

Yellow Level Labs

- Basic Electrical Lab
- Motors and Motor Controls Lab
- Wiring and Distribution Lab
- Basic Fluid Power Lab
- Advanced Fluid Power Lab

Basic Electrical Lab

Introduction

In these lab exercises the student will explore electrical, performing various exercises designed to give an understanding of voltage, current and resistance in DC and AC circuits. The student will build and test electrical circuits and develop techniques to measure circuit quantities, using the electrical test equipment provided. The exercises will emphasize proper and safe usage of all components and systems.

Key Learning/ Performance Objectives

- Safely use electrical tools and equipment in accordance with NEC and OSHA
- Calculate and measure voltage, current, and resistance in electrical circuits
- Build circuits
- Select, setup and use electrical test equipment to test previously built circuits
- Read and use schematics to identify components in an electrical circuit on industrial machinery

Success Measures

The student will calculate electrical values for assigned circuits accurately. Build and test the circuits, using electrical test equipment, and record data with no appreciable errors. Perform all electrical tests while adhering to accepted safety practices.

Equipment and Special Requirements

- Digital multimeters, megohmmeters, oscilloscopes and calculators
- Various resistors, capacitors and discrete components
- Soldering iron, circuit breadboard, wire and wiring components
- Ugly's Reference guide

Prerequisite Labs

- None

Description of Procedure

The student will calculate and measure voltage, current and resistance in various DC and AC electrical circuits, build the same circuits and test them with the appropriate electrical test equipment such as multimeters, oscilloscopes, etc.



Basic Electrical Lab Procedure and Worksheet

Name	Start Time
Date	Finish Time
Instructor's Signature	

In this lab, your objective is to complete various tasks which will be used to evaluate your mastery of the requisite skills. It is your responsibility to complete these tasks accurately in a timely manner complying with all appropriate safety measures and use of all required Personal Protective Equipment (PPE).

Task I - Identify the various wiring items mounted on the electrical display board

	Pass	Fail	Initials
A.			
B.			
C.			
D.			
E.			
F.			
G.			
H.			

Task I - Identify the various wiring items mounted on the electrical display board cont.

	Pass	Fail	Initials
I.			
J.			
K.			
L.			
M.			
N.			
O.			
P.			
Q.			
R.			
S.			
T.			
U.			

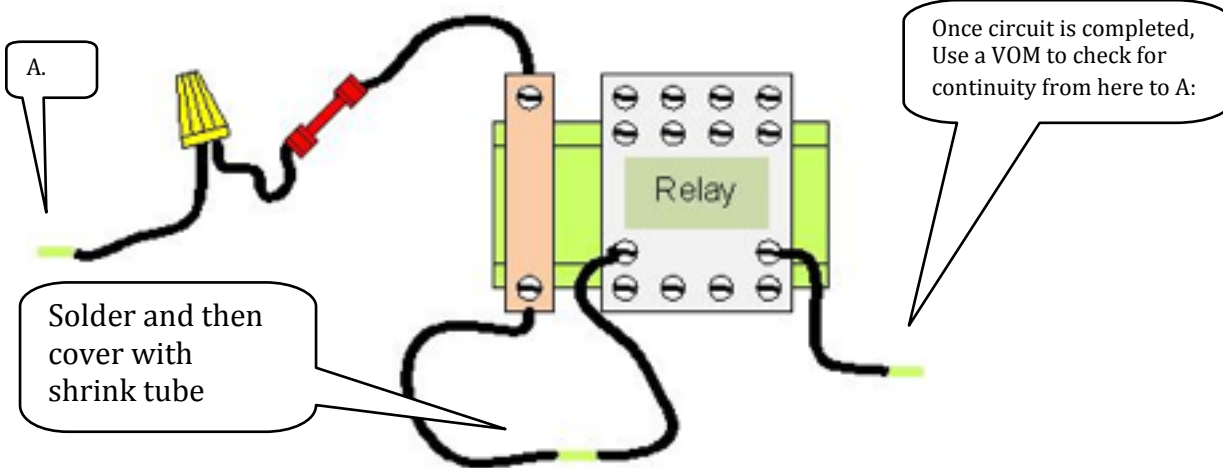
Task II - Constructing and measuring a circuit

Pass

Fail

Initials

1. Construct this circuit using a wire nut, a crimped butt splice and a soldered connection, route it through a terminal strip and through a relay coil. Check for continuity and record.



