PASSAIC COUNTY TECHNICAL INSTITUTE

WAYNE, NJ

PLTW | Engineering

PROJECT LEAD THE WAY™ 3 CURRICULUM

Principles of Engineering

Revised February 2015

Project Lead the Way 3 Curriculum – Overview

I. Course Description

Principles Of Engineering ™ (POE) is a high school-level survey course of engineering. The course exposes students to some of the major concepts that they will encounter in a postsecondary engineering course of study. Students have an opportunity to investigate engineering and high tech career POE gives students the opportunity to develop skills and understanding of course concepts through activity-, project-, and problem-based (APPB) learning. Used in combination with a teaming approach, APPB learning challenges students to continually hone their interpersonal skills, creative abilities, and problem solving skills based upon engineering concepts. It also allows students to develop strategies to enable and direct their own learning, which is the ultimate goal of education.

To be successful in POE, students should be concurrently enrolled in college preparatory mathematics and science. Students will employ engineering and scientific concepts in the solution of engineering design problems. Students will develop problem-solving skills and apply their knowledge of research and design to create solutions to various challenges. Students will also learn how to document their work and communicate their solutions to their peers and members of the professional community.

Principles Of Engineering is one of the foundation courses in the Project Lead The Way high school engineering program. The course applies and concurrently develops secondary level knowledge and skills in mathematics, science, and technology.

The course of study includes:

Mechanisms
Energy Sources
Energy Applications
Machine Control
Fluid Power
Statics
Material Properties
Material Testing
Statistics
Kinematics

II. Course Objectives & Outline

Content Area	Project Lead The Way 3	**Grade(s): 11**
Unit Plan Title	Unit 1: Energy and Power	Time Frame: 10 weeks
Standard(s)		

- **Common Core Reading Standards:**
  - (RST.11-12.1) (RST.11-12.2) (RST.11-12.3) (RST.11-12.4) (RST.11-12.5)
  - (RST.11-12.6) (RST.11-12.7) (RST.11-12.8) (RST.11-12.9) (RST.11-12.10)
- **Common Core Writing Standards:**
  - (WHST.11-12.1) (WHST.11-12.2) (WHST.11-12.3) (WHST.11-12.4) (WHST.11-12.5)
  - (WHST.11-12.6) (WHST.11-12.7) (WHST.11-12.8) (WHST.11-12.9) (WHST.11-12.10)
- **Common Core Mathematics Standards:**
  - Quantities (N.Q .1) (N.Q .2) (N.Q .3)
  - Seeing Structure In Expressions (A.SSE.1) (A.SSE.1.a) (A.SSE.1.b)
  - Creating Equations (A.CED.1) (A.CED.4)
  - Reasoning With Equations And Inequalities (A.REI.3)
  - Linear, Quadratic, And Exponential Models (F.LE.1.b)
  - Modeling With Geometry (G.MG.1) (G.MG.3)
- **Career & Technical Education (CTE) Content Area:**
  - (9.3.ST.1)(9.3.ST.2)(9.3.ST.3)(9.3.ST.4)(9.3.ST.5)(9.3.ST.6)
  - (9.3.ST-ET.1)(9.3.ST-ET.2)(9.3.ST-ET.3)(9.3.ST-ET.4)(9.3.ST-ET.5)(9.3.ST-ET.6)
  - (9.3.ST-SM.1) (9.3.ST-SM.2) (9.3.ST-SM.3) (9.3.ST-SM.4)
- **NJCCCS Technology:**
  - (8.2.12.A.2) (8.2.12.A.3)
  - (8.2.12.B.1) (8.2.12.B.2) (8.2.12.B.4) (8.2.12.B.5)
  - (8.2.12.C.2) (8.2.12.C.3) (8.2.12.C.5) (8.2.12.C.6) (8.2.12.C.7)
  - (8.2.12.D.1) (8.2.12.D.2) (8.2.12.D.3) (8.2.12.D.4) (8.2.12.D.5) (8.2.12.D.6)
  - (8.2.12.E.1)

Essential Questions
1. Why is it important to begin considering career paths during high school? 2. What are some current applications of simple machines, gears, pulleys, and sprockets? 3. What are the trades-offs of mechanical advantage related to design? 4. What sources of energy are available for use? 5. What are the benefits and drawbacks regarding efficiency, usefulness, and the environment? 6. Describe where and how the electricity that reaches your home is produced. 7. Describe and identify inefficient use of energy and power at home, school, or work. 8. What limitations affect electricity production using solar cells and hydrogen fuel cells? 9. How does thermodynamics relate to energy and power? 10. What are some everyday examples of the First and Second Laws of Thermodynamics?
Anchor Text(s)
• Project Lead The Way® Curriculum: Principles of Engineering © 2014 Charitable Venture Foundation, Indianapolis, IN. • Principles of Engineering (Handley, Marshall, Coon) © 2012 Delmar, Cengage Learning, Clifton Park, NY
Suggested Writing Assessments
• Engineering Notebook • Activity and Project Conclusion Questions • Research Report on Professional Interview • Technical Report on Compound Machine
Resources
Microsoft Office, Autodesk Inventor Professional 2015, Internet, Engineering Notebook
Informational Texts *[career-related readings; journal articles, books, etc]*
The PLTW Learning Management System (LMS)

