throughout the day?
- Q2 – Describe how hydrogen fuel cells could become a viable way of producing energy for vehicles. What advancements in technology and infrastructure need to take place to make its usage more common?
- Q3 – A hydrogen fuel cell by itself is not sufficient to power much of anything in our society. How could fuel cells be configured to produce enough voltage and current to a system?
- Q4 – What are some materials in your home that provide prevent energy transfer from inside your home to the outside environment? Which of the three forms of energy transfer are they attempting to limit?
- Q5 – Which of the three forms of energy transfer are the

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

• G5 – Demonstrate an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. • G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. • G7 – Demonstrate an understanding of professional and ethical responsibility. • G8 – Demonstrate an ability to function on multidisciplinary teams. • G9 – Demonstrate an ability to communicate effectively. • G10 – Gain knowledge of contemporary issues. • G11 – Recognize the need for, and develop an ability to engage in life-long learning.	create solutions to existing problems. (Same as U2 of Lesson 1.4.) • U6 – *(Design Process)* Working in a team requires effective communication, clear responsibilities, and attention to interpersonal relationships. (Same as U4 of Lesson 1.4.)	materials in your home inhibiting the least? What could be done to change that?
	Acquisition	
	KNOWLEDGE: *Students will …* • K1 – Explain that hydrogen fuel cells transform chemical energy stored in hydrogen gas to electrical energy and heat, converting hydrogen and oxygen into water. U1, U2, U3 • K2 – Describe the use of reversible fuel cells as electrolyzers to store electrical energy for later use. U1, U2, U3 • K3 – Describe the use of solar cells to convert light energy into electricity. U1, U2, U3 • K4 – Describe convection, conduction, and radiation as they relate to thermal energy transfer. U4	***SKILLS:*** *Students will…* • S1 – Test and apply the relationships among voltage, current, and resistance in series and parallel circuits that incorporate photovoltaic cells and hydrogen fuel cells. U1, U2, U3 • S2 – Design a system to convert solar power to mechanical power using photovoltaic and fuel cells. U1, U3, U5, U6 • S3 – Design, construct, and test insulation materials for reducing thermal energy transfer. U4 • S4 – Calculate the rate at which energy is transferred by conduction and radiation through materials having various R-values. U4

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

Evidence *(stage 2)*			Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems(B)	Assessment FOR Learning	Assessment OF Learning	Activities (A) Projects (P) Problems(B)	Knowledge and Skills
A.1.3.1 Solar Hydrogen System	• Essential Questions • Calculations and measurements	• Conclusion Questions	A.1.3.1 Solar Hydrogen System	K1, K2, K3, S1, S2
P.1.3.2 Fuel Cell Technology		• Conclusion Questions • Presentation of designed solution	P.1.3.2 Fuel Cell Technology	K1, K2, K3, S1, S2
A.1.3.3 Thermodynamics	• Essential Questions • Student responses to presentation examples	• Conclusion Questions • Thermodynamic Calculations	A.1.3.3 Thermodynamics	K4, S4
P.1.3.4 Renewable Insulation	• 1.3.4.P.RU Renewable Insulation Rubric • Essential Questions	• 1.3.4.P.RU Renewable Insulation Rubric • Conclusion Questions • Thermodynamic Calculations	P.1.3.4 Renewable Insulation	K4, S3, S4

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

Curriculum Framework – Principles of Engineering (2015-2016)
Unit 1 Energy and Power – Lesson 1.4 Design Problem: Renewable Electrical Energy Design

Desired Results *(stage 1)*

ESTABLISHED GOALS
It is expected that students will…

- G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
- G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
- G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.

Transfer

TRANSFER: *Students will be able to independently use their learning to …*

- T1 – Apply an engineering design process to the creation of a renewable electrical energy design.
- T2 – To apply a decision matrix in a design process to best defend a selection or choice in a design process.
- T3 – To apply professional skills and work within a design team.
- T4 – Design and create a renewable electrical energy generating and distribution system that utilizes wind, solar electric, and fuel cell energy conversion systems as part of a team.

Meaning

UNDERSTANDINGS: *Students will understand that …*

- U1 – Design problems can be solved by individuals or in teams.
- U2 – Engineers use a design process to create solutions to existing problems.
- U3 – Design briefs are used to identify the problem specifications and to establish project constraints.
- U4 – Working in a team requires effective communication, clear responsibilities, and attention to interpersonal relationships.
- U5 – Design teams conduct research to develop their knowledge base, stimulate creative ideas, and make informed decisions.
- U6 – Effective presentations are the result of preparation, are tailored to suit the purpose and audience, and are

ESSENTIAL QUESTIONS: *Students will keep considering …*

- Q1 – How does a design team come to know what problem to solve?
- Q2 – Why is it important for the team to come to a consensus on issues that arise? What are some reasons why the team leader should not dictate the direction of the group?
- Q3 – What are two possible ways that a team could come to a consensus in a disagreement over a solution to a problem?
- Q4 – Engineers follow the design process, when solving a problem. What possible problems could arise, if the design process is not followed?

