GEORGIA | PEACH STATE PATHWAYS

Career, Technical, & Agricultural Education

ENGINEERING & TECHNOLOGY

PATHWAY: Manufacturing

COURSE: Robotics and Automation

UNIT: Design and Mechanics; Hydraulics and Pneumatics

INTRODUCTION

Annotation:

In this unit students will study the concepts, components, and applications of hydraulics and pneumatics as used for movement of robotic components.

Grade(s):

	9th
x	10th
x	11th
x	12th

Time:

15 hours

Author:

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Additional Author(s):

Students with Disabilities:

For students with disabilities, the instructor should refer to the student's IEP to be sure that the accommodations specified are being provided. Instructors should also familiarize themselves with the provisions of Behavior Intervention Plans that may be part of a student's IEP. Frequent consultation with a student's special education instructor will be beneficial in providing appropriate differentiation.

FOCUS STANDARDS

GPS Focus Standards:

ENGR-RAS-3. Students will discuss the systems and applications of automation including: AGV, PLC, CNC, CIM, CAD, CAM, and robotics as essential to succeeding globally in a manufacturing market.
ENGR-RAS-5. Students will apply the principles of PLC, CIM, CAD, CAM, and robotics in the manufacturing of a product.
ENGR-STEM-1. Students will recognize the systems, components, and processes of a technological system.
ENGR-STEM-2. Students will identify the impact of engineering and technology within global, economic, environmental, and societal contexts.
ENGR-STEM-3. Students will design technological problem solutions using scientific investigation, analysis and interpretation of data, innovation, invention, and fabrication while considering economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability constraints.
ENGR-STEM-4. Students will apply principles of science, technology, engineering, mathematics, interpersonal communication, and teamwork to the solution of technological problems.
ENGR-STEM-5. Students will select and demonstrate techniques, skills, tools, and understanding related to energy and power, bio-related, communication, transportation, manufacturing, and construction technologies.
ENGR-STEM-6. Students will enhance reading by developing vocabulary and comprehension skills associated with text materials, problem descriptions, and laboratory activities associated with engineering and technology education.

GPS Academic Standards:

SCSh1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.
SCSh7. Students analyze how scientific knowledge is developed.
MM3P4. Students will make connections among mathematical ideas and to other disciplines.

National / Local Standards / Industry / ISTE:

UNDERSTANDINGS & GOALS

Enduring Understandings:

- Students will understand how pressurized systems work and their impact on society.

Essential Questions:

- What is hydraulics? How does it differ from pneumatics?
- How does one safely set up and operate a fluidic system?
- What is the difference between a single and double action cylinder?
- How can fluid components aid in the manufacturing process?

Knowledge from this Unit:

- Students will be able to define the terms hydraulics and pneumatics
- Students will be able to identify the scientific laws that describe how fluids and gasses react under pressure
- Students will be able to describe the function of the major components of a fluid system
- Students will be able to identify single and double action cylinders

Skills from this Unit:

- Students will be able to construct simple hydraulic systems to perform work.

ASSESSMENT(S)

Assessment Method Type: Select one or more of the following. Please consider the type(s) of differentiated instruction you will be using in the classroom.

- x Pre-test
- x Objective assessment - multiple-choice, true- false, etc.
  - __ Quizzes/Tests
  - _x_ Unit test
- x Group project
- ____ Individual project
- x Self-assessment - May include practice quizzes, games, simulations, checklists, etc.
  - _x_ Self-check rubrics
  - __ Self-check during writing/planning process
  - __ Journal reflections on concepts, personal experiences and impact on one's life
  - _x_ Reflect on evaluations of work from teachers, business partners, and competition judges
  - __ Academic prompts
  - __ Practice quizzes/tests
- x Subjective assessment/Informal observations
  - __ Essay tests
  - _x_ Observe students working with partners
  - __ Observe students role playing
- ____ Peer-assessment
  - __ Peer editing & commentary of products/projects/presentations using rubrics
  - __ Peer editing and/or critiquing
- x Dialogue and Discussion
  - __ Student/teacher conferences
  - __ Partner and small group discussions
  - _x_ Whole group discussions
  - __ Interaction with/feedback from community members/speakers and business partners
- x Constructed Responses
  - __ Chart good reading/writing/listening/speaking habits
  - _x_ Application of skills to real-life situations/scenarios
- ____ Post-test

Assessment(s) Title:

Hydraulic Robotic Arm Rubric

Assessment(s) Description/Directions:

Students are given the challenge to develop a robotic arm powered by hydraulic pistons, tubing, and water.