Content Area	Project Lead The Way 3	Grade(s): 11
Unit Plan Title	Unit 2: Materials and Statics	Time Frame: 8 weeks

Standard(s)

- **Common Core Reading Standards:**
  - (RST.11-12.1) (RST.11-12.2) (RST.11-12.3) (RST.11-12.4) (RST.11-12.5)
  - (RST.11-12.6) (RST.11-12.7) (RST.11-12.8) (RST.11-12.9) (RST.11-12.10)
- **Common Core Writing Standards:**
  - (WHST.11-12.1) (WHST.11-12.2) (WHST.11-12.3) (WHST.11-12.4) (WHST.11-12.5)
  - (WHST.11-12.6) (WHST.11-12.7) (WHST.11-12.8) (WHST.11-12.9) (WHST.11-12.10)
- **Common Core Mathematics Standards:**
  - Key Ideas and Details (AS.R.1) (AS.R.2) (AS.R.7) (AS.R.9) (AS.R.10)
  - Text Types and Purposes (AS.W.2) (AS.W.4)(AS.W.7) (AS.W.8) (AS.W.9) (AS.W.10)
  - Comprehension and Collaboration (AS.SL.2) (AS.SL.4) (AS.SL.5)
  - Conventions of Standard English (AS.L.1) (AS.L.2) (AS.L.6)
  - Geometric Measurement And Dimension (G.GMD.3)(G.GMD.4)
  - Modeling With Geometry (G.MG.1) (G.MG.2)
  - Quantities (N.Q .1) (N.Q .2) (N.Q .3)
  - Seeing Structure In Expressions (A.SSE.1) (A.SSE.1.a) (A.SSE.1.b)
- **Career & Technical Education (CTE) Content Area:**
  - (9.3.ST.2)(9.3.ST.3)(9.3.ST.4)(9.3.ST.5)(9.3.ST.6)
  - (9.3.ST-ET.1)(9.3.ST-ET.2)(9.3.ST-ET.3)(9.3.ST-ET.4)(9.3.ST-ET.5)
  - (9.3.ST-SM.1) (9.3.ST-SM.2) (9.3.ST-SM.3) (9.3.ST-SM.4)
- **NJCCCS Technology:**
  - (8.2.12.A.3)
  - (8.2.12.C.2) (8.2.12.C.3) (8.2.12.C.5) (8.2.12.C.6) (8.2.12.C.7)
  - (8.2.12.D.1) (8.2.12.D.2) (8.2.12.D.3) (8.2.12.D.5) (8.2.12.D.6) (8.2.12.E.1)

Essential Questions

1. Why is it crucial for designers and engineers to construct accurate free body diagrams of the parts and structures that they design?
2. Why must designers and engineers calculate forces acting on bodies and structures?
3. When solving truss forces, why is it important to know that the structure is statically determinate?
4. How does an engineer predict the performance and safety for a selected material?
5. What are the advantages and disadvantages of utilizing synthetic materials designed by engineers?
6. What ethical issues pertain to engineers designing synthetic materials?
7. What did you learn about the significance of selecting materials for product design?
8. How can an existing product be changed to incorporate different processes to make it less expensive and provide better performance?
9. How does an engineer decide which manufacturing process to use for a given material?

10. How do the recycling codes and symbols differ from state to state?
11. Why is it critical for engineers to document all calculation steps when solving problems?
12. How is material testing data useful?
13. Stress strain curve date points are useful in determining what specific material properties?