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

• G5 – Demonstrate an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. • G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. • G7 – Demonstrate an understanding of professional and ethical responsibility. • G8 – Demonstrate an ability to function on multidisciplinary teams. • G9 – Demonstrate an ability to communicate effectively. • G10 – Gain knowledge of contemporary issues. • G11 – Recognize the need for, and develop an ability to engage in life-long learning.	improved by attending to posture, gestures, appearance, eye contact, and time constraints.	
	Acquisition	
	KNOWLEDGE: *Students will…* • K1 – Know the purpose of each part of a design brief. U3 • K2 – Describe a step-by-step, iterative design process. U2	***SKILLS:*** *Students will…* • S1 – Brainstorm and sketch possible solutions to an existing design problem. U1, U2, U4, U5 • S2 – Create a decision making matrix for their design problem.U1, U2 • S3 – Select an approach that meets or satisfies the constraints provided in a design brief. U1, U3 • S4 – Create a detailed pictorial sketch or use 3D modeling software to document a proposed design. U1, U2, U4 • S5 – Present a workable solution to a design problem. U1, U2, U4, U6

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

Evidence *(stage 2)*		
Activities (A) Projects (P) Problems(B)	Assessment FOR Learning	Assessment OF Learning
B.1.4.1 Design Problem: Renewable Electrical Energy Design	• 1.4.1.P.RU Renewable Electrical Energy Design Rubric • Decision Matrix Rubric • Essential Questions	• 1.4.1.P.RU Renewable Electrical Energy Design Rubric • Decision Matrix Rubric • Conclusion Questions • Presentation of Design Process

Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems(B)	Knowledge and Skills
B.1.4.1 Design Problem: Renewable Electrical Energy Design	K1, S1, S2, S3, S4, S5

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

Curriculum Framework – Principles of Engineering (2015-2016)
Unit 2 Materials and Structures – Lesson 2.1 Statics

Desired Results *(stage 1)*

ESTABLISHED GOALS
It is expected that students will…

- G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
- G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
- G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.
- G5 – Demonstrate an ability to use the techniques, skills, and

Transfer

TRANSFER: *Students will be able to independently use their learning to …*

- T1 – Explore career opportunities in engineering and gain insight to current state of engineering.
- T2 – Characterize the forces acting on an object or system.
- T3 – Use vectors and moments to analyze forces acting on objects and design structural elements to transfer force effectively.

Meaning

UNDERSTANDINGS: *Students will understand that …*

- U1 – Laws of motion describe how forces affect a body.
- U2 – Applied forces are vector quantities with a defined magnitude, direction, and sense, and can be broken into vector components.
- U3 – Free body diagrams are used to illustrate and calculate forces acting upon a given body.
- U4 – Forces acting at a distance from an axis or point attempt or cause an object to rotate.
- U5 – Structural member properties – including centroid location, moment of inertia, and modulus of elasticity – are important considerations for structure design.
- U6 – Static equilibrium occurs when the sum of all forces acting on a body are equal to zero.
- U7 – Under static equilibrium conditions, the laws of motion can be used to calculate external forces on a truss and internal forces in truss members.
- U8 – *(Design Process)* Engineers and engineering

ESSENTIAL QUESTIONS: *Students will keep considering …*

- Q1 – Why is it crucial for designers and engineers to construct accurate free body diagrams of the parts and structures that they design?
- Q2 – Why must designers and engineers calculate forces acting on bodies and structures?
- Q3 – When solving truss forces, why is it important to know that the structure is statically determinate?

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

modern engineering tools necessary for engineering practice. • G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. • G7 – Demonstrate an understanding of professional and ethical responsibility. • G8 – Demonstrate an ability to function on multidisciplinary teams. • G9 – Demonstrate an ability to communicate effectively. • G10 – Gain knowledge of contemporary issues. • G11 – Recognize the need for, and develop an ability to engage in life-long learning.	technologists apply math, science, and discipline-specific skills to solve problems. (Same as U1 of Lesson 1.1.) • U9 – *(Career Exploration)* Engineering and engineering technology careers offer creative job opportunities for individuals with a wide variety of backgrounds and goals. (Same as U2 of Lesson 1.1.)	
	Acquisition	
	KNOWLEDGE: *Students will…* • K1 – Differentiate between scalar and vector quantities. • K2 – Identify magnitude, direction, and sense of a vector. • K3 - Know beam deflection is related to cross sectional geometry and material properties. • K4 – Know the moment of inertia is related cross sectional geometry. • K5 – Know the modulus of elasticity defines the stiffness of an object related to material and chemical properties. • K6 – Know the forces acting on an object are in equilibrium. • K7 – Understand how Newton's Laws are applied to determine the forces acting on an object.	***SKILLS:*** *Students will…* • S1 – Create free body diagrams of objects, identifying all forces acting on the object. U2, U3 • S2 – Mathematically locate the centroid of structural members. U4, U5 • S3 – Calculate the area moment of inertia of structural members. U5 • S4 – Calculate the deflection of a center-loaded beam from the beam's geometry and material properties. U5, U7 • S5 – Calculate the x- and y-components of a given vector. U2 • S6 – Calculate moments or torques given a force and a point of application relative to a specified axis. U4 • S7 – Use equations of equilibrium to calculate unknown external forces on a truss. U2, U3, U4, U6, U7 • S8 – Use the method of joints to calculate tension and compression forces in the members of a statically determinate truss. U2, U3, U6, U7 • S9 – Construct and destructively test a truss, and relate observations to calculated predications. U2, U3, U5, U6, U7

Evidence *(stage 2)*		
Activities (A) Projects (P) Problems(B)	Assessment FOR Learning	Assessment OF Learning
A.2.1.0 Career Field Description	• 2.1.RU Career Field	• 2.1.RU Career Field

Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems(B)	Knowledge and Skills
A.2.1.0 Career Field Description	K1

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

	Description Rubric • Essential Questions	Description Rubric • Presentation of career field description		
A.2.1.1 Centroids	• Essential Questions • Centroid calculations • Student responses to presentation examples	• Conclusion Questions	A.2.1.1 Centroids	S2
A.2.1.2 Beam Deflection	• Essential Questions • Centroid calculations • Student responses to presentation examples	• Conclusion Questions • Graph of deflection vs. moment	A.2.1.2 Beam Deflection	S3, S4
A.2.1.3 Free Body Diagrams	• Essential Questions • Student responses to presentation examples	• Conclusion Questions • Free body diagrams	A.2.1.3 Free Body Diagrams	S1
A.2.1.4 Calculating Force Vectors	• Essential Questions • Force calculations • Student responses to presentation examples	• Calculations and Conclusion Questions	A.2.1.4 Calculating Force Vectors	S1, S5
A.2.1.5 Calculating Moments	• Essential Questions • Moment calculations • Student responses to presentation examples	• Calculations and Conclusion Questions	A.2.1.5 Calculating Moments	S5, S6
A.2.1.6 Step-by-Step Truss Calculations	• Essential Questions • Truss calculations • Student responses to presentation examples	• Truss calculations	A.2.1.6 Step-by-Step Truss Calculations	S5, S6, S7, S8
A.2.1.7 Calculating Truss Forces	• Essential Questions • Truss calculations • Student responses to presentation examples	• Truss calculations and Conclusion Questions	A.2.1.7 Calculating Truss Forces	S5, S6, S7, S8