2. Set up and demonstrate how to use a multimeter to measure the following values:

a. Resistance

b. DC volts

c. AC volts

d. DC amps

e. AC amps

f. DC milliamps

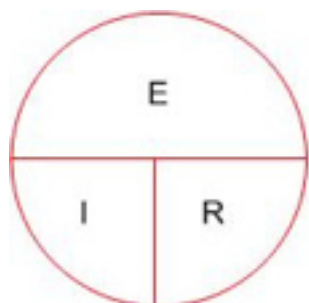
Task III - Series Circuit

Pass

Fail

Initials

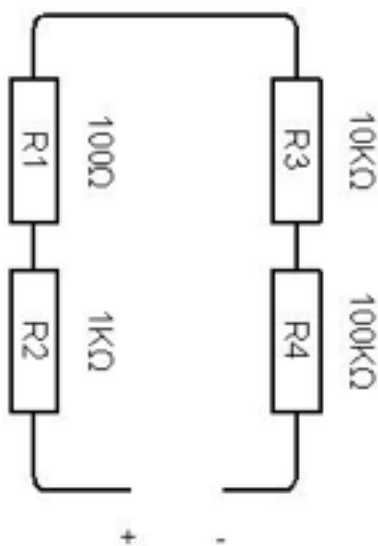
1. Calculate E, I and R for the following circuit. Then construct it and measure the same values.



$$E = I \cdot R$$

$$I = E / R$$

$$R = E / I$$



Calculated Values

E_T _____
 R_T _____
 I_T 0.00018A
 I_{R1} _____
 E_{R1} _____
 E_{R2} _____
 E_{R3} _____
 E_{R4} _____

Measured Values

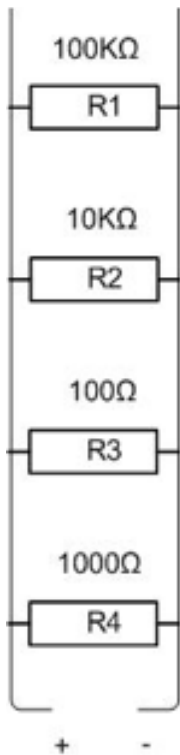
Task IV - Parallel Circuit

Pass

Fail

Initials

1. Calculate E, I and R for the following circuit. Then construct it and measure the same values.



Calculated Values

E_T _____
 R_T _____
 I_T 0.133A
 I_{R1} _____
 I_{R2} _____
 I_{R3} _____
 I_{R4} _____
 E_{R1} _____
 E_{R2} _____
 E_{R3} _____
 E_{R4} _____