Anchor Text(s)

- Project Lead The Way® Curriculum: Principles of Engineering © 2014 Charitable Venture Foundation, Indianapolis, IN.
- Principles of Engineering (Handley, Marshall, Coon) © 2012 Delmar, Cengage Learning, Clifton Park, NY

Suggested Writing Assessments

- Engineering Notebook
- Activity and Project Conclusion Questions
- Research Report on Career Field Description
- Technical Report on Truss Design Challenge

Resources

Microsoft Office, Autodesk Inventor Professional 2015, Internet, Engineering Notebook, MDSolids, West Point Bridge Builder design software

Informational Texts *[career-related readings; journal articles, books, etc]*

The PLTW Learning Management System (LMS)

Content Area	Project Lead The Way 3	Grade(s): 11
Unit Plan Title	Unit 3: Control Systems	Time Frame: 9 weeks

Standard(s)

- **Common Core Reading Standards:**
  - (RST.11-12.1) (RST.11-12.2) (RST.11-12.3) (RST.11-12.4) (RST.11-12.5)
  - (RST.11-12.6) (RST.11-12.7) (RST.11-12.8) (RST.11-12.9) (RST.11-12.10)
- **Common Core Writing Standards:**
  - (WHST.11-12.1) (WHST.11-12.2) (WHST.11-12.3) (WHST.11-12.4) (WHST.11-12.5)
  - (WHST.11-12.6) (WHST.11-12.7) (WHST.11-12.8) (WHST.11-12.9) (WHST.11-12.10)
- **Common Core Mathematics Standards:**
  - Quantities (N.Q .3)
- **Career & Technical Education (CTE) Content Area:**
  - (9.3.ST.2)(9.3.ST.3)(9.3.ST.4)(9.3.ST.5)(9.3.ST.6)
  - (9.3.ST-ET.1)(9.3.ST-ET.2)(9.3.ST-ET.3)(9.3.ST-ET.4)(9.3.ST-ET.5)
  - (9.3.ST-SM.1) (9.3.ST-SM.2) (9.3.ST-SM.3) (9.3.ST-SM.4)
- **NJCCCS Technology:**
  - (8.2.12.A.3)
  - (8.2.12.C.2) (8.2.12.C.3) (8.2.12.C.5) (8.2.12.C.6) (8.2.12.C.7)
  - (8.2.12.D.1) (8.2.12.D.2) (8.2.12.D.3) (8.2.12.E.1) (8.2.12.E.2) (8.2.12.E.3) (8.2.12.E.4)

Essential Questions

1. What are the advantages and disadvantages of using programmable logic to control machines versus monitoring and adjusting processes manually?
2. What are some everyday seemingly simple devices that contain microprocessors, and what function do the devices serve?
3. What questions must designers ask when solving problems in order to decide between digital or analog systems and between open or closed loop systems?
4. What impact does fluid power have on our everyday lives?
5. Can you identify devices or systems that do not use fluid power that might be improved with the use of fluid power?
6. What are similarities and differences of mechanical advantage in simple machines and hydraulic systems?
7. 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?
8. What is a design brief and what are design constraints?
9. Why is a design process so important to follow when creating a solution to a problem?
10. What is a decision matrix and why is it used?
11. What does consensus mean, and how do teams use consensus to make decisions?
12. How does the use of mechanisms affect the overall solution to a design problem?

Anchor Text(s)
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Suggested Writing Assessments
• Engineering Notebook • Activity and Project Conclusion Questions • Research Report on Career Demand, Salary, and Education • Technical Report on Machine Control Design (using Pneumatics and Hydraulics)
Resources
Microsoft Office, Autodesk Inventor Professional 2015, Internet, Engineering Notebook, VEX Robotics Kit, ROBOTC Programming Software
Informational Texts *[career-related readings; journal articles, books, etc]*
The PLTW Learning Management System (LMS)

Content Area	Project Lead The Way 3	Grade(s): 11
Unit Plan Title	Unit 4: Statistics and Kinematics	Time Frame: 6 weeks

Standard(s)