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

A.2.1.8 Truss Design	• Essential Questions	• Conclusion Questions • Presentation of truss design and testing results

A.2.1.8 Truss Design	S5, S6, S7, S8, S9

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

Curriculum Framework – Principles of Engineering (2015-2016)
Unit 2 Energy and Power – Lesson 2.2 Material Properties

Desired Results *(stage 1)*

ESTABLISHED GOALS
It is expected that students will…

- G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
- G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
- G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.
- G5 – Demonstrate an ability to use the techniques, skills, and

Transfer

TRANSFER: *Students will be able to independently use their learning to…*

- T1 – Describe the role and impact of engineering and engineering solutions within a global, economic, environmental, and societal context.
- T2 – Describe the properties of materials and calculate or identify through testing basic properties such as weight, volume, mass, density, surface area, and continuity, is the material ferrous metal, its hardness, and flexure.
- T3 – Select materials to meet design criteria based upon mechanical, thermal, electromagnetic, and chemical properties.
- T4 – Describe the importance of recycling and consideration of a products end of life while being designed.

Meaning

UNDERSTANDINGS: *Students will understand that…*

- U1 – Materials are the substances from which all things are made and are built from the elements.
- U2 – Materials can be categorized by their composition as pure elements, compounds, or mixtures, and are also typically classified as metallic, ceramic, organic, polymeric, or composite.
- U3 – Materials can be categorized by intrinsic physical and chemical properties, including mechanical, thermal, electromagnetic, and chemical properties.
- U4 – Material properties including recyclability and cost are important considerations for engineers when choosing appropriate materials for a design.
- U5 – Material selection is based upon mechanical, thermal, electromagnetic, and chemical properties.
- U6 – Raw materials undergo various manufacturing

ESSENTIAL QUESTIONS: *Students will keep considering…*

- Q1 – How does an engineer predict the performance and safety for a selected material?
- Q2 – What are the advantages and disadvantages of utilizing synthetic materials designed by engineers?
- Q3 – What ethical issues pertain to engineers designing synthetic materials?
- Q4 – What did you learn about the significance of selecting materials for product design?
- Q5 – How can an existing product be changed to incorporate different processes to make it less expensive and provide better performance?
- Q6 – How does an engineer decide which manufacturing process to use for a given material?
- Q7 – How do the recycling codes and symbols differ from state to state?

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

modern engineering tools necessary for engineering practice. • G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. • G7 – Demonstrate an understanding of professional and ethical responsibility. • G8 – Demonstrate an ability to function on multidisciplinary teams. • G9 – Demonstrate an ability to communicate effectively. • G10 – Gain knowledge of contemporary issues. • G11 – Recognize the need for, and develop an ability to engage in life-long learning.	processes in the production of consumer goods.	
	Acquisition	
	KNOWLEDGE: *Students will…* • K1 – List material properties that are important too design including mechanical, chemical, electrical, and magnetic. • K2 – Know common manufacturing processes related to create a product from raw materials. • K3 - Know the steps of product life cycle for a common product.	***SKILLS:*** *Students will…* • S1 – Conduct non-destructive tests for material properties on selected common household products including tests for continuity, ferrous metal, hardness, and flexure. U2, U5 • S2 – Measure or calculate weight, volume, mass, density, and surface area of selected common household products. U3, U5 • S3 – Identify the manufacturing processes used to create the selected common household product. U6 • S4 – Identify materials that can be recycled. U4

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

Evidence *(stage 2)*		
Activities (A) Projects (P) Problems(B)	Assessment FOR Learning	Assessment OF Learning
A.2.2.1 Product Analysis	• Essential Questions	• Product analysis document and conclusion questions
A.2.2.2 Manufacturing Processes	• Essential Questions • Student responses to presentation examples	• Conclusion questions
A.2.2.3 Recycling	• Essential Questions • Student responses to presentation examples	• Essential Questions • Recycling rubric

Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems(B)	Knowledge and Skills
A.2.2.1 Product Analysis	S1, S2, S3
A.2.2.2 Manufacturing Processes	S4
A.2.2.3 Recycling	K1, S5

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

Curriculum Framework – Principles of Engineering (2015-2016)
Unit 2 Materials and Structures – Lesson 2.3 Material Testing

Desired Results *(stage 1)*

ESTABLISHED GOALS
It is expected that students will…

- G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
- G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
- G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.
- G5 – Demonstrate an ability to use the techniques, skills, and

Transfer

TRANSFER: *Students will be able to independently use their learning to …*

- T1 – Use a systematic process to solve problems.
- T2 – Interpreted and calculate material properties utilizing a stress strain curve for a tested sample.

Meaning

UNDERSTANDINGS: *Students will understand that …*

- U1 – Material testing helps determine a product's reliability, safety, and predictability in function.
- U2 – Engineers perform destructive and non-destructive tests on material specimens for the purpose of identifying and verifying the properties of various materials.
- U3 – Material testing, including tensile testing, is conducted under standardized conditions to provide a reproducible evaluation of material properties.
- U4 – Many properties related to a material's strength can be determined from a stress-strain curve for that material, including elastic range, proportional limit, modulus of elasticity, elastic limit, resilience, yield point, plastic deformation, ultimate strength, failure, and ductility
- U5 – Stress-strain data points are used to construct a stress-strain curve and to identify and calculate sample material properties.