Measured Values

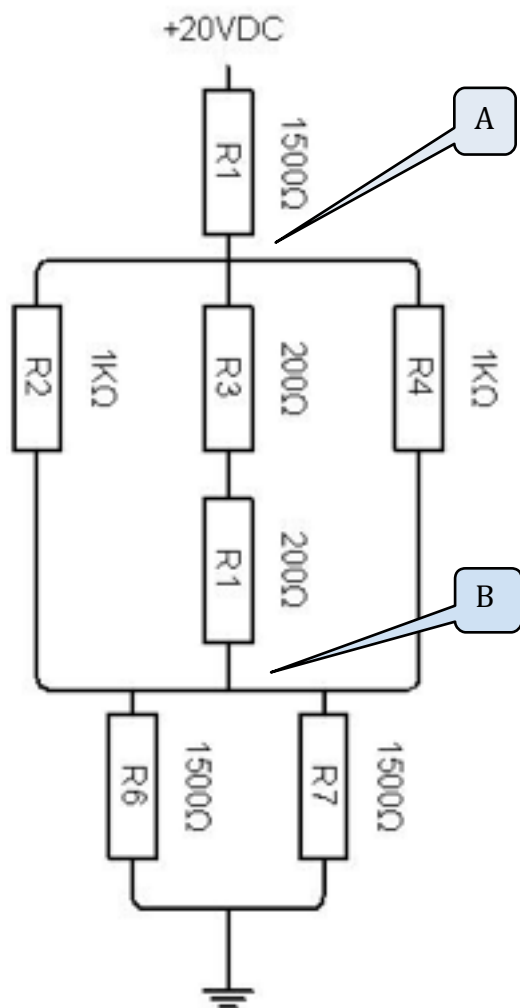
Task V - Combination Circuit

Pass

Fail

Initials

1. Calculate E , I and R for the following circuit. Then construct it and measure the same values.



Calculated Values

E_T _____
 R_T _____
 I_T _____
 I_{R7} _____
 E_A _____
 E_B _____
 I_A _____
 I_B _____

Measured Values

Task VI - AC Circuits

	Pass	Fail	Initials
1. Using the Transformer Connections section of the Ugly's book, answer the following questions:			
a. What is the line voltage in a Delta connection?			
b. What is the line current in a Delta connection?			
c. What is the line voltage in a Wye connection?			
d. What is the line current in a Wye connection?			
2. Using the Scopemeter oscilloscope, answer the following questions:			
a. The face of a Scopemeter has _____ horizontal squares and _____ vertical squares.			
b. Each square represents a metric measurement of _____.			
c. The horizontal squares will display a signal related to _____.			
d. The vertical squares will display a signal related to _____.			
e. Write the formula for time. _____			
f. Write the formula for frequency. _____			
g. What is the frequency of a signal that has a sweep time of 200 microseconds? _____			

Task VI - AC Circuits cont.

	Pass	Fail	Initials
3. Set up the Scopemeter to check an unknown signal and record the following: a. Frequency _____ Hz b. Peak voltage _____ V c. RMS voltage _____ V d. Peak to peak voltage _____ V			
4. Perform a power panel check using the Scopemeter. Measure each phase of the 3-phase incoming voltage lines and record: a. Phase 1 voltage _____ V b. Phase 2 voltage _____ V c. Phase 3 voltage _____ V d. What is the phase shift, if any? _____ degrees shift e. What is considered a normal phase shift in a 3-phase system?			
5. Connect the power panel to a 3-phase motor. Energize the motor and check for proper operation. a. Using a clamp-on meter, measure the phase current for each motor lead, T1, T2 and T3. i. T1 amps _____ A ii. T2 amps _____ A iii. T3 amps _____ A b. Is system operating correctly? Yes / No c. De-energize system and return to pre-test condition.			

Motors & Motor Controls Lab

Introduction

In these lab exercises the student will explore motors and motor control circuits, identifying the different types of motors and performing a disassembly and reassembly of selected DC and AC motors. The student will read schematics and test motor control circuits. The exercises will emphasize tools and techniques developed in prior lab experiences. The student will develop troubleshooting techniques for diagnosing problems with motors and motor control circuits.

Key Learning/ Performance Objectives

- Identify, disassemble, test, and rebuild various AC and DC motors
- Identify motor control components
- Read and interpret motor control schematics
- Operate a designated system and evaluate its performance
- Troubleshoot system faults and repair as necessary

Success Measure

The student will perform all tasks with 90% accuracy, as defined by the lab instructor.

Equipment and Special Requirements

- AC and DC motors
- Motor control circuit components, such as contactors, relays and switches
- Suitable motor control panel
- Multimeters and megohmmeter

Prerequisite Labs

- Basic Electrical Lab

Description of Procedure

The student will be identify, disassemble and reassemble various DC and AC motors and troubleshoot motor control circuits.

Motors & Motor Controls Lab Procedure and Worksheet

Name	Start Time
Date	Finish Time
Instructor's Signature	

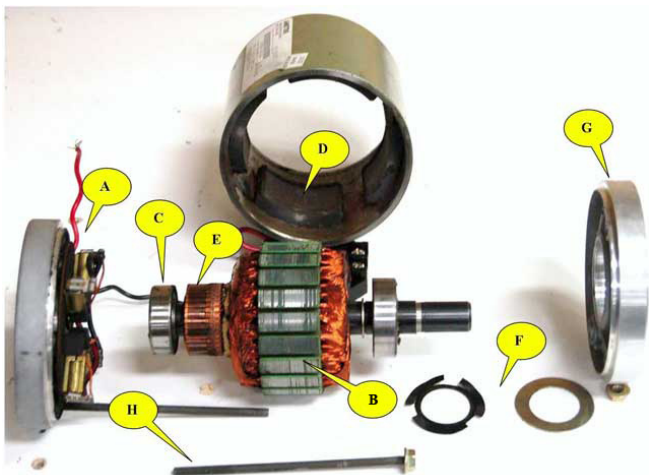
In this lab, your objective is to complete various tasks which will be used to evaluate your mastery of the requisite skills. It is your responsibility to complete these tasks accurately in a timely manner complying with all appropriate safety measures and use of all required Personal Protective Equipment (PPE).