- **Common Core Reading Standards:**
  - (RST.11-12.1) (RST.11-12.2) (RST.11-12.3) (RST.11-12.4) (RST.11-12.5)
  - (RST.11-12.6) (RST.11-12.7) (RST.11-12.8) (RST.11-12.9) (RST.11-12.10)
- **Common Core Writing Standards:**
  - (WHST.11-12.1) (WHST.11-12.2) (WHST.11-12.3) (WHST.11-12.4) (WHST.11-12.5)
  - (WHST.11-12.6) (WHST.11-12.7) (WHST.11-12.8) (WHST.11-12.9) (WHST.11-12.10)
- **Common Core Mathematics Standards:**
  - Interpreting Categorical And Quantitative Data (S.ID.1) (S.ID.2) (S.ID.3) (S.ID.4)
  - Making Inferences And Justifying Conclusions (S.IC.1) (S.IC.2) (S.IC.4)
  - Conditional Probability And The Rules Of Probability (S.CP.1) (S.CP.2) (S.CP.3) (S.CP.4) (S.CP.5) (S.CP.6) (S.CP.7) (S.CP.8) (S.CP.9)
  - Using Probability To Make Decisions (S.MD.7)
  - The Real Number System (N.RN.2)
  - Quantities (N.Q .1) (N.Q .2) (N.Q .3)
  - Vector And Matrix Quantities (N.VM.1) (N.VM.2) (N.VM.3)
  - Seeing Structure In Expressions (A.SSE.1) (A.SSE.1.a) (A.SSE.1.b)
  - Creating Equations (A.CED.3) (A.CED.4)
  - Reasoning With Equations And Inequalities (A.REI.3) (A.REI.4)
  - Trigonometric Functions (F.TF.7)
  - Similarity, Right Triangles, And Trigonometry (G.SRT.6) (G.SRT.8)
  - Modeling With Geometry (G.MG.3)
  - Interpreting Categorical And Quantitative Data (S.ID.2)
- **Career & Technical Education (CTE) Content Area:**
  - (9.3.ST.2)(9.3.ST.3)(9.3.ST.4)(9.3.ST.5)(9.3.ST.6)
  - (9.3.ST-ET.1)(9.3.ST-ET.2)(9.3.ST-ET.3)(9.3.ST-ET.4)(9.3.ST-ET.5)
  - (9.3.ST-SM.1) (9.3.ST-SM.2) (9.3.ST-SM.3) (9.3.ST-SM.4)
- **NJCCCS Technology:**
  - (8.2.12.A.3)(8.2.12.B.4)
  - (8.2.12.C.2) (8.2.12.C.3) (8.2.12.C.5) (8.2.12.C.6) (8.2.12.C.7)
  - (8.2.12.D.1) (8.2.12.D.2) (8.2.12.D.3)
  - (8.2.12.E.1)

Essential Questions

1. Why is it crucial for designers and engineers to utilize statistics throughout the design process?
2. Why is process control a necessary statistical process for ensuring product success?
3. Why is theory-based data interpretation valuable in decision making?
4. Why is experiment-based data interpretation valuable in decision making? What are the relationships between distance, displacement, speed, velocity, and acceleration?
5. Why is it important to understand and be able to control the motion of a projectile?

Anchor Text(s)

- Project Lead The Way® Curriculum: Principles of Engineering © 2014 Charitable Venture Foundation, Indianapolis, IN.
- Principles of Engineering (Handley, Marshall, Coon) © 2012 Delmar, Cengage Learning, Clifton Park, NY

Suggested Writing Assessments

- Engineering Notebook
- Activity and Project Conclusion Questions
- Research Report on Career Reflection, Abstract, and Presentation
- Technical Report on Ballistic Device

Resources

Microsoft Office, Autodesk Inventor Professional 2015, Internet, Engineering Notebook, Logger Pro, Convert

Informational Texts *[career-related readings; journal articles, books, etc]*

The PLTW Learning Management System (LMS)

III. Methods of Student Evaluations

The following assessment methods may be used in a variety of combinations by teachers and students in order to gather information on student understanding and instruction. This information should be used in the preparation and designing of future lessons or related activities. Teachers and students should consider the various assessment methods as a means to improve instruction and learning.

- Computerized assessment
- Concept mapping
- Demonstrations/Presentations
- Engineering Notebook
- Informal observations/discussions/conferences
- Student self-reflection/assessment …
- Performance assessment Paper and pencil tests
- Performance tasks
- Portfolios
- Project/Product
- Individual and group work
- Research Papers
- Technical Reports
- Tests and/or Quizzes

Mastering of the core proficiencies of Project Lead The Way 3 shall be evaluated in accordance with the general grading policies as listed in the student handbook:

- PLTW Projects/Tests 40%
- PLTW Activities/Engineering Notebook 20%
- Quizzes 20%
- Homework/Class Notebook 10%
- Class Participation 10%

IV. List of Textbooks, Instructional Materials and Software

- Project Lead The Way® Curriculum: Principles of Engineering™ © 2014 Charitable Venture Foundation, Indianapolis
- Principles of Engineering (Handley, Marshall, Coon) © 2012 Delmar, Cengage Learning, Clifton Park, NY, (Includes workbook and solutions manual)
- Technical Drawing textbook, 13th Ed.,(Giesecke/Mitchell/Spencer, et al.) © 2009 Pearson Education, Upper Saddle River, NJ
- Logger Pro® data collection software © 1996-2013 Vernier Software & Technology
- Autodesk® Inventor® Professional 2014, 64-Bit Edition © 2013 Autodesk, Inc.
- MDSolids Version 3.5.0 © 1997-2009 Timothy A. Philpot
- West Point Bridge Designer 2013, Version 1.13.43
- SSA1000 Structural Stress Analyzer data collection software, Advanced MFG. Techniques, Inc.
- ROBO Pro Graphical Programming Language V3.1.2, © 2004-2011 fischertechnik GmbH
- ROBOTC 4.26 Programming Software for the VEX® CORTEX and VEX® IQ Robotic Systems ©2013 Robomatter LLC/DRJ Software LLC
- Microsoft® Office Professional Plus 2010, © 2010 Microsoft Corporation
- Adobe® Reader® XI, © 1984-2012 Adobe Systems Inc.