ESSENTIAL QUESTIONS: *Students will keep considering …*

- Q1 – Why is it critical for engineers to document all calculation steps when solving problems?
- Q2 – How is material testing data useful?
- Q3 – Stress strain curve date points are useful in determining what specific material properties?

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

	Acquisition	
modern engineering tools necessary for engineering practice. • G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. • G7 – Demonstrate an understanding of professional and ethical responsibility. • G8 – Demonstrate an ability to function on multidisciplinary teams. • G9 – Demonstrate an ability to communicate effectively. • G10 – Gain knowledge of contemporary issues. • G11 – Recognize the need for, and develop an ability to engage in life-long learning.	***KNOWLEDGE:*** *Students will…* • K1 – Distinguish between stress and strain. • K2 – Distinguish between elastic and plastic deformation. U4, U5 • K3 – Describe the relationship between the tensile force applied to a material and the elongation of the material as it deforms elastically, plastically, and then ruptures. U4, U5 • K4 – Define the modulus of elasticity.	***SKILLS:*** *Students will…* • S1 – Calculate minimum or maximum design parameters to ensure a safe or reliable product using material strength properties. U1, U4, U5 • S2 – Measure axial force and elongation data of material samples and create stress-strain diagrams describing the intrinsic properties of the materials. U2, U3 • S3 – Identify and calculate test sample material properties using a stress-strain curve. U1, U2, U3, U4, U5

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

Evidence *(stage 2)*		
Activities (A) Projects (P) Problems(B)	Assessment FOR Learning	Assessment OF Learning
A.2.3.1 Stress/Strain Calculations	• Essential Questions • Student responses to presentation examples	• Calculations and Conclusion Questions
A.2.3.2 Tensile Testing	• Essential Questions	• Calculations and Conclusion Questions

Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems(B)	Knowledge and Skills
A.2.3.1 Stress/Strain Calculations	S1, S3
A.2.3.2 Tensile Testing	K1, K2, S2, S3

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

Curriculum Framework – Principles of Engineering (2015-2016)
Unit 2 Lesson 2.4 Design Problem: Bridge Simulated Structural Design

Desired Results *(stage 1)*

ESTABLISHED GOALS
It is expected that students will…

- G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
- G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
- G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.
- G5 – Demonstrate an ability to use the techniques, skills, and modern engineering tools

Transfer

TRANSFER: *Students will be able to independently use their learning to …*

- T1 – Apply an engineering design process to the creation of a simulated bridge design.
- T2 – To apply professional skills and work within a design team.
- T3 – Design and create the most efficient simulated bridge design based on specific design criteria.

Meaning

UNDERSTANDINGS: *Students will understand that …*

- U1 – Design problems can be solved by individuals or in teams.
- U2 – Engineers use a design process to create solutions to existing problems.
- U3 – Design briefs are used to identify the problem specifications and to establish project constraints.
- U4 – Working in a team requires effective communication, clear responsibilities, and attention to interpersonal relationships.
- U5 – Design teams conduct research to develop their knowledge base, stimulate creative ideas, and make informed decisions.

ESSENTIAL QUESTIONS: *Students will keep considering …*

- Q1 – What is a design brief? What are design constraints?
- Q2 – Why is a design process so important to follow when creating a solution to a problem?
- Q3 – What is a decision matrix and why is it used?
- Q4 – What does consensus mean, and how do teams use consensus to make decisions?
- Q5 – How do the properties and types of materials affect the solution to a design problem?

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

necessary for engineering practice. • G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. • G7 – Demonstrate an understanding of professional and ethical responsibility. • G8 – Demonstrate an ability to function on multidisciplinary teams. • G9 – Demonstrate an ability to communicate effectively. • G10 – Gain knowledge of contemporary issues. • G11 – Recognize the need for, and develop an ability to engage in life-long learning.	**Acquisition** ***KNOWLEDGE:*** *Students will …* • K1 – Know the purpose of each part of a design brief. U3 • K2 – Describe a step-by-step, iterative design process. U2	***SKILLS:*** *Students will …* • S1 – Brainstorm and sketch possible solutions to an existing design problem. U1, U2, U4, U5 • S2 – Create a decision-making matrix for a design problem. U1, U2 • S3 – Select an approach that meets or satisfies the constraints provided in a design brief. U1, U3 • S4 – Create a detailed pictorial sketch or use 3D-modeling software to document a proposed design. U1, U2, U4

Evidence *(stage 2)*		
Activities (A) Projects (P) Problems(B)	Assessment FOR Learning	Assessment OF Learning
B.2.4.1 Design Problem: Bridge Simulated Structural Design	• Essential Questions	• Conclusion Questions • Presentation of final simulated design

Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems(B)	Knowledge and Skills
B.2.4.1 Design Problem: Bridge Simulated Structural Design	K1, S1, S2, S3, S4

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

Curriculum Framework – Principles of Engineering (2015-2016)
Unit 3 Control Systems – Lesson 3.1 Machine Control

Desired Results *(stage 1)*

ESTABLISHED GOALS
It is expected that students will…

- G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
- G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
- G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.
- G5 – Demonstrate an ability to use the techniques, skills, and modern engineering tools necessary for engineering

Transfer

TRANSFER: *Students will be able to independently use their learning to …*

- T1 – *(Career Exploration)* Explore career opportunities, salaries, and required education to engineering.
- T2 – Create control system operating programs that utilize computer software given needs and constraints.