Task I - Identify the parts of the DC motor

Pass

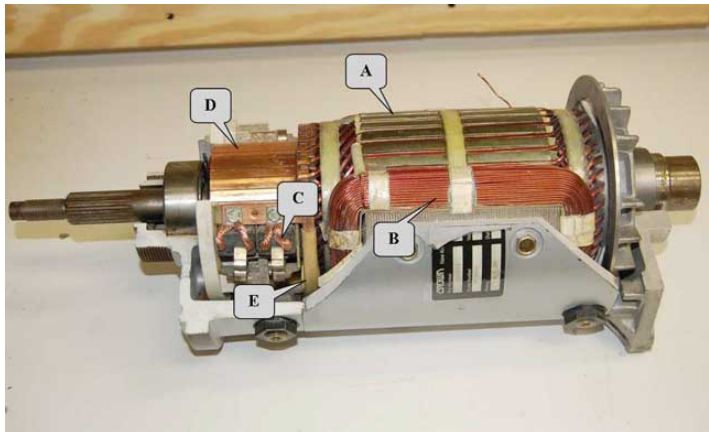
Fail

Initials



Slip ring	
Bearing	
Brush Holder	
Permanent Magnet	
Armature	
End Bell	
Case bolt	
Commutator	

Task II - Identify the parts of a DC series Shunt Motor

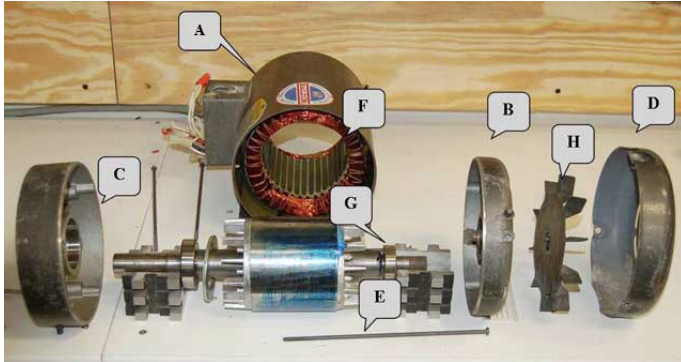


Commutator	
Shunt	
Field	
Armature	
Brushes	

Pass

Fail

Initials

Task III - Identify the parts of a 3-Phase AC Motor
Pass
Fail
Initials


Motor Face	
Bearing	
Stator	
Motor Case	
Rotor	
Cooling Fan	
Fan Cover	
Case Bolt	

Task IV - Evaluate a 3-Phase Motor
Pass
Fail
Initials

1. Record all findings.

a. Listen to motor run. Identify any unusual noises.

b. Touch motor case to feel any excessive vibrations.

Task IV - Evaluate a 3-Phase Motor cont.
Pass
Fail
Initials

c. Use a clamp-on Ammeter to measure the current draw per leg.

d. Use a digital thermometer to check bearing and connection temperatures.

2. Remove motor from service and tear down.

a. Clean and check bearings.

b. Inspect stator and rotor.

c. Using a Megohmmeter, check winding to winding and winding to ground resistance for all phases.

d. If findings are satisfactory re-assemble motor.

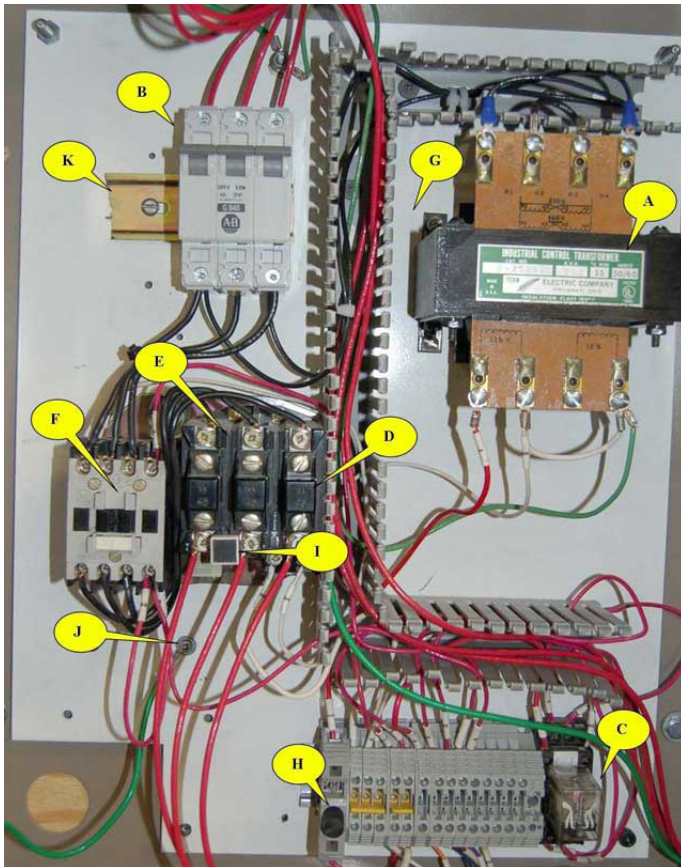
e. Re-connect and repeat steps in Task 4.1.