V. Instructional Strategies

The main goal of this course is to recruit students into a career in one of the many fields of engineering by using hands-on activities for motivation. The curriculum content engages students is APPB learning: Activities, Projects, and Problem-Based. Projects allow the students to demonstrate understanding of the subject content, engage in meaningful activities, become independent learners, make connections from prior knowledge, use real life technologies and resources, obtain ownership of their learning, and exhibit growth in social skills, self-management skills, and ability to learn on one's own.

Instruction will be given using class notes, prepared worksheets, and activities from the Principles of Engineering Curriculum 2014. Hands on experience in problem solving (in teams and individually) is used along with computer aided drawing, technical writing, creating spreadsheets and PowerPoint presentations. Research requiring the internet is included.

VI. Scope and Sequence

Scope and Sequence Chart – Unit 1				
SKILL TO BE LEARNED **Key: I – Introduced, D – Developed, R– Reinforced**	**SUGGESTED GRADE LEVELS**			
	9	**10**	**11**	**12**
Differentiate between engineering and engineering technology	I		ID	IDR
Conduct a professional interview and reflect on it in writing.			I	
Identify and differentiate among different engineering disciplines.	I	ID	IDR	IDR
Measure forces and distances related to mechanisms.			ID	IDR
Distinguish between the six simple machines, their attributes, and components.			ID	IDR
Calculate mechanical advantage and drive ratios of mechanisms.			ID	IDR
Design, create, and test gear, pulley, and sprocket systems.			ID	IDR
Calculate work and power in mechanical systems.	I	ID	IDR	IDR
Determine efficiency in a mechanical system.		I	ID	IDR
Design, create, test, and evaluate a compound machine design.		I	IR	IDR
Identify and categorize energy sources as nonrenewable, renewable, or inexhaustible.			I	ID
Create and deliver a presentation to explain a specific energy source.			I	ID
Summarize and reflect upon information collected during a visit to a local utility company.	I	ID	IDR	IDR
Define the possible types of power conversion.		I	ID	IDR
Calculate work and power.		I	ID	IDR
Demonstrate the correct use of a digital multimeter.		ID	IDR	IDR
Calculate power in a system that converts energy from electrical to mechanical.		I	ID	IDR
Determine efficiency of a system that converts an electrical input to a mechanical output.		I	ID	IDR
Calculate circuit resistance, current, and voltage using Ohm's law.		ID	IDR	IDR

Scope and Sequence Chart – Unit 1				
SKILL TO BE LEARNED **Key: I – Introduced, D – Developed, R– Reinforced**	**SUGGESTED GRADE LEVELS**			
	9	**10**	**11**	**12**
Understand the advantages and disadvantages of parallel and series circuit design in an application.		ID	IDR	
Test and apply the relationship between voltage, current, and resistance relating to a photovoltaic cell and a hydrogen fuel cell.		ID	IDR	IDR
Experiment with a solar hydrogen system to produce mechanical power.			ID	IDR
Design, construct, and test recyclable insulation materials.			ID	IDR
Test and apply the relationship between R-values and recyclable insulation.			ID	IDR
Complete calculations for conduction, R-values, and radiation.			ID	
Brainstorm and sketch possible solutions to an existing design problem.	I	ID	IDR	IDR
Create a decision-making matrix for a design problem.	I	ID	IDR	IDR
Select an approach that meets or satisfies the constraints provided in a design brief.	I	ID	IDR	IDR
Create a detailed pictorial sketch or use 3D modeling software to document the best choice, based upon the design team's decision matrix	I		ID	IDR
Present a workable solution to the design problem.	I		ID	IDR