Meaning

UNDERSTANDINGS: *Students will understand that …*

- U1 – Control systems are designed to provide consistent process control, reliability, and automation.
- U2 – Control system algorithms are a sequence of instructions, often involving conditional statements and iterative loops.
- U3 – Machines can use open-loop or closed-loop control systems; closed-loop control systems can use digital and/or analog sensor feedback to make decisions.
- U4 – Complex algorithms are created by decomposing the algorithm into simple pieces, and complex machine behavior can similarly be decomposed into simple component behavior.
- U5 – Documentation – in the form of pseudocode, comments, and other documentation – can be an important part of creating and maintaining a computer program.
- U6 – Version control can be an important part of creating

ESSENTIAL QUESTIONS: *Students will keep considering …*

- Q1 – What are the advantages and disadvantages of using programmable logic to control machines versus monitoring and adjusting processes manually?
- Q2 – What are some everyday seemingly simple devices that contain microprocessors, and what function do the devices serve?
- Q3 – What questions must designers ask when solving problems in order to decide between digital or analog systems and between open or closed loop systems?

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

practice. • G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. • G7 – Demonstrate an understanding of professional and ethical responsibility. • G8 – Demonstrate an ability to function on multidisciplinary teams. • G9 – Demonstrate an ability to communicate effectively. • G10 – Gain knowledge of contemporary issues. • G11 – Recognize the need for, and develop an ability to engage in life-long learning.	and maintaining a computer program. • U7 – *(Design Process)* Design problems can be solved by individuals or in teams. (Same as U1 in Lesson 1.4) • U8 – *(Design Process)* Engineers use a design process to create solutions to existing problems. (Same as U2 in Lesson 1.4) • U9 – *(Design Process)* Engineers and engineering technologists apply math, science, and discipline-specific skills to solve problems. (Same as U1 of Lesson 1.1.) • U10 – *(Career Exploration)* Engineering and engineering technology careers offer creative job opportunities for individuals with a wide variety of backgrounds and goals. (Same as U2 of Lesson 1.1.)	
	Acquisition	
	KNOWLEDGE: *Students will …* • K1 – Distinguish between digital and analog data, and between the inputs and outputs of a computational system. U3 • K2 – Distinguish open and closed loop systems based on whether decisions are made using time delays or sensor feedback. U3 • K3 – Identify the relative advantage of an open-loop or closed-loop control system for a given technological problem. U3 • K4 – *(Career Exploration)* Describe the market demand and salary range for one type of engineer or engineering technician, and understand the education path that leads to that career. U8, U9	***SKILLS:*** *Students will …* • S1 – Choose appropriate input and output devices based on the need of a technological system. U1, U3 • S2 – Create a flow chart to describe an algorithm. U2, U5 • S3 – Create pseudocode to describe an algorithm. U2, U4, U5 • S4 – Analyze and describe an algorithm represented as a flowchart or as programming code. U2, U5 • S5 – Create a computer program to implement an algorithm, including conditional statements and iterations. U2, U3, U4, U5, U6 • S6 – Predict the behavior of a control system by examining the program it is going to execute. U2, U3, U4, U5 • S7 – Evaluate algebraic and logical expressions involving programming variables. U2, U5 • S8 – Use a variety of methods for finding, identifying, and correcting bugs in a program. U2, U3, U4, U5, U6 • S9 – Design and create a control system, including the

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

		inputs, computer program, and outputs, based on given needs and constraints. U1, U2, U3, U4, U5, U6, U7, U8 • S10 – *(Design Process)* Brainstorm and sketch possible solutions to an existing design problem. U1, U2, U3, U4, U7, U8 (Same as S1 of Lesson 1.4.) • S11 – *(Design Process)* Create a decision making matrix for a design problem. U7, U8 (Same as S1 of Lesson 1.4.) • S12 – *(Design Process)* Select an approach that meets or satisfies the constraints provided in a design brief. U1, U2, U3, U4, U7, U8 (Same as S1 of Lesson 1.4.) • S13 – *(Design Process)* Create a detailed pictorial sketch or use 3D modeling software to document a proposed design. U5, U7, U8 (Same as S1 of Lesson 1.4.) • S14 – *(Design Process)* Present a workable solution to a design problem. U1, U2, U4, U5, U7, U8 (Same as S1 of Lesson 1.4.)

Evidence *(stage 2)*			Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems(B)	Assessment FOR Learning	Assessment OF Learning	Activities (A) Projects (P) Problems(B)	Knowledge and Skills
A3.1.0 Career, Demand, Salary, and Education	• 3.1.RU Career Demand, Salary, & Education Rubric • Essential Questions	• 3.1.RU Career Demand, Salary, & Education Rubric	A3.1.0 Career, Demand, Salary, and Education	K4
A3.1.1 Inputs and Outputs	• Essential Questions • Instructor signoff of student demonstrated program	• Conclusion Questions	A3.1.1 Inputs and Outputs	K1, S1
A3.1.2 Basic Outputs Programming	• Essential Questions	• Conclusion Questions • Print out of program	A3.1.2 Basic Outputs Programming	K1, S1, S2, S3, S4
A3.1.3 Basic Inputs Programming	• Essential Questions	• Conclusion Questions • Print out of program	A3.1.3 Basic Inputs Programming	K1, S1, S2, S3, S4, S5
A3.1.4 While and If-else Structures	• Essential Questions	• Conclusion Questions • Print out of program	A3.1.4 While and If-else Structures	K1, S1, S2, S3, S4, S5, S6, S7, S8
A3.1.5 Variables and Functions	• Essential Questions	• Conclusion Questions • Print out of program	A3.1.5 Variables and Functions	K1, S1, S2, S3, S4, S5, S6, S7, S8
A3.1.6 Open and Closed Loop Systems	• Essential Questions	• Conclusion Questions • Print out of program	A3.1.6 Open and Closed Loop Systems	K2, K3, S1, S2, S3, S4, S5, S6, S7
P3.1.7 Machine Control Design	• 3.1.7.P.RU Machine Control Design Rubric (7 Problems) • Essential Questions	• 3.1.7.P.RU Machine Control Design Rubric (7 Problems) • Conclusion Questions	P3.1.7 Machine Control Design	K1, K2, K3, S1, S2, S3, S4, S5, S6, S7, S8, S9, S10, S11, S12, S13, S14

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

		• Presentation of machine control design with program.		

