Fluid Power 1

Actuators

Describe the operation of a double-acting pneumatic cylinder and give its schematic symbol
Describe the function of a single-acting pneumatic cylinder and give an application
Describe how cylinder sizes are specified, Size a pneumatic cylinder given a load, and Describe how to size a pneumatic cylinder
Describe five common tie rod cylinder mounting styles and give an application of each
Select a cylinder mounting style for a given application
Describe the function of a quick exhaust valve and give its schematic symbol
Describe 6 symptoms of pneumatic cylinder failure
Describe the function of a rotary actuator and give an application
Describe the function of a shock absorber
Describe how to troubleshoot slow actuator speed
Calculate the extension force of a cylinder given its size and pressure

Best Practices

Describe the importance of eliminating air leaks
Describe four common pneumatic component failures and their probable causes
Give five guidelines used in the construction of pneumatic circuits

Circuits and Logic

Describe the function of a pneumatic schematic
Describe the line symbols used with fluid power circuits
Design speed control circuits
Design a pneumatic circuit that uses an externally air-piloted DCV
Define air logic and give four applications
Describe the function of a shuttle valve and give an application
Connect and operate an air logic circuit to control a reciprocating cylinder
Connect a hydraulic circuit given a schematic

Compressor and Conditioners

Explain how air pressure is created in a pneumatic system
Describe the function of a dryer and give an application
Describe the operation of a refrigeration type air dryer
Describe the principle of operation of three types of dryers and give an application of each
Describe the function of pneumatic system trap
Describe the operation of two types of pneumatic traps and give the schematic symbol of each
Connectors

Describe the function of a pneumatic quick connect fitting and give its schematic symbol
Describe the function of a tee and give its schematic symbol
Describe the function of a hydraulic quick disconnect fitting and give its schematic symbol
Describe the function of a hydraulic quick disconnect fitting and give its schematic symbol

Direction Control Valves

Describe the function of a 5-way, 3-position pneumatic DCV and give an application
Describe the operation of a 5-way, 3-position pneumatic DCV and give its schematic symbol
Describe the function of a 3/2 pneumatic DCV and give an application
Connect and operate a pneumatic cam-operated 3/2 DCV
Describe the operation of a 3/2 pneumatic DCV and give its schematic symbol
Describe the function of a pneumatic cam-operated valve and give an application
Describe the operation of a pneumatic cam-operated DCV and give its schematic symbol
Describe the function of an externally air-piloted DCV and give an application
Describe the operation of an externally air-piloted DCV and give its schematic symbol
Describe the function of a pilot-operated DCV and give an application
Describe the operation of internal and external DCV pilots of a pilot-operated DCV
Describe the function of internal and external DCV pilots
Describe the symptoms of pilot-operated DCV failure and their causes
Describe how to inspect and troubleshoot a pilot-operated DCV
Describe the operation of a 3-position, 4-way DCV and give an application
Describe the operation of a 3-position, 4-way DCV and give its schematic symbol
Connect and operate a double-acting cylinder using a 4/3 solenoid-operated hydraulic DCV
Connect and operate a double-acting cylinder using a 4/2 solenoid-operated DCV
Connect and operate a single-acting cylinder using a 5/2 solenoid-operated pneumatic DCV

Electro-Fluid Power

Describe the operation of two types of hydraulic solenoids and explain the application of each
Describe the operation of two types of solenoid-operated pneumatic DCVs
Describe the function of a solenoid-operated hydraulic DCV and give its schematic symbol
Describe the function and operation of a hydraulic DCV manual override
Use the manual override of a solenoid-operated pneumatic DCV to jog a cylinder
Use the manual override if a solenoid-operated hydraulic DCV to jog a cylinder
Describe the function of electro-pneumatic controls and give an application
Describe the function and operation of a pneumatic DCV manual override
Describe the function of a limit switch and give an application
Describe how to interpret limit switch symbols
Describe the operation of a limit switch and give its schematic symbol
Describe the operation of limit switch in an event sequencing circuit
Describe the operation of a single-cycle cylinder reciprocation circuit
**Filters**

Describe the function of an air filter  
Describe the operation of an air filter and give its schematic symbol  
Drain a pneumatic filter  
Describe two methods of removing water vapor from a pneumatic system  
Describe four symptoms of filter failure and their causes  
Describe how to inspect and troubleshoot a filter

**Fittings**

Describe the construction and give an application of three types of pneumatic fitting threads  
Install and seal a straight thread fitting  
Describe the function of an adapter and give an application  
Describe the UNF thread size used for pneumatic fittings  
Describe the operation of straight threaded fittings  
Describe how to identify and specify pipe size  
Identify the nominal pipe size of a fitting given an example  
Describe the function of a reducing bushing and give an application  
Install a reducing bushing to connect an oversized port  
Describe how to specify the size of a reducing bushing  
Identify the shape, type and size of tubing connectors