Scope and Sequence Chart – Unit 2				
SKILL TO BE LEARNED **Key: I – Introduced, D – Developed, R– Reinforced**	**SUGGESTED GRADE LEVELS**			
	9	**10**	**11**	**12**
Create free body diagrams of objects, identifying all forces acting on the object			ID	IDR
Mathematically locate the centroid of structural members.			I	
Calculate moment of inertia of structural members.			I	
Differentiate between scalar and vector quantities.			ID	IDR
Identify magnitude, direction, and sense of a vector.			ID	IDR
Calculate the X and Y components given a vector.			ID	IDR
Calculate moment forces given a specified axis.			ID	IDR
Use equations of equilibrium to calculate unknown forces.			ID	
Use the method of joints strategy to determine forces in the members of a statically determinate truss.			I	
Investigate specific material properties related to a common household product.	I		ID	IDR
Conduct investigative non-destructive material property tests on selected common household products. Property testing conducted to identify continuity, ferrous metal, hardness, and flexure.	I		ID	IDR
Calculate weight, volume, mass, density, and surface area of selected common household product	ID		IDR	IDR
Identify the manufacturing processes used to create the selected common household product.	I		ID	IDR
Identify the recycling codes.			ID	
Promote recycling using current media trends.			ID	
Utilize a five-step technique to solve word problems.			ID	IDR
Obtain measurements of material samples.			ID	
Tensile test a material test sample.			ID	
Identify and calculate test sample material properties using a stress strain curve.			I	

Scope and Sequence Chart – Unit 3				
SKILL TO BE LEARNED **Key: I – Introduced, D – Developed, R– Reinforced**	**SUGGESTED GRADE LEVELS**			
	9	**10**	**11**	**12**
Create detailed flow charts utilizing a computer software application.			ID	DR
Create control system operating programs utilizing computer software.		ID	DR	R
Create system control programs that utilize flowchart logic.		ID	DR	R
Choose appropriate inputs and output devices based on the need of a technological system.		ID	DR	R
Differentiate between the characteristics of digital and analog devices.		ID	DR	R
Judge between open and closed loop systems in order to choose the most appropriate system for a given technological problem.		ID	DR	R
Design and create a control system based on given needs and constraints.		I	D	R
Identify devices that utilize fluid power.	I		ID	R
Identify and explain basic components and functions of fluid power devices.	I		ID	R
Differentiate between the characteristics of pneumatic and hydraulic systems.	I		ID	R
Distinguish between hydrodynamic and hydrostatic systems.			I	D
Design, create, and test a hydraulic device.			ID	R
Design, create, and test a pneumatic device.			ID	R
Calculate values in a fluid power system utilizing Pascal's Law.			ID	IDR
Distinguish between pressure and absolute pressure.			ID	
Distinguish between temperature and absolute temperature.			ID	
Calculate values in a pneumatic system, utilizing the perfect gas laws.			ID	DR
Calculate flow rate, flow velocity, and mechanical advantage in a hydraulic system.			ID	DR

Scope and Sequence Chart – Unit 4				
SKILL TO BE LEARNED **Key: I – Introduced, D – Developed, R– Reinforced**	**SUGGESTED GRADE LEVELS**			
	9	**10**	**11**	**12**
Calculate the theoretical probability that an event will occur.			I	ID
Calculate the experimental frequency distribution of an event occurring.			I	ID
Apply the Bernoulli process to events that only have two distinct possible outcomes.			I	ID
Apply AND, OR, and NOT logic to probability			I	ID
Apply Bayes' theorem to calculate the probability of multiple events occurring.			I	
Create a histogram to illustrate frequency distribution.	I		DR	R
Calculate the central tendency of a data array, including mean, median, and mode.	I		DR	R
Calculate data variation, including range, standard deviation, and variance.	I		DR	R
Calculate distance, displacement, speed, velocity, and acceleration from data.			ID	R
Design, build, and test a vehicle that stores and releases potential energy for propulsion.			ID	R
Calculate acceleration due to gravity given data from a free fall device.			ID	R
Calculate the X and Y components of a projectile motion.			ID	R
Determine the angle needed to launch a projectile a specific range given the projectile's initial velocity.			ID	DR

VII. Pacing Chart

Unit 1 Energy and Power (10 Weeks)

Lesson 1.1 Mechanisms (3 weeks):

Understandings Addressed in Lesson:

1. Engineers and engineering technologists apply math, science, and discipline-specific skills to solve problems.
2. Engineering and engineering technology careers offer creative job opportunities for individuals with a wide variety of backgrounds and goals.
3. Technical communication can be accomplished in oral, written, and visual forms and must be organized in a clear and concise manner.
4. Most mechanisms are composed of gears, sprockets, pulley systems, and simple machines.
5. Mechanisms are used to redirect energy within a system by manipulating force, speed, and distance.
6. Mechanical advantage ratios mathematically evaluate input work versus output work of mechanisms.

Lesson 1.2 Energy Sources (2 weeks):

Understandings Addressed in Lesson:

1. Energy source classifications include nonrenewable, renewable, and inexhaustible.
2. Energy source processes include harnessing, storing, transporting, and converting.
3. Energy often needs to be converted from one form to another to meet the needs of a given system.
4. An understanding of work, energy, and power is required to determine system efficiency.
5. An understanding of the basics of electricity requires the understanding of three fundamental concepts of voltage, current, and resistance.
6. The atomic structure of a material determines whether it is a conductor, an insulator, or a semiconductor.