Task V - Identify the components in this motor control panel

Pass

Fail

Initials



Control Circuit fuse	
Reset Button	
Case Ground	
Din Rail	
Motor Contactor	
Overload section	
Heaters	
Circuit Breaker	
Ice cube relay	
Wire way	
Transformer	

Task VI - Control transformers

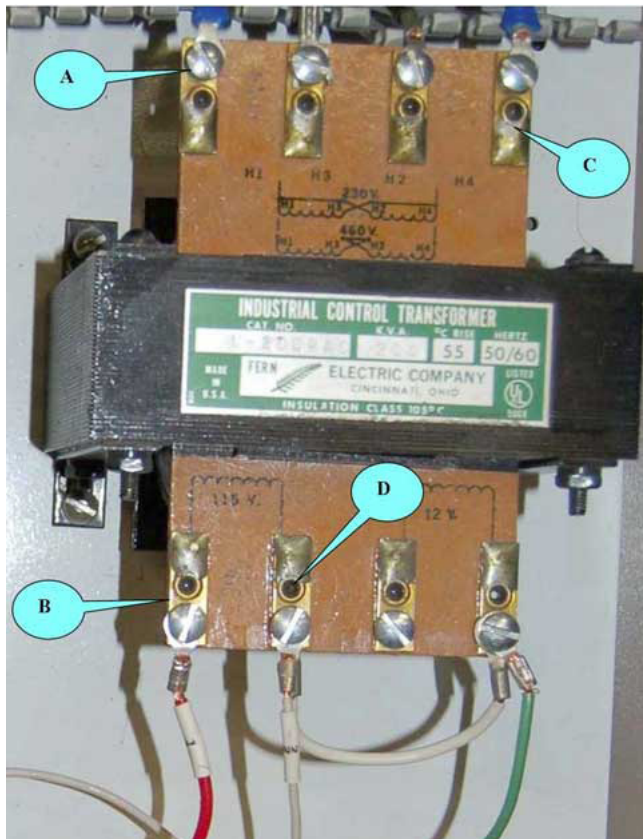
Pass

Fail

Initials

1. Describe the function of a control transformer.

2. Identify the connections below.



	A
	B
	C
	D

Task VII - Motor Control Troubleshooting
Pass
Fail
Initials

Using the provided wiring diagram, check out the electrical panel provided and restore it to service. Do not swap parts! If you can convince the lab instructor that a part is bad, you will be provided with a suitable replacement.

1. Track down the immediate problem.

2. Find the cause of the immediate problem.

3. Check all grounds.

4. When you have finished your troubleshooting, explain to the instructor what you did to solve problem and steps that should be taken to prevent recurrence.

Wiring & Distribution Lab

Introduction

In these lab exercises the student will apply the National Electric Code standards to the design and fabrication of electrical distribution branch circuits. The student will select components and lay out and measure a branch circuit and then build the circuit, using the appropriate conduit and wire, with the appropriate tools. The exercises will emphasize proper techniques and safe usage of all tools.

Key Learning/ Performance Objectives

- Apply NEC standards to electrical distribution branch circuit design
- Select appropriate fittings and components for a branch circuit
- Lay out, measure, and build a branch circuit
- Select, pull and terminate wire to complete branch circuit

Success Measure

The student will design and build a branch circuit, applying the proper NEC standards, with 100% accuracy.

Equipment and Special Requirements

- Thin wall, rigid, plastic and Fextight conduit and fittings
- Conduit benders and heater
- Wire fish tape or appropriate pulling equipment
- Pliers, cutters and wire strippers
- Tape, wire nuts and connectors as required
- Ugly's Reference guide

Prerequisite Lab

- Basic Electrical Lab

Description of Procedure

The student will identify and select appropriate fittings and components to create an electrical distribution branch circuit, applying NEC standards, lay out and build the various conduit connections, and pull the appropriate wire to complete the assigned circuit.



