Mechatronics Program
Pneumatics and Hydraulics Course
Suggested Syllabus

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
    a. OSHA and its Role
    b. Safe Dress
    c. PPE – Personal Protective Equipment
    d. Mechanical Transmission Safety
    e. Hydraulic/Pneumatic Safety
    f. Machine Guarding
    g. LOTO – Lock Out Tag Out
3. Lab Activities:
    a. Familiarization with Simulation Software
    b. Hydraulic/Pneumatic Trainers

Lesson 2: Pneumatics and Hydraulics Systems Date

1. Complex Mechatronics Systems
    a. Systems Approach
    b. System Block Diagram
    c. Measuring Concepts
2. Lab Activity: Reverse Engineering Simple Pneumatic Parts
3. Introduction to Fluid Power Systems
    a. Description of Fluid Power, Hydraulic, and Pneumatic Systems
    b. Advantages and Disadvantages of Hydraulic and Pneumatic Systems
4. Lab Activity: Pneumatic or Hydraulic System Observation

5. Quiz: Safety Rules and Procedures

Lesson 3: Physical Principles of Air and Fluids Date

1. Behavior of Fluids I
    a. Review Systems Approach
    b. Relation of Simple Machines to Fluid Power Systems
    c. Basic Principles of Heat Transfer
    d. Difference Between Laminar and Turbulent Flow
    e. Pascal's Law and Pressure Measurements in Fluids
2. Lab Activity: Block Diagram Composition
3. Behavior of Fluids II
    a. Boyle's Law
    b. Archimedes' Principle
    c. Bernoulli's Theorem
    d. General Gas Law
    e. Viscosity
4. Lab Activity: Behavior of Fluids
5. Quiz: Hydraulic and Pneumatic Systems

Lesson 4: Standards and Symbols Date

1. Fluid Power Standards
    a. Block Diagrams of Energy, Mass, and Material
    b. Reasons for Standardization
    c. Types of Fluid Power Standards Organizations
2. Lab Activity: Creating Block Diagrams of Fluid Power Circuits
3. Fluid Power Symbols
    a. Symbols
    b. Creating Fluid Power Circuit Diagrams
4. Lab Activity: Identifying Fluid Power Components and Function and Creating Circuit Drawings.

5. 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
    a. Generation and Distribution
    b. Valves
    c. Processors
    d. Power
    e. Systems
2. Lab Activity: General Fluid Power System Components
3. Compressed Air and Its Conditioning and Distribution
    a. Review of Safety Issues
    b. Composition of Atmospheric Air
    c. “Conditioning” of Compressed Air
    d. General Principles of Compression and Expansion
    e. Air’s Reaction to Temperature, Pressure, and Volume
4. Lab Activity: Compressed Air
5. Quiz: Standards and Symbols

Lesson 6: Hydraulic Fluids and Conditioning Date

1. Hydraulic Fluid
    a. Review of Safety Issues
    b. Function of Hydraulic Fluid
    c. Properties
    d. Additives
    e. Procedures to Handle Hydraulic Fluids
    f. Reading Basic Hydraulic Fluid Data
2. Lab Activity: Hydraulic Fluid
3. Hydraulic Fluid Conditioning
    a. Effects of Contamination

   b. Types of Contaminants
   c. Role of Reservoirs
   d. Types of Filters
   e. Causes of Increased Heat
   f. Heat Exchangers and their Specifications
4. Lab Activity: Hydraulic Fluid Conditioning
5. Quiz: Basic Fluid Power Systems and Compressed Air

Lesson 7: Fluid Pumps and Air Compressors Date

1. Hydraulic Pumps
   a. Function of Pumps
   b. Pump Designs
   c. Cavitation
   d. Procedures for Selecting Pumps
   e. Reading Basic Hydraulic Pump Data Specifications
2. Lab Activity: Hydraulic Pumps
3. Air Compressors
   a. Operation of Air Compressors
   b. Limiting Maximum Air Pressure in a System
   c. Troubleshooting Air Compressor Problems
4. Lab Activity: Air Compressors
5. Quiz: Hydraulic Fluids and Conditioning

Lesson 8: Fluid Storage and Distribution Date

1. Hydraulic Fluid Storage and Distribution
   a. Reservoirs
   b. Conductors
   c. Analysis of Circuit and System Operation
   d. Conductor Installation
   e. Air Distribution

2. Lab Activity: Hydraulic Fluid Storage and Distribution
3. Air Distribution
    a. Air Filtration, Regulation, and Lubrication at the Machine
    b. Pneumatic System Conductors and Fittings
    c. Manufacturer Specifications
4. Lab Activity: Air Distribution
5. Quiz: Fluid Pumps and Air Compressors

Lesson 9: Actuators Date

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

Lesson 10: Controlling System Pressure Date

1. Controlling System Pressure
    a. Relief Valves
    b. Safety Valves
    c. Pressure Regulators
    d. Pressure Switches
    e. Sequence Control
    f. Restrained Movement Control
    g. Unloading Control

   h. Reduced Pressure Control
2. Lab Activity: Controlling System Pressure
3. Controlling System Pressure - Continued
   a. Pressure Control Valve Specifications
   b. Pressure Control Valve Troubleshooting
4. Lab Activity: Controlling System Pressure
5. Quiz: Actuators
6. Midterm Exam

Lesson 11: Controlling Direction Date

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

Lesson 12: Controlling Flow Date

1. Controlling Flow:
   a. Design and Operation of Flow Control Vales
   b. Design of Flow Control Circuits
   c. Flow Control: Orifice Characteristics
   d. Non-compensated Flow Control Valves
   e. Compensated Flow Control Valves
   f. Bypass Flow Control Valves
   g. Flow Divider Valves
2. Lab Activity: Controlling Flow
3. Controlling Flow – Continued
   a. Pneumatic Special Purpose Control Valves and Other Devices

   b. Flow Control Valve Specs and Sizing
   c. Flow Control Valve Troubleshooting
4. Lab Activity: Controlling Flow
5. Quiz: Controlling Direction

Lesson 13: Accumulators Date

1. Accumulators
   a. Safety Requirements
   b. Basic Design, Operation, and Characteristics of Accumulators
   c. Testing Accumulators in a Circuit
2. Lab Activity: Accumulators
3. Accumulators – Continued
   a. Sizing and Selecting Accumulators using Spec Sheets
   b. Sizing Accumulator using Manufacturer's Software
   c. Troubleshooting Accumulators
4. Lab Activity: Accumulators
5. Quiz: Controlling Flow

Lesson 14: Hydraulic Circuits Date

1. Hydraulic Circuit Basics
   a. Pressure-Control Circuits
   b. Flow-Control Circuits
2. Lab Activity: Hydraulic Circuit Basics
3. Hydraulic Motion Control Circuits
   a. Rapid-Advance-To-Work Circuits
   b. Safety Circuits
   c. System Protection Circuits
   d. Troubleshooting
4. Lab Activity: Hydraulic Motion Control Circuits
5. Quiz: Accumulators

Lesson 15: Pneumatic Circuits **Date**

1. Pneumatic Circuit Basics
    a. Pressure Control Circuits
    b. Speed Control Circuits
    c. Direction Control Circuits
2. Lab Activity: Pneumatic Circuits
3. Pneumatic Motion Control Circuits
    a. Quick Exhaust valves
    b. Safety Circuits
    c. Troubleshooting
4. Quiz: Hydraulic Circuits
5. 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

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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.

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