# Part 1: Course Information

## Course Overview

### Basic Information

College:   
Department:  
Semester:   
Instructor:   
Office:   
Office Hours:   
Office Telephone:   
Email:

### Description

Pneumatics and Hydraulics is a study of fluid power technology using fluids or compressed air as the transfer media. This course consists of 15 lessons along with corresponding labs and/or class activities. Topics covered include basic functions and physical properties of complete hydraulic and pneumatic systems, such as power sources, reservoirs, pumps, compressors, lines, valves and actuators; troubleshooting techniques and strategies to identify, localize, and correct malfunctions; and safety and systematic preventative maintenance.

### Prerequisites

No Mechatronics courses are required as prerequisites.

To succeed in this course, students should be proficient in English and basic Algebra.

## Course Materials

### Recommended Textbook(s)

Daines, J.R. (2009). *Fluid Power: Hydraulics and Pneumatics* (1st ed.). Tinley Park, IL: Goodheart-Willcox Publisher. ISBN-13: 978-1605250816. (Note: Includes student version of FluidSIM Hydraulics simulation software; 1st edition was used in developing this course.)

Daines, J.R. (2012). *Fluid Power, Laboratory Manual: Hydraulics and Pneumatics* (2nd ed.). Tinley Park, IL: Goodheart-Willcox Publisher. ISBN-13: 978-1605250823.

## Course Structure

This course is designed to provide a hybrid experience, including both face-to-face and online activities. Activities to be completed online and face-to-face will be updated weekly and provided as a supplement to the course syllabus.

Contact time will be divided in the following way:

80% face-to-face  
20% online

### Face-to-face sessions

Laboratory exercises and in-class work will emphasize skill attainment and content mastery.

### Online Sessions

Online sessions will include content and activities from Platform +, Wisc-Online, Tooling U, simulated lab activities, and other resources. To access online activities, students will need access to the Internet and a supported Web browser. Technical assistance can be obtained from local technical support.

### Technical Requirements

* Internet connection
* Access to college learning management system and Platform+.
* Access to college email account
* Microsoft PowerPoint
* Microsoft Word

# Part 2: Learning Outcomes

Following successful completion of the Pneumatics and Hydraulics course, the student will be able to:

**Applied Mathematics**

* Use basic algebra to solve problems involving basic force, speed, air consumption, pressure, area, torque, work, power, efficiency, Ohm’s Law, Pascal’s Law, and Ideal and General Gas Laws.

### Critical Thinking/Problem Solving

* Diagram a complete pneumatic or hydraulic system, showing fluid flow/air distribution through the system.

### Equipment

* Correctly use pneumatic and hydraulic devices, such as air compressors, cylinders, fluid pumps, actuators, and motors.
* Use rulers, calipers, micrometers, and other instruments to take accurate measurements.

### Foundational Principles

* Explain the basic interrelationships of components and modules within a complex mechatronic system.
* Explain the basic principles and physical properties of air and fluids.
* Explain the basic principles of pneumatic and hydraulic circuits.
* Describe methods for controlling pressure, direction, and flow.

### Safety

* Understand safety regulations and their importance.
* Use appropriate attire and protective equipment.
* Operate equipment according to safety protocols.

**Technical Literacy**

* Read, analyze and utilize technical fluid power documentation, such as data sheets, circuit diagrams, displacement step diagrams, timing diagrams, and function charts for the pneumatic and hydraulic components within a mechatronic system.

### Troubleshooting

* Correct malfunctions in pneumatic and hydraulic circuits or correctly identify the expertise required to correct a malfunction.

# Part 3: Course Calendar

This course calendar provides a schedule of lessons and an outline of topics covered. Activities, assignments, and assessments will be explained in detail throughout the course. Please contact the instructor with questions.