Lesson 1.3 Energy Applications (2 weeks):

Understandings Addressed in Lesson:

1. Energy management is focused on efficient and accessible energy use.
2. System energy requirements must be understood in order to select the proper energy source.
3. Energy systems can include multiple energy sources that can be combined to convert energy into useful forms.
4. Hydrogen fuel cells create electricity and heat through an electrochemical process that converts hydrogen and oxygen into water.
5. Solar cells convert light energy into electricity by using photons to create electron flow.

6. Thermodynamics is the study of the effects of work, thermo energy, and energy on a system.
7. Thermo energy can transfer via convection, conduction, or radiation.
8. Material conductivity, resistance, and energy transfer can be calculated.

Lesson 1.4 Design Problem – Energy and Power (3 weeks):

Understandings Addressed in Lesson:

1. Design problems can be solved by individuals or in teams.
2. Engineers use a design process to create solutions to existing problems.
3. Design briefs are used to identify the problem specifications and to establish project constraints.
4. Teamwork requires constant communication to achieve the desired goal.
5. Design teams conduct research to develop their knowledge base, stimulate creative ideas, and make informed decisions.

Unit 2 Materials and Structures (8 weeks)

Lesson 2.1 Statics (3 Weeks):

Understandings Addressed in Lesson:

1. Laws of motion describe the interaction of forces acting on a body.
2. Structural member properties including centroid location, moment of inertia, and modulus of elasticity are important considerations for structure design.
3. Static equilibrium occurs when the sum of all forces acting on a body are equal to zero.
4. Applied forces are vector quantities with a defined magnitude, direction, and sense, and can be broken into vector components.
5. Forces acting at a distance from an axis or point attempt or cause an object to rotate.
6. In a statically determinate truss, translational and rotational equilibrium equations can be used to calculate external and internal forces.
7. Free body diagrams are used to illustrate and calculate forces acting upon a given body.

Lesson 2.2 Material Properties (2 weeks):

Understandings Addressed in Lesson:

1. Materials are the substances with which all objects are made.
2. Materials are composed of elements and area categorized by physical and chemical properties.
3. Materials consist of pure elements. Compounds and mixtures and are typically classified as metallic, ceramic, organic, polymeric, and composite.

4. Material properties including recyclability and cost are important considerations for engineers when choosing appropriate materials for a design.
5. Material selection is based upon mechanical, thermal, electromagnetic, and chemical properties.
6. Raw materials undergo various manufacturing processes in the production of consumer goods.

Lesson 2.3 Material Testing (2 weeks):

Understandings Addressed in Lesson:

1. Engineers utilize a design process and mathematical formulas to solve and document design problems.
2. Material testing aids in determining a product's reliability, safety, and predictability in function.
3. Engineers perform destructive and non-destructive tests on material specimens for the purpose of identifying and verifying the properties of various materials.
4. Material testing provides a reproducible evaluation of material properties.
5. Tensile testing data is used to create a test sample stress strain curve.
6. Stress strain data points are used to identify and calculate sample material properties including elastic range, proportional limit, modulus of elasticity, elastic limit, resilience, yield point, plastic deformation, ultimate strength, failure, and ductility.

Lesson 2.4 Design Problem – Materials and Structures (1 week):

Understandings Addressed in Lesson:

1. Design problems can be solved by individuals or in teams.
2. Engineers use a design process to create solutions to existing problems.
3. Design briefs are used to identify the problem specifications and establish project constraints.
4. Teamwork requires constant communication to achieve the desired goal.
5. Design teams conduct research to develop their knowledge base, stimulate creative ideas, and make informed decisions.

Unit 3 Control Systems (9 weeks)

Lesson 3.1 Machine Control (3 Weeks):

Understandings Addressed in Lesson:

1. Flowcharts provide a step by step schematic representation of an algorithm or process.
2. Control systems are designed to provide consentient process control and reliability.
3. Control system protocols are an established set of commands or functions typically created in a computer programming language.
4. Closed loop systems use digital and analog sensor feedback to make operational and process decisions.

5. Open loop systems use programming constants such as time to make operational and process decisions.

Lesson 3.2 Fluid Power (3 weeks):

Understandings Addressed in Lesson:

1. Fluid power systems are categorized as either pneumatic, which utilizes gas, or hydraulic, which utilizes liquid.
2. Fluid power is possible because in a system of confined fluid, pressure acts equally in all directions.
3. The most basic components of all fluid power systems include a reservoir or receiver, a pump or compressor, a valve, and a cylinder.
4. Fluid power systems are designed to transmit force over great distances, multiply an input force, and increase the distance that an output will move.
5. 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.
6. Standard schematic symbols and conventions are used to communicate fluid power designs.