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

Curriculum Framework – Principles of Engineering (2015-2016)
Unit 3 Control Systems – Lesson 3.2 Fluid Power

Desired Results *(stage 1)*

ESTABLISHED GOALS
It is expected that students will…

- G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
- G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
- G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.

Transfer

TRANSFER: *Students will be able to independently use their learning to …*

- T1 – Design a system to solve a problem using hydraulic or pneumatics components.

Meaning

UNDERSTANDINGS: *Students will understand that …*

- U1 – The two types of fluid power systems – pneumatics and hydraulics – have both common and distinguishing characters.
- U2 – Fluid power is possible because in a system of confined fluid, pressure acts equally in all directions.
- U3 – All fluid power systems have basic components and functions in common, including a reservoir or receiver, a pump or compressor, a valve, and a cylinder.
- U4 – Fluid power systems are designed to transmit force over great distances, multiply an input force, and/or increase the distance that an output will move.
- U5 – Laws about the behavior of fluid systems and standard conventions for calculating values within fluid systems aid in the design and understanding of such systems.
- U6 – Standard schematic symbols and conventions are used to communicate fluid power designs.

ESSENTIAL QUESTIONS: *Students will keep considering …*

- Q1 – What impact does fluid power have on our everyday lives?
- Q2 – Can you identify devices or systems that do not use fluid power that might be improved with the use of fluid power?
- Q3 – What are similarities and differences of mechanical advantage in simple machines and hydraulic systems?
- Q4 – Why are Pascal's Law, the perfect gas laws, Bernoulli's Principle, and other similar rules important to engineers and designers of fluid power systems?

Acquisition

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

• G5 – Demonstrate an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. • G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. • G7 – Demonstrate an understanding of professional and ethical responsibility. • G8 – Demonstrate an ability to function on multidisciplinary teams. • G9 – Demonstrate an ability to communicate effectively. • G10 – Gain knowledge of contemporary issues. • G11 – Recognize the need for, and develop an ability to engage in life-long learning.	***KNOWLEDGE:*** *Students will …* • K1 – Identify the advantages of hydraulic and pneumatic systems relative to each other. U1 • K2 – Identify and explain basic components and functions of fluid power devices. U3 • K3 – Distinguish between pressure and absolute pressure. U5 • K4 – Distinguish between temperature and absolute temperature. U5	***SKILLS:*** *Students will …* • S1 – Identify devices that utilize hydraulic and pneumatic power. U1 • S2 – Distinguish between hydrodynamic and hydrostatic systems. U1 • S3 – Design, create, and test a hydraulic device. U1, U2, U3, U4, U5, U6 • S4 – Design, create, and test a pneumatic device. U1, U2, U3, U4, U5, U6 • S5 – Calculate design parameters in a fluid power system utilizing Pascal's Law. U2, U4, U5 • S6 – Calculate values in a pneumatic system utilizing the ideal gas laws. U2, U5 • S7 – Calculate flow rate, flow velocity, power, and mechanical advantage in a fluid power system. U5

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

Evidence *(stage 2)*			Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems(B)	Assessment FOR Learning	Assessment OF Learning	Activities (A) Projects (P) Problems(B)	Knowledge and Skills
A3.2.1 Fluid Power Applications	• Essential Questions • Gear Calculations • Student responses to presentation examples	• Conclusion Questions • Student presentation	A3.2.1 Fluid Power Applications	K2, S1
A3.2.2 Pneumatic Demonstration	• Essential Questions	• Conclusion Questions	A3.2.2 Pneumatic Demonstration	K2, S1
A3.2.3 Fluid Power Practice Problems	• Essential Questions • Student responses to presentation examples	• Practice problems	A3.2.3 Fluid Power Practice Problems	K3, K4, S5, S6, S7
P3.2.3 Pneumatic Brake Design (FT)	• 3.2.3.P.FT.RU Pneumatic Brake Design Rubric • Essential Questions	• 3.2.3.P.FT.RU Pneumatic Brake Design Rubric • Conclusion Questions • Presentation of final design	P3.2.3 Pneumatic Brake Design (FT)	K2, S1, S2
A3.2.4 Hydraulic Demonstration	• Essential Questions • Student responses to presentation examples	• Conclusion Questions	A3.2.4 Hydraulic Demonstration	K1, K2, S1, S3
P3.2.5 Hydraulic Lift Design	• 3.2.5.P.FT.RU Hydraulic Lift Design Rubric • Essential Questions	• 3.2.5.P.FT.RU Hydraulic Lift Design Rubric • Conclusion Questions • Presentation of final design	P3.2.5 Hydraulic Lift Design	K1, K2, S1, S4, S5

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

Curriculum Framework – Principles of Engineering (2015-2016)
Unit 3 Control Systems – Lesson 3.3 Design Problem: Materials Sorter

Desired Results *(stage 1)*

ESTABLISHED GOALS
It is expected that students will…

- G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
- G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
- G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.
- G5 – Demonstrate an ability to use the techniques, skills, and

Transfer

TRANSFER: *Students will be able to independently use their learning to …*

- T1 – Apply an engineering design process to the creation of a material sorter design.
- T2 – To apply a decision matrix in a design process to best defend a selection or choice in a design process.
- T3 – To apply professional skills and work within a design team.
- T4 – Design and create a renewable electrical energy generating and distribution system that utilizes wind, solar electric, and fuel cell energy conversion systems as part of a team.

Meaning

UNDERSTANDINGS: *Students will understand that …*

- U1 – Design problems can be solved by individuals or in teams. (Same as U1 of Lesson 1.4.)
- U2 – Engineers use a design process to create solutions to existing problems. (Same as U2 of Lesson 1.4.)
- U3 – Design briefs are used to identify the problem specifications and to establish project constraints. (Same as U3 of Lesson 1.4.)
- U4 – Working in a team requires effective communication, clear responsibilities, and attention to interpersonal relationships. (Same as U4 of Lesson 1.4.)
- U5 – Design teams conduct research to develop their knowledge base, stimulate creative ideas, and make informed decisions. (Same as U5 of Lesson 1.4.)
- U6 – Effective presentations are the result of preparation,

ESSENTIAL QUESTIONS: *Students will keep considering …*

- Q1 – What is a design brief and what are design constraints?
- Q2 – Why is a design process so important to follow when creating a solution to a problem?
- Q3 – What is a decision matrix and why is it used?
- Q4 – What does consensus mean, and how do teams use consensus to make decisions?
- Q5 – How does the use of mechanisms affect the overall solution to a design problem?