## Lesson 1: Introduction and Safety Date

1. Course Syllabus, Policies, and Procedures
2. Safety
3. OSHA and its Role
4. Safe Dress
5. PPE – Personal Protective Equipment
6. Mechanical Transmission Safety
7. Hydraulic/Pneumatic Safety
8. Machine Guarding
9. LOTO – Lock Out Tag Out
10. Lab Activities:
11. Familiarization with Simulation Software
12. Hydraulic/Pneumatic Trainers

## Lesson 2: Pneumatics and Hydraulics Systems Date

1. Complex Mechatronics Systems
2. Systems Approach
3. System Block Diagram
4. Measuring Concepts
5. Lab Activity: Reverse Engineering Simple Pneumatic Parts
6. Introduction to Fluid Power Systems
7. Description of Fluid Power, Hydraulic, and Pneumatic Systems
8. Advantages and Disadvantages of Hydraulic and Pneumatic Systems
9. Lab Activity: Pneumatic or Hydraulic System Observation
10. Quiz: Safety Rules and Procedures

## Lesson 3: Physical Principles of Air and Fluids Date

1. Behavior of Fluids I
2. Review Systems Approach
3. Relation of Simple Machines to Fluid Power Systems
4. Basic Principles of Heat Transfer
5. Difference Between Laminar and Turbulent Flow
6. Pascal’s Law and Pressure Measurements in Fluids
7. Lab Activity: Block Diagram Composition
8. Behavior of Fluids II
9. Boyle’s Law
10. Archimedes’ Principle
11. Bernoulli’s Theorem
12. General Gas Law
13. Viscosity
14. Lab Activity: Behavior of Fluids
15. Quiz: Hydraulic and Pneumatic Systems

## Lesson 4: Standards and Symbols Date

1. Fluid Power Standards
2. Block Diagrams of Energy, Mass, and Material
3. Reasons for Standardization
4. Types of Fluid Power Standards Organizations
5. Lab Activity: Creating Block Diagrams of Fluid Power Circuits
6. Fluid Power Symbols
7. Symbols
8. Creating Fluid Power Circuit Diagrams
9. Lab Activity: Identifying Fluid Power Components and Function and Creating Circuit Drawings.
10. Quiz: Principles of Air and Fluids

## Lesson 5: Basic Fluid Power Systems and Compressed Air Date

1. General Fluid Power System Components, Structure, and Operation
2. Generation and Distribution
3. Valves
4. Processors
5. Power
6. Systems
7. Lab Activity: General Fluid Power System Components
8. Compressed Air and Its Conditioning and Distribution
9. Review of Safety Issues
10. Composition of Atmospheric Air
11. “Conditioning” of Compressed Air
12. General Principles of Compression and Expansion
13. Air’s Reaction to Temperature, Pressure, and Volume
14. Lab Activity: Compressed Air
15. Quiz: Standards and Symbols

## Lesson 6: Hydraulic Fluids and Conditioning Date

1. Hydraulic Fluid
2. Review of Safety Issues
3. Function of Hydraulic Fluid
4. Properties
5. Additives
6. Procedures to Handle Hydraulic Fluids
7. Reading Basic Hydraulic Fluid Data
8. Lab Activity: Hydraulic Fluid
9. Hydraulic Fluid Conditioning
10. Effects of Contamination
11. Types of Contaminants
12. Role of Reservoirs
13. Types of Filters
14. Causes of Increased Heat
15. Heat Exchangers and their Specifications
16. Lab Activity: Hydraulic Fluid Conditioning
17. Quiz: Basic Fluid Power Systems and Compressed Air

## Lesson 7: Fluid Pumps and Air Compressors Date

1. Hydraulic Pumps
2. Function of Pumps
3. Pump Designs
4. Cavitation
5. Procedures for Selecting Pumps
6. Reading Basic Hydraulic Pump Data Specifications
7. Lab Activity: Hydraulic Pumps
8. Air Compressors
9. Operation of Air Compressors
10. Limiting Maximum Air Pressure in a System
11. Troubleshooting Air Compressor Problems
12. Lab Activity: Air Compressors
13. Quiz: Hydraulic Fluids and Conditioning