Lesson 3.3 Design Problem – Control Systems (3 weeks):

Understandings Addressed in Lesson:

1. Design problems can be solved by individuals or in teams.
2. Engineers use a design process to create solutions to existing problems.
3. Design briefs are used to identify the problem specifications and to establish project constraints.
4. Teamwork requires constant communication to achieve the desired goal.
5. Design teams conduct research to develop their knowledge base, stimulate creative ideas, and make informed decisions.

Unit 4 Statistics and Kinematics (6 weeks)

Lesson 4.1 Statistics (3 weeks):

Understandings Addressed in Lesson:

1. Engineers use statistics to make informed decisions based upon established principles.
2. Visual representations of data analyses allow for easy distribution and understanding of data.
3. Statistics is based upon both theoretical and experimental data analysis.

Lesson 4.2 Kinematics (3 weeks):

Understandings Addressed in Lesson:

1. When working with bodies in motion, engineers must be able to differentiate and calculate distance, displacement, speed, velocity, and acceleration.
2. When air resistance is not taken into account, released objects will experience acceleration due to gravity, also known as freefall.
3. Projectile motion can be predicted and controlled using kinematics equations.
4. When a projectile is launched, velocity in the x direction remains constant; whereas, with time, the velocity in the Y direction in magnitude and direction changes due to gravity.

VIII. Student Handout

PASSAIC COUNTY TECHNICAL INSTITUTE

COURSE OVERVIEW

Principles Of Engineering ™ (POE) is a high school-level survey course of engineering. The course exposes students to some of the major concepts that they will encounter in a postsecondary engineering course of study. Students have an opportunity to investigate engineering and high tech career POE gives students the opportunity to develop skills and understanding of course concepts through activity-, project-, and problem-based (APPB) learning. Used in combination with a teaming approach, APPB learning challenges students to continually hone their interpersonal skills, creative abilities, and problem solving skills based upon engineering concepts. It also allows students to develop strategies to enable and direct their own learning, which is the ultimate goal of education.

To be successful in POE, students should be concurrently enrolled in college preparatory mathematics and science. Students will employ engineering and scientific concepts in the solution of engineering design problems. Students will develop problem-solving skills and apply their knowledge of research and design to create solutions to various challenges. Students will also learn how to document their work and communicate their solutions to their peers and members of the professional community.

Principles Of Engineering is one of the foundation courses in the Project Lead The Way high school engineering program. The course applies and concurrently develops secondary level knowledge and skills in mathematics, science, and technology.

PROFICIENCIES

Upon successful completion of the requirements for this course, the student will be able to:

1. Students will have an understanding of engineering.
2. Students will have an understanding that an engineering team must work together to solve problems, with each team member having individual and collective responsibilities.
3. Students will be able to understand how ethics, social, environmental, and financial constraints influences the engineering process.
4. Students will research and discover the educational requirements to become an engineer.
5. Students will become familiar with a specific area of engineering.
6. Students will plan and compose a written technical report.
7. Students will design and deliver a presentation utilizing appropriate support materials about research they have conducted.

8. Students will examine the design process an invention to observe and report on how the design process is applied.
9. Students will mathematically explain the mechanical advantage gained and explain the function of the six different types of simple machines.
10. Students will apply simple machines to create mechanical systems in the solution of a design problem.
11. Students will research and evaluate systems undergoing thermodynamic.
12. Students will mathematically calculate and demonstrate explain the work being done in a fluid power system.
13. Students will apply Ohm’s and Watt’s laws in electrical circuits.
14. Students will design, diagram and implement a computer program to control a device they construct.
15. Students will be able to define, describe and analyze the stresses and forces acting on an object.
16. Students will design, construct and test a model bridge.
17. Students will describe the effects that stress has on a material and explain how the material will react.
18. Students will be able to identify and differentiate the five basic categories of solid engineering materials.
19. Students will be able to analyze word problems about forces acting on materials.
20. Students will be able to define and state examples of the major categories of manufacturing processes.
21. Students will be able to state the difference between mass and weight.
22. Students will be able to utilize a variety of precision measurement.
23. Students will be able to calculate the mean, median, mode, and standard deviation.
24. Students will be able to analyze a product that breaks through material testing.
25. Students will be able to mathematically estimate chance of failure of a system.
26. Students will be able to explain difference between velocity and acceleration.
27. Students will be able to calculate range and velocity.
28. Students will design and produce a ballistic device.
29. Students will be able to analyze test data and utilize the results to make decisions.