Attachments for Assessment(s):

LEARNING EXPERIENCES

Sequence of Instruction

1. **Identify the Standards. Standards should be posted in the classroom for each lesson.**
2. **Review Essential Questions.**

3. **Identify and review the unit vocabulary.**
4. **Assessment Activity.**

Step 1:
Discuss the use of pressurized fluid systems, the basic components, operational safety, disadvantages and advantages of using hydraulic systems in manufacturing. Advantages might include the nature of being non-electrical, smooth motion, and softer sensitivity in pneumatic operations. *(see Open Experimentation with Hydraulics.doc)*

Step 2:
Research various applications of hydraulics on the Internet. *(see Hydraulic Web Search.doc)*

Step 3:
Research, discuss and demonstrate the laws of science that pertain to hydraulics, namely Archimedes' Principle, Boyle's law and Pascal's law *(see Hydraulic Laws.doc)*

Step 4:
Reinforce vocabulary and basic principle understanding by using the crossword puzzle. *(see HydroCrossword.doc)*

Step 5:
Create a robotics arm using medical syringes and plastic tubing that will move assembly line components from one location to another. *(see Syringe Robot Arm.doc and Hydraulic Robotic Arm Rubric.doc)*

Step 6: Vocabulary exam over the major components of a hydraulic system. *(see Hydraulic Vocab.doc)*

Attachments for Learning Experiences:

Hydraulic Web Search Document
Hydraulic Laws Document
Hydraulic Vocabulary Document
Syringe Robotic Arm Document

Notes & Reflections:

Some labs may possess pneumatic trainers, others hydraulic trainers, while a few may have both, many will have neither. This unit is based on the understanding that there are few differences between the two systems, and those can be taught utilizing both trainers, either, or neither. The vocabulary terms work for both, and the differences between them are inherent to the differences between gas (compressible), and liquids (not compressible).

Labs without specific training equipment can still talk about, and build simple systems utilizing hypodermic syringes. I recommend checking the Internet for medical supply dealers who supply everything from small syringes (no needles) in sizes 20cc, 30cc, and up to the larger 60cc irrigation syringes. These purchased in bulk are very cost competitive to educational supply companies. For instance when last I purchased, I received 60 for the price I would have paid for 10 if I had used the common educational resources suppliers. Of course, district purchasing regulations often interfere with good pricing, but I would check into the medical suppliers online.

There are a lot of vocabulary words for this unit. (Maybe too many) You may wish to trim the list to the most important concepts and components.

For the culminating activity, students will build a robotic arm that is operated by hydraulic principles using medical syringes. The larger syringes work better, giving more traveling distance, and are easier to work with. Syringes, piping and valves can be reused, as only water is provided as the fluid. A small drop of food coloring can help distinguish one line from another, and it looks cool too. Students and equipment do get wet with this project. Take care with near by electronic equipment.

Kelvin Scientific has a robot arm battle set that is, in my personal opinion, rather expensive, but the construction is very nice, and the controllers can be used again and again. I bought a set. One could also build the same type of controller, and create a similar game with pvc piping, screws, base, etc. Pitsco also sells syringes, tubing, and even electric motor mounts that fit certain sizes of syringes very well.

Several websites exist with student built balsa, Popsicle stick, or plastic armed hypodermic robots. Once your students see examples, they should be ready to start the problem solving design activities inherent with any project. The arm can be constructed of almost any material, but lighter might be better as excess pressure on the water lines will cause them to pop right off. Eye protection is of course required during operations.

End effectors, especially grippers, can be frustrating to build and operate. Alternative solutions for your students might be to use a rod, or hook to lift something. An electro-magnet might be employed, (for example see Kelvin Science www.kelvin.com) or even a sensor of some type.

CULMINATING PERFORMANCE TASK (Optional)

Culminating Unit Performance Task Title:

Hydraulic Robotic Arm

Culminating Unit Performance Task Description/Directions/Differentiated Instruction:

Students will create a hydraulic operated robotic arm using hypodermic syringes, aquarium plastic piping, and water.

Attachments for Culminating Performance Task:

Syringe Robotic Arm.Doc

UNIT RESOURCES

Web Resources:

http://www.imslo.com/HydraulicsTraining.html Videos for sale
http://hydraulicspneumatics.com/200/FPE/IndexPage.aspx Fluid power tutorials
http://www.metacafe.com/tags/hydraulic/ Multimedia downloads blocked in many schools
http://www.youtube.com/watch?v=ycAgr6tpRQg Multimedia downloads blocked in many schools
http://dsc.discovery.com/videos/deadliest-catch-crane-pots-hydraulics.html Discovery Channel video clips
http://www.pneumatics.be/ Some foreign languages, some English. Good moving images
http://alltechhydraulics.com/hydraulicterms.htm Vocabulary
http://www.swtc.edu/Ag_Power/hydraulics/terms.htm Vocabulary

http://www.pneumatic-source.com/resources/glossary/ Vocabulary

Attachment(s):

Materials & Equipment:

See syringe robotic arm attachment

What 21st Century Technology was used in this unit?

	Slide Show Software		Graphing Software		Audio File(s)
	Interactive Whiteboard		Calculator		Graphic Organizer
	Student Response System		Desktop Publishing	x	Image File(s)
	Web Design Software		Blog	x	Video
	Animation Software		Wiki		Electronic Game or Puzzle Maker
	Email	x	Website		