Wiring & Distribution Lab Procedure and Worksheet

Name

Start Time

Date

Finish Time

Instructor's Signature

In this lab, your objective is to complete various tasks which will be used to evaluate your mastery of the requisite skills. It is your responsibility to complete these tasks accurately in a timely manner complying with all appropriate safety measures and use of all required Personal Protective Equipment (PPE).

Task I - Identify conduits and fittings and applications

	Pass	Fail	Initials
1. EMT			
a. Box connector			
b. LB			
2. Rigid			
3. PVC			

Task II - Identify conductors

	Pass	Fail	Initials
1. Sizes			
2. Ampacity			
3. Conduit fill			

Task III - Bend Conduit

	Pass	Fail	Initials
Following the directions of the lab instructor, form and install a conduit run.			
1. EMT			
a. Offset			
b. Back to back bend			
2. PVC			
a. Box to box connector			
b. Heated bend			
3. Flectight			
a. Box to device connection			
i. Measure, cut and install Flectight as directed.			

Task IV - Wiring practices

	Pass	Fail	Initials
1. Select appropriate size wire and complete the connection from the box to the device.			
2. After verification, energize and test.			
a. Make corrections, if needed.			

Basic Fluid Power Lab

Introduction

In these lab exercises the student will explore industrial fluid power (pneumatic and hydraulic) components and circuits, identifying the different types of valves, actuators and filtration systems. The student will also read and interpret schematics and build and test basic fluid power circuits. The exercises will emphasize troubleshooting techniques for diagnosing problems with fluid power components and circuits.

Key Learning/ Performance Objectives

- Identify pneumatic and hydraulic components
- Read fluid power schematics
- Design, build and operate fluid power circuits
- Troubleshoot fluid power circuits

Success Measure

The student will perform all tasks to within 90% accuracy, as defined by lab instructor.

Equipment and Special Requirement

- Fluid power components
- Fluid power trainer

Prerequisite Labs

- None

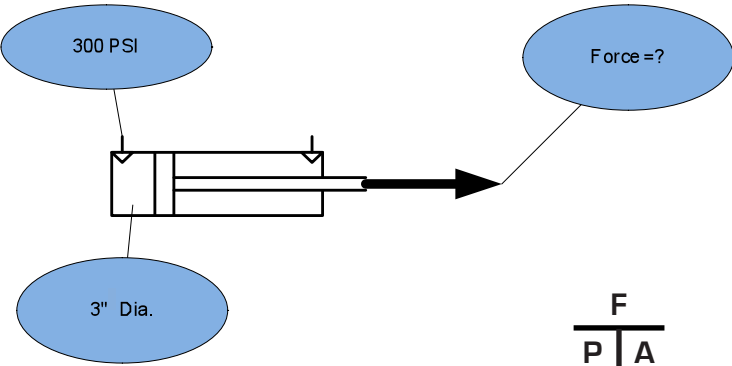
Description of Procedure

The student will identify fluid power components, interpret schematics, and assemble and troubleshoot various fluid power circuits.

Basic Fluid Power Lab Procedure and Worksheet

Name	Start Time
Date	Finish Time
Instructor's Signature	

In this lab, you will be required to complete various tasks which will be used to evaluate your mastery of the requisite skills. It is your responsibility to complete these tasks accurately in a timely manner complying with all appropriate safety measures and use of all required Personal Protective Equipment (PPE).

Task I - Force, pressure and area	Pass	Fail	Initials
1. Calculate the force exerted: $F =$ _____ Show your work.  $\frac{F}{P \times A}$			