## Lesson 8: Fluid Storage and Distribution Date

1. Hydraulic Fluid Storage and Distribution
2. Reservoirs
3. Conductors
4. Analysis of Circuit and System Operation
5. Conductor Installation
6. Air Distribution
7. Lab Activity: Hydraulic Fluid Storage and Distribution
8. Air Distribution
9. Air Filtration, Regulation, and Lubrication at the Machine
10. Pneumatic System Conductors and Fittings
11. Manufacturer Specifications
12. Lab Activity: Air Distribution
13. Quiz: Fluid Pumps and Air Compressors

## Lesson 9: Actuators Date

1. Pneumatic and Hydraulic Actuators
2. Cylinders
3. Motors
4. Miscellaneous Air-Driven Equipment
5. Lab Activity: Hydraulic and Pneumatic Actuators
6. Pneumatic and Hydraulic Motors and Pneumatic Air Tools
7. Types of Fluid Power Motors
8. Troubleshooting Fluid Power Motors
9. Motor or Air Tool Selection
10. Using Specifications to Gather Information
11. Lab Activity: Pneumatic and Hydraulic Motors and Pneumatic Air Tools
12. Quiz: Fluid Storage and Distribution
13. Midterm Lab Project: Pneumatic Ladder Climbing Robot

## Lesson 10: Controlling System Pressure Date

1. Controlling System Pressure
2. Relief Valves
3. Safety Valves
4. Pressure Regulators
5. Pressure Switches
6. Sequence Control
7. Restrained Movement Control
8. Unloading Control
9. Reduced Pressure Control
10. Lab Activity: Controlling System Pressure
11. Controlling System Pressure - Continued
12. Pressure Control Valve Specifications
13. Pressure Control Valve Troubleshooting
14. Lab Activity: Controlling System Pressure
15. Quiz: Actuators
16. Midterm Exam

## Lesson 11: Controlling Direction Date

1. Controlling Direction in a Fluid System
2. Design and Operation of Control Valves
3. Controlling Direction
4. Lab Activity: Controlling Direction
5. Controlling Direction – Continued
6. Directional Control Valve Specs and Sizing
7. Directional Control Valve Troubleshooting
8. Lab Activity: Controlling Direction
9. Quiz: Controlling Pressure

## Lesson 12: Controlling Flow Date

1. Controlling Flow:
2. Design and Operation of Flow Control Vales
3. Design of Flow Control Circuits
4. Flow Control: Orifice Characteristics
5. Non-compensated Flow Control Valves
6. Compensated Flow Control Valves
7. Bypass Flow Control Valves
8. Flow Divider Valves
9. Lab Activity: Controlling Flow
10. Controlling Flow – Continued
11. Pneumatic Special Purpose Control Valves and Other Devices
12. Flow Control Valve Specs and Sizing
13. Flow Control Valve Troubleshooting
14. Lab Activity: Controlling Flow
15. Quiz: Controlling Direction

## Lesson 13: Accumulators Date

1. Accumulators
2. Safety Requirements
3. Basic Design, Operation, and Characteristics of Accumulators
4. Testing Accumulators in a Circuit
5. Lab Activity: Accumulators
6. Accumulators – Continued
7. Sizing and Selecting Accumulators using Spec Sheets
8. Sizing Accumulator using Manufacturer’s Software
9. Troubleshooting Accumulators
10. Lab Activity: Accumulators
11. Quiz: Controlling Flow

## Lesson 14: Hydraulic Circuits Date

1. Hydraulic Circuit Basics
2. Pressure-Control Circuits
3. Flow-Control Circuits
4. Lab Activity: Hydraulic Circuit Basics
5. Hydraulic Motion Control Circuits
6. Rapid-Advance-To-Work Circuits
7. Safety Circuits
8. System Protection Circuits
9. Troubleshooting
10. Lab Activity: Hydraulic Motion Control Circuits
11. Quiz: Accumulators