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

<table>
<tr>
<td rowspan="3">modern engineering tools necessary for engineering practice.
• G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
• G7 – Demonstrate an understanding of professional and ethical responsibility.
• G8 – Demonstrate an ability to function on multidisciplinary teams.
• G9 – Demonstrate an ability to communicate effectively.
• G10 – Gain knowledge of contemporary issues.
• G11 – Recognize the need for, and develop an ability to engage in life-long learning.</td>
<td colspan="2">are tailored to suit the purpose and audience, and are improved by attending to posture, gestures, appearance, eye contact, and time constraints. (Same as U6 of Lesson 1.4.)</td>
</tr>
<tr>
<td colspan="2">Acquisition</td>
</tr>
<tr>
<td>KNOWLEDGE: Students will …

• K1 – Know the purpose of each part of a design brief. U3
• K2 – Describe a step-by-step, iterative design process. U2</td>
<td>SKILLS: Students will …

• S1 – Brainstorm and sketch possible solutions to an existing design problem. U1, U2, U4, U5
• S2 – Create a decision making matrix for a design problem. U1, U2
• S3 – Select an approach that meets or satisfies the constraints provided in a design brief. U1, U3
• S4 – Create a detailed pictorial sketch or use 3D modeling software to document a proposed design. U1, U2, U4
• S5 – Present a workable solution to a design problem. U1, U2, U4, U6</td>
</tr>
</table>

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

Evidence *(stage 2)*		
Activities (A) Projects (P) Problems(B)	Assessment FOR Learning	Assessment OF Learning
B.3.3.1 Design Problem: Materials Sorter	• 3.3.1.P.RU Material Sorter Design Rubric • Essential Questions	• 3.3.1.P.RU Material Sorter Design Rubric • Conclusion Questions • Presentation of final design

Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems(B)	Knowledge and Skills
B.3.3.1 Design Problem: Materials Sorter	S1, S2, S3, S4, S5

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

Curriculum Framework – Principles of Engineering (2015-2016)
Unit 4 Statistics and Kinematics – Lesson 4.1 Statistics

Desired Results *(stage 1)*

ESTABLISHED GOALS
It is expected that students will…

- G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
- G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
- G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.
- G5 – Demonstrate an ability to use the techniques, skills, and modern engineering tools

Transfer

TRANSFERS: *Students will be able to independently use their learning to …*

- T1 – Analyze and interpret data in order to make valid and reliable claims or determine optimal design solutions.
- T2 – Determine the theoretical probability that an event will occur.

Meaning

UNDERSTANDINGS: *Students will understand that …*

- U1 – Engineers use statistics to make informed decisions based upon established principles.
- U2 – Visual representations of data allow a person to understand and gain knowledge from the data.
- U3 – Descriptive statistics produce an abstraction from data, allowing us to communicate a meaningful summary instead of unenlightening details.
- U4 – The theoretical likelihood of an event can often be calculated based on a small number of simple assumptions.
- U5 – Inferential statistics allow us to generalize by drawing conclusions from data based on the laws of theoretical probability.
- U6 – *(Design Process)* Engineers and engineering technologists apply math, science, and discipline-specific skills to solve problems. (Same as U1 of Lesson 1.1.)
- U7 – *(Career Exploration)* Engineering and engineering technology careers offer creative job opportunities for individuals with a wide variety of backgrounds and goals.

ESSENTIAL QUESTIONS: *Students will keep considering …*

- Q1 – Why is it crucial for designers and engineers to utilize statistics throughout the design process?
- Q2 – Why is process control a necessary statistical process for ensuring product success?
- Q3 – Why is theory-based data interpretation valuable in decision making?
- Q4 – Why is experiment-based data interpretation valuable in decision making?

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

necessary for engineering practice. • G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. • G7 – Demonstrate an understanding of professional and ethical responsibility. • G8 – Demonstrate an ability to function on multidisciplinary teams. • G9 – Demonstrate an ability to communicate effectively. • G10 – Gain knowledge of contemporary issues. • G11 – Recognize the need for, and develop an ability to engage in life-long learning.	(Same as U2 of Lesson 1.1.)	
	Acquisition	
	KNOWLEDGE: *Students will …* • K1 – Name measures of central tendency and variation and describe their meaning. • K2 – Distinguish between sample statistics and population statistics and know appropriate applications of each.	***SKILLS:*** *Students will …* • S1 – *(Career Exploration)* Evaluate how personal career interests align or do not align with one or more fields of engineering or engineering technology. U6 • S2 – Calculate the theoretical probability that a simple event will occur. U4 • S3 – Produce a frequency distribution to describe experimental results and create a histogram to communicate these results. U2, U3 • S4 – Calculate the probability of making a set of observations in a series of trials where each trial has two distinct possible outcomes. U4 • S5 – Apply AND, OR, and NOT logic to probability. U4 • S6 – Apply Bayes' Theorem to calculate a probability in a manufacturing context. U4 • S7 – Calculate the central tendency of a data set, including mean, median, and mode.U3 • S8 – Calculate the variation in a set of data, including range, standard deviation, and variance. U3