Task II - Fluid Power Components

Pass

Fail

Initials

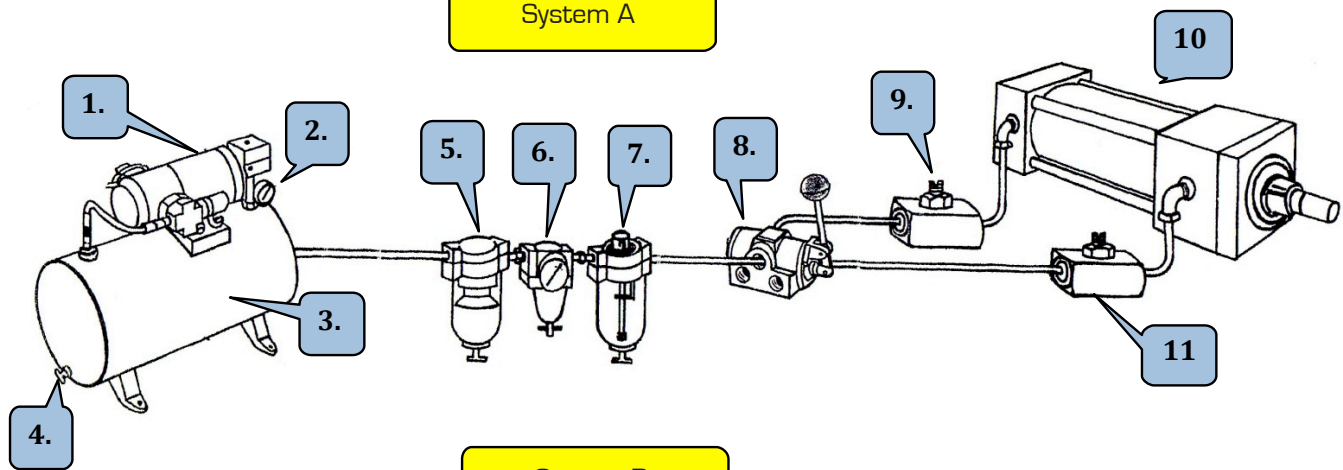
1. Refer to the diagrams below:

System A is a _____ system.

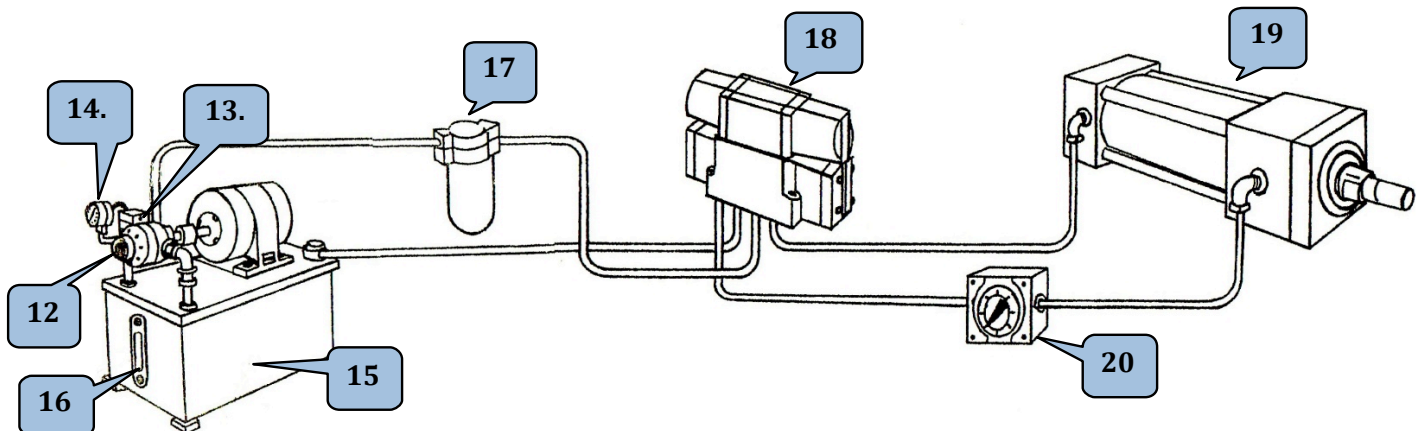
System B is a _____ system.

2. Identify the components of systems A and B.

System A



System B



1.		2.		3.		4.	
5.		6.		7.		8.	
9.		10.		11.		12.	
13.		14.		15.		16.	
17.		18.		19.		20.	