**Flow Control & Relief Valves**

Describe the function of a muffler and give its schematic symbol  
Describe the function of a pneumatic check valve and give an application  
Describe the operation of three types of check valves and give their schematic symbol  
Describe the function of a check valve and give an application  
Connect and operate a check valve  
Describe the operation of two types of pneumatic check valves and give their schematic symbols  
Describe the operation of a flow control valve and give its schematic symbol  
Connect and adjust a flow control valve to control speed of an actuator  
Describe what determines the speed of a pneumatic actuator  
Describe the effect of actuator load changes on flow control valve operation  
Describe the operation of a flow control valve and give its schematic symbol  
Describe the function of the flow control valve and give an application  
Troubleshoot a flow control valve using an in-circuit test  
Describe how to inspect and troubleshoot a flow control valve  
Describe the symptoms of flow control valve failure and their causes  
Connect and adjust a flow control valve to control speed of an actuator  
Describe the operation of a meter-in flow control circuit and give an application  
Connect and operate a meter-in flow control circuit  
Describe the operation of a meter-out flow control circuit and give an application  
Connect and operate an exhaust port speed control circuit  
Connect and operate a meter-out flow control circuit  
Describe the operation of an exhaust port speed control and give an application  
Connect and operate a needle valve to control actuator speed  
Connect and operate a needle valve to control the speed of an actuator  
Describe the operation of a needle valve and give its schematic symbol
Describe the main function of a pneumatic needle valve and give an application
Describe the symptoms of quick exhaust valve failure and their causes
Describe how to inspect and troubleshoot a quick exhaust valve
Describe the function of an exhaust restrictor and give an application
Describe the symptoms of exhaust restrictor failure
Describe the operation and construction of an exhaust restrictor
Describe the function of a relief valve and give an application
Connect and adjust the pressure setting of a PRV
Describe the operation of an integral check valve and give its schematic symbol
Connect a relief valve in a circuit to limit pressure in the system
Describe the operation of a direct-acting relief valve and give its schematic symbol

Gages and Instruments

Read a pneumatic pressure gage
Read a hydraulic pressure gage
Describe how pressure gages are calibrated
Measure Delta P across pneumatic components
Connect and read a manometer
Describe the operation of two types of manometers
Describe the function of a flowmeter and give an application
Connect and read a flowmeter
Describe the operation of two types of flowmeters and give their schematic symbol
Connect and read a flowmeter
List and give an advantage of each of three devices used to measure vacuum levels
Connect and read a vacuum gage
Convert between units of mercury and units of air pressure
Convert between units of water column and units of water pressure

Hoses

Describe the three functions of an air line
Describe how hose is specified
Describe how to determine the length of a hose for an application
Identify hose size given a specification
Identify hose size by measurement
Describe how to cut hose
Cut off hose using a cut-off saw
Describe how to calculate the pressure drop given hose size and flow rate
Calculate the pressure drop given hose size and flow rate
Describe how to maintain a hose system

Lubricators

Describe the function of air lubrication and list three lubrication methods
Describe the operation of three types of pneumatic lubricators and give an application of each
Describe the function of a lubricator and give its schematic symbol
Describe four symptoms of lubricator failure and their causes
Describe how to inspect and troubleshoot a lubricator
**Metal Tubing**

- Describe how metal tubing is specified
- Select and size metal tubing for an application
- Describe how to select and size metal tubing for a given application
- Calculate the head loss given metal tubing size and flow rate
- Write a tubing specification given its dimensions
- Identify metal tubing given a specification
- Identify metal tubing specification by measurement
- Describe four types of metal tubing and give an application of each
- Describe the operation of a tube bender
- Use a tube bender to bend tubing to a certain angle
- Determine bend locations and angles given a tubing layout drawing
- Describe how to determine bend locations and angles
- Describe how to use a tube cutter to cut metal tubing
- Describe three methods of assembling metal tubing
- Describe how to solder metal tubing
- Cut, bend and assemble steel tubing using flared and flareless fittings
- Assemble copper tubing using flared and flareless fittings
- Describe how to assemble tubing using flared and flareless fittings

**Motors**

- Describe the function of a pneumatic motor and give an application
- Describe how to size a pneumatic motor
- List three types of hydraulic motors and give an application of each
- Describe the operation of a hydraulic motor and give its schematic symbol
- Describe the function of a hydraulic motor and give an application
- Calculate the air flow needed for a pneumatic motor
- Select a pneumatic motor
- List three common pneumatic motor designs and explain where they are used
- Describe the operation of a pneumatic motor and give its schematic symbol
- Define pneumatic motor torque and give its units of measurement
- Describe how to use a torque-speed curve to determine pneumatic motor speed
- Define three types of torque and give its units of measurement
- Describe four symptoms of pneumatic motor failure
- Troubleshoot a motor using an in-circuit test
- Describe how to inspect and troubleshoot a pneumatic motor