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

Evidence *(stage 2)*		
Activities (A) Projects (P) Problems(B)	Assessment FOR Learning	Assessment OF Learning
A4.1.0 Career Reflection, Abstract, Presentation	• 4.1.RU Career Reflection Abstract Presentation Rubric • Essential Questions	• 4.1.RU Career Reflection Abstract Presentation Rubric • Final student presentation
A4.1.1 Statistical Data Exploration	• Essential Questions • Student responses to presentation examples	• Histogram and Conclusion Questions
A4.1.2 Candy Statistics	• Essential Questions • Student responses to presentation examples	• Histogram and Conclusion Questions

Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems(B)	Knowledge and Skills
A4.1.0 Career Reflection, Abstract, Presentation	S1
A4.1.1 Statistical Data Exploration	S2, S3, S4, S5, S6, S7, S8
A4.1.2 Candy Statistics	S2, S3, S4, S5, S6, S7, S8

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

Curriculum Framework – Principles of Engineering (2014-2015)
Unit 4 Statics and Kinematics – Lesson 4.2 Kinematics

Desired Results *(stage 1)*

ESTABLISHED GOALS
It is expected that students will…

- G1 – Demonstrate an ability to identify, formulate, and solve engineering problems.
- G2 – Demonstrate an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- G3 – Demonstrate an ability to design and conduct experiments, as well as to analyze and interpret data.
- G4 – Demonstrate an ability to apply knowledge of mathematics, science, and engineering.
- G5 – Demonstrate an ability to use the techniques, skills, and

Transfer

TRANSFER: *Students will be able to independently use their learning to …*

- T1 – Predict theoretically where a projectile should land based on the calculated initial velocity and the angle the projectile is fired at.

Meaning

UNDERSTANDINGS: *Students will understand that …*

- U1 – When working with bodies in motion, engineers must be able to distinguish and calculate distance, displacement, speed, velocity, and acceleration.
- U2 – When air resistance is not taken into account, released objects will experience acceleration due to gravity, also known as freefall.
- U3 – Projectile motion can be predicted and controlled using kinematics equations.
- U4 – During projectile motion, velocity in the x-direction remains constant; while velocity in the y-direction changes at a constant rate due to gravity.
- U5 – *(Design Process)* Design problems can be solved by individuals or in teams. (Same as U1 of Lesson 1.4.)
- U6 – *(Design Process)* Engineers use a design process to create solutions to existing problems. (Same as U2 of Lesson 1.4.)
- U7 – *(Design Process)* Design briefs are used to identify the problem specifications and to establish project constraints. (Same as U3 of Lesson 1.4.)

ESSENTIAL QUESTIONS: *Students will keep considering …*

- Q1 – What are the relationships between distance, displacement, speed, velocity, and acceleration?
- Q2 – Why is it important to understand and be able to control the motion of a projectile?

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

modern engineering tools necessary for engineering practice. • G6 – Pursue the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context. • G7 – Demonstrate an understanding of professional and ethical responsibility. • G8 – Demonstrate an ability to function on multidisciplinary teams. • G9 – Demonstrate an ability to communicate effectively. • G10 – Gain knowledge of contemporary issues. • G11 – Recognize the need for, and develop an ability to engage in life-long learning.	• U8 – *(Design Process)* Working in a team requires effective communication, clear responsibilities, and attention to interpersonal relationships. (Same as U4 of Lesson 1.4.) • U9 – *(Design Process)* Design teams conduct research to develop their knowledge base, stimulate creative ideas, and make informed decisions. (Same as U5 of Lesson 1.4.) • U10 – *(Design Process)* Effective presentations are the result of preparation, are tailored to suit the purpose and audience, and are improved by attending to posture, gestures, appearance, eye contact, and time constraints. (Same as U6 of Lesson 1.4.)	
	Acquisition	
	KNOWLEDGE: *Students will …* • K1 – Describe freefall motion of a projectile as having constant velocity in the horizontal direction and uniformly accelerating motion in the vertical direction. U4 • K2 – *(Design Process)* Know the purpose of each part of a design brief. U7 • K3 – *(Design Process)* Describe a step-by-step, iterative design process. U6	***SKILLS:*** *Students will …* • S1 – Calculate distance, displacement, speed, velocity, and acceleration from data. U1, U2, U3, U4 • S2 – Design, build, and test a machine that efficiently channels mechanical energy when friction and limited input energy are significant constraints. U1 • S3 – Calculate acceleration due to gravity given data from a free-fall trajectory. U2, U4 • S4 – Calculate the x- and y-components of a projectile motion. U1, U3, U4 • S5 – Determine the angle needed to launch a projectile a specific range given the projectile's initial velocity. U1, U2, U3, U4 • S6 – *(Design Process)* Brainstorm and sketch possible solutions to an existing design problem. U5, U6, U8, U9 • S7 – *(Design Process)* Create a decision making matrix for a design problem. U5, U6 • S8 – *(Design Process)* Select an approach that meets or satisfies the constraints provided in a design brief. U5, U7 • S9 – *(Design Process)* Create a detailed pictorial sketch or use 3D modeling software to document a proposed design. U5, U6, U7

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD

		• S10 – *(Design Process)* Present a workable solution to a design problem. U5, U6, U8, U9

Evidence *(stage 2)*		
Activities (A) Projects (P) Problems(B)	Assessment FOR Learning	Assessment OF Learning
A4.2.1 Self Propelled Vehicle Design	• Essential Questions	• Conclusion Questions • Presentation of final design
A4.2.2 Projectile Motion	• Essential Questions • Student responses to presentation examples	• Calculations and Conclusion Questions
4.2.3 Design Problem: Ballistic Device		• Conclusion Questions • Presentation of final design

Learning Plan *(stage 3)*	
Activities (A) Projects (P) Problems(B)	Knowledge and Skills
A4.2.1 Self Propelled Vehicle Design	K1, S2, S4, S5, S6
A4.2.2 Projectile Motion	S3
4.2.3 Design Problem: Ballistic Device	K2, K3, S6,S7, S8,S9,S10

Format guided by: Wiggins, G. & McTighe, J. (2011). The understanding by design guide to creating high quality units. Alexandria. VA: ASCD