Task III - Fluid Power Symbols and Components

Pass

Fail

Initials

1. Draw the symbol for a pneumatic flow control.

2. Draw the symbol for a hydraulic flow control.

3. Draw the symbol for a 3-position, 5-way solenoid/
pilot pressure operated valve. Briefly
describe its operation.

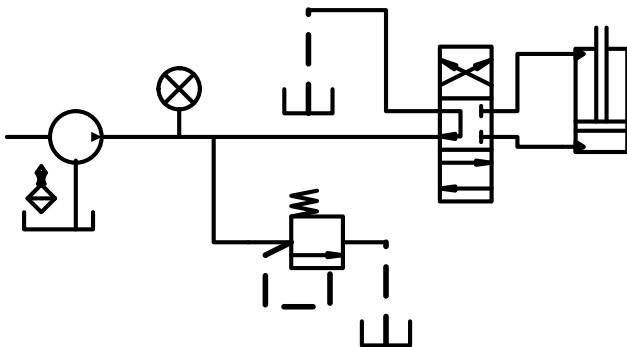
Task IV - Fluid Power Circuits

Pass

Fail

Initials

1. Assemble the following fluid power circuit on the
training system. Set the pressure to 200 PSI.



Task IV - Fluid Power Circuits cont.
Pass
Fail
Initials

2. Test the circuit and troubleshoot it as necessary.

3. Cycle the system and note the system pressure.

4. Install a flow control on the cylinder extend action.

5. Cycle and adjust to the lab instructor's specification.

6. Describe the effect of flow control on system pressure.

Advanced Fluid Power Lab

Introduction

In these lab exercises the student will apply the knowledge gained in the Basic Fluid Power lab to examine more complex fluid power components and systems. The student will disassemble components and examine their internal workings. In addition the student will operate and evaluate the performance of a given fluid power system. The exercises will emphasize troubleshooting techniques for diagnosing problems with fluid power components and circuits.

Key Learning/ Performance Objectives

- Identify complex fluid power components
- Read fluid power schematics
- Disassemble, inspect, repair and reassemble fluid power components
- Operate a system and evaluate its performance
- Troubleshoot and repair a fluid power system

Success Measure

The student will perform all tasks to within 90% accuracy, as defined by lab instructor.

Equipment and Special Requirements

- Fluid power components
- Fluid power trainer
- Fluid power system for evaluation

Prerequisite Lab

- Basic Fluid Power lab

Description of Procedure

The student will identify complex fluid power components, disassemble, inspect and reassemble various components, evaluate the performance of a given system and troubleshoot various fluid power circuits.



Advanced Fluid Power Lab Procedure and Worksheet

Name	Start Time
Date	Finish Time
Instructor's Signature	

In this lab, your objective is to complete various tasks which will be used to evaluate your mastery of the requisite skills. It is your responsibility to complete these tasks accurately in a timely manner complying with all appropriate safety measures and use of all required Personal Protective Equipment (PPE).

Task I - Fluid Power Components	Pass	Fail	Initials
1. Explain the function and applications of the following: a. Cylinders			
b. Pumps, motors and rotary actuators			
c. Manual and solenoid operated control valves			

Task I - Fluid Power Components cont.

	Pass	Fail	Initials
d. Flow control devices			
e. Accumulators			
f. Pressure regulator valves			

Task II - Disassembly, inspection and re-assembly of fluid power components

	Pass	Fail	Initials
1. Completely disassemble the components given by the lab instructor. Inspect them for broken parts, wear and leaking seals. Then, re-assemble them and test for functionality. Ensure the work area is clean prior to disassembly to avoid any unnecessary contamination.			

Task III - Fluid Power Circuit

	Pass	Fail	Initials
1. Using the assigned schematic, guide the lab instructor through one complete operational cycle.			

Task IV - Pre-startup inspection of a designated system

	Pass	Fail	Initials
1. Check all electrical lines and connections.			
2. Check all mechanical connections.			
3. Check the hydraulic fluid level.			
4. Check the air supply pressure.			
5. Check oilers, filters and strainers.			
6. Check for chafing of fluid lines.			
7. Check for leaks on fluid lines and fittings.			
8. Document unusual conditions.			

Task V - Startup inspection of a designated system

	Pass	Fail	Initials
1. Check components for noise and/or vibration.			
2. Check the pump, if installed, for cavitation.			
3. Check relief valves and gauges for proper settings.			
4. Check components for hot spots.			
5. Check components for leaks.			
6. Cycle the system in manual mode to check for proper cycle operation.			
7. (Optional) Take a sample of hydraulic fluid and inspect for visible contamination.			

Task VI - Troubleshooting a designated system

	Pass	Fail	Initials
1. Start up the system.			
2. Troubleshoot system problems.			

**Task VI - Troubleshooting a designated system
cont.**

	Pass	Fail	Initials
3. Document problems and corrective action.			
4. Demonstrate a complete working system to the lab instructor.			



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