**Pressure Sequence Valves**

- Describe the function of a pressure sequence valve and give an application
- Design a two-sequence valve control circuit
- Design a pressure sequence circuit
- Connect and operate a pressure sequence circuit
- Connect and adjust the pressure setting of a sequence valve
- Explain why a sequence valve is externally drained
- Describe the function of a two-sequence valve control circuit
Describe the function of a by-pass check valve in a sequence valve circuit
Describe the operation of a direct-acting sequence valve and give its schematic symbol

Pump and Reservoir

Describe the operation of a hydraulic power unit
Describe the operation of a fixed-displacement pump and give its schematic symbol
Describe the operation of three types of fixed displacement pumps and give an application of each describe maintenance of a hydraulic power unit

Regulators

Describe the operation of a pressure regulator and give its schematic symbol
Describe the operation of a pressure regulator under flow conditions
Describe the function of a pressure regulator valve and give an application
Describe four symptoms of regulator failure and their causes
Describe how to inspect and troubleshoot a regulator
Describe the operation of a direct-acting PRV and give its schematic symbol

Safety

Explain six pneumatic safety rules
Describe eight pneumatic troubleshooting safety rules
Piping safety test
Describe the function of a lockout/tagout system
Describe the operation of an electrical lockout/tagout system
Describe the operation of a pneumatic lockout/tagout system
Perform a lockout/tagout on a pneumatic system
Describe seven rules of safe dress for working with piping

Theory

Define pneumatic pressure and give its units of measurement
Convert between absolute pressure and gage hydraulic pressure
Define hydraulic pressure and give its units of measurement
Convert between gage and absolute pressures
Describe two methods of representing pressure
Describe how to calculate the force output of an extending cylinder
Describe how to calculate the force output of a hydraulic cylinder in retraction (pull)
Describe how to calculate the actual force output of an extending cylinder
Calculate the retraction force of a cylinder given its size and pressure
Calculate the extension force of a cylinder given its size and pressure
Describe how to calculate the force output of a cylinder in retraction (pull)
State Pascal's Law and explain its significance in pneumatics
State Pascal's Law and explain its significance in hydraulics
Explain how force is multiplied using Pascal's Law
Explain how force is multiplied using Pascal's Law
State Boyle's Law and explain its significance
Use Boyle's Law to calculate changes in pressure and volume
Explain how a pneumatic system creates air flow
Measure Delta P across a hydraulic component
Explain how Delta P describes hydraulic resistance
Explain how Delta P describes pneumatic resistance and explain its importance
Define air flow rate and give its units of measurement
Define flow rate and explain how it can be measured
Define dew point and relative humidity and explain their importance
Explain how water condenses in a pneumatic systems and its effect
Define hydraulics and give an application
Describe the function of a hydraulic schematic
Describe the functions of five basic components of a hydraulic system
Define pneumatics and give an application
Explain how pressure is distributed in a hydraulic system
Describe how to calculate the extend speed of a hydraulic cylinder
Calculate the cylinder stroke time given its size and a flow rate
Calculate the extend speed of a cylinder given its size and a flow rate
Describe how to calculate the stroke time of a cylinder
Describe how to calculate the retract speed of a cylinder

**Threaded Pipe**

Identify pipe size and type by measurement
Write a pipe specification given its dimensions
Identify pipe size given a specification
Describe the function of a piping schematic drawing
Read and interpret a piping schematic drawing
Identify the pipe fitting schematic symbols
Describe the function of an expansion joint and give an application
Install an expansion joint
Describe the operation of an expansion joint

**Troubleshooting & Testing**

Describe two levels of pneumatic troubleshooting and give an application of each
Define pneumatic troubleshooting and explain its importance
Describe two methods of testing a pneumatic component and give an application of each
Describe four types of in-circuit component tests and give an application of each
Describe three pneumatic troubleshooting measurements and give an application of each
Use a pressure test point to check system pressure
Describe the construction of a pressure test point and give an application
Describe how to use a flowchart to aid in troubleshooting
Describe the construction of a troubleshooting flowchart
Describe the function of a troubleshooting flowchart
Describe the four methods of system level troubleshooting
Describe how to use PLC I/O indicators to troubleshoot a pneumatic system process
Troubleshoot a pneumatic system using PLC indicator lights
Describe how to troubleshoot zero system pressure
Troubleshoot high system pressure
Troubleshoot low system pressure
Describe how to troubleshoot high system pressure
Describe how to troubleshoot low system pressure

**Vacuum**

List two methods used to produce vacuums and give an advantage of each
Define an vacuum and give three industrial applications
Describe three symptoms of vacuum generator failure and their causes
Describe how to inspect and troubleshoot a vacuum generator
Describe two symptoms of vacuum cup failure and their causes
Describe how to inspect and troubleshoot a vacuum cup
Describe the function of an vacuum switch and give an application
Describe how to inspect and troubleshoot a vacuum switch
Describe a symptom of vacuum switch failure
Describe the operation of a vacuum switch
Describe the function of a vacuum pump and give an application
Describe the operation of a reciprocating vacuum pump
Describe how to inspect and troubleshoot a vacuum pump