## Lesson 15: Pneumatic Circuits Date

1. Pneumatic Circuit Basics
2. Pressure Control Circuits
3. Speed Control Circuits
4. Direction Control Circuits
5. Lab Activity: Pneumatic Circuits
6. Pneumatic Motion Control Circuits
7. Quick Exhaust valves
8. Safety Circuits
9. Troubleshooting
10. Quiz: Hydraulic Circuits
11. Final Lab Project

# Part 4: Grading Information

## Graded Activities

### Midterm Exam

There will be a midterm exam worth 20% of the final grade.

### Midterm Lab Project

There will be a midterm lab project worth 20%

### Final Lab Project

There will be a final lab project worth 25% of the final grade.

### Laboratory Exercises

Laboratory exercises measure skills and abilities relating to knowledge learned in class and will be worth 15% of the final grade.

### Quizzes

Quizzes on assigned material will be designed for review and evaluation of learning and will be worth 10% of the final grade.

### Homework

Doing work outside of class is critical to success. Homework is graded and will be worth 5% of the final grade.

### Class Participation

Class participation is important and will be worth 5% of the final grade.

## Grading Breakdown

Midterm Exam = 20%  
Midterm Lab Project = 20%

Final Lab Project = 25%  
Laboratory Exercises = 15%  
Quizzes = 10%  
Homework = 5%  
Class Participation = 5%

## Grading Scale

A = 90-100   
B = 80-89   
C = 70-79   
D = 60-69   
F = 59 and below

## Late Work

Late work will not be accepted unless it is pre-approved by the instructor. All graded work will be posted in the college learning management system with 48 hours of due date.

# Part 5: College Policies and Resources

## Policies

### Attendance

### Academic Integrity

### Campus Civilitybb

## Resources

### ****Counseling****

### ****Veterans****

### ****Students with Disabilities****

# About These Materials

## Copyright

© 2015 National STEM Consortium.

The National STEM (Science, Technology, Engineering, and Mathematics) Consortium (NSC), a collaborative of ten colleges in nine states, was funded by a Trade Adjustment Assistance Community College and Career Training (TAACCCT) grant from the U.S. Department of Labor to develop new workforce training programs in technical fields. For more information about NSC, visit the NSC website: [http://www.nationalstem.org](http://www.nationalstem.org/).

## License

[This icon displays "CC" for Creative Commons and "BY" for the Attribution 4.0 International License, and is hyperlinked to the Creative Commons webpage on attribution licenses.](http://creativecommons.org/licenses/by/4.0/) Unless otherwise specified, this work is licensed under a [Creative Commons Attribution 4.0 International License](http://creativecommons.org/licenses/by/4.0/).

## Attribution and Citation

To attribute this work, use: Margie Porter.

To cite this work, use:

Porter, M. (2015). *Pneumatics and Hydraulics.* Mechatronics Technology certificate program of the National STEM Consortium. Retrieved from http://oli.cmu.edu.

## Accessibility

The NSC has made every effort to create accessible materials, following best practices and Americans with Disabilities Act (ADA) guidelines. For example, to ensure screen reader systems can work with these materials, we write using plain English, heading styles in outline structure, simple layout, minimal tables and charts, bulleted and numbered lists, high-contrast colors, standard fonts, white space for ease of reading, and so on. For more information about ADA compliance, see the 2010 Design Standards on the ADA website: <http://www.ada.gov/2010ADAstandards_index.htm>.

## Disclaimer

This workforce solution was funded by a grant awarded by the U.S. Department of Labor’s Employment and Training Administration. The solution was created by the grantee and does not necessarily reflect the official position of the U.S. Department of Labor. The Department of Labor makes no guarantees, warrantees, or assurances of any kind, express or implied, with respect to such information, including any information on linked sites and including, but not limited to, accuracy of the information or its completeness, timeliness, usefulness, adequacy, continued availability, or ownership.