Unit 24: Applications of Pneumatics and Hydraulics

Unit code: J/601/1496 QCF level: 4 Credit value: 15

ASSIGNMENT OUTCOME 2
FLUID POWER STANDARDS

TARGET SUBMISSION DATE:

NAME:

I agree to the assessment as contained in this assignment. I confirm that the work submitted is my own work.

Date Issued:

Signature: ***Date submitted:***

This assignment will be used to grade the sections highlighted.

PASS CRITERIA

	Assessment Criteria for a pass	Achieved
L02 Understand the construction, function and operation of pneumatic and hydraulic equipment components, equipment and plant	2.1 identify the features, describe the function and explain the operation of given items of pneumatic and hydraulic	
	2.2 analyse, compare and contrast the performance characteristics for two given items of pneumatic and two given items of hydraulic equipment	

MERIT

	Descriptor	Achieved
• identify and apply strategies to find appropriate solutions.	• effective judgments have been made • complex problems with more than one variable have been explored • an effective approach to study and research has been applied	
• select/design and apply appropriate methods/ techniques	• relevant theories and techniques have been applied.	
	• a range of methods and techniques have been applied.	
	• a range of sources of information has been used.	
	• the selection of methods and techniques/sources has been justified	
	• the design of methods/techniques has been justified	
	• complex information/data has been synthesized and processed	
	• appropriate learning methods/techniques have been applied	
• present and communicate the appropriate findings	• the appropriate structure and approach has been used	
	• coherent, logical development of principles/concepts for intended audience	
	• a range of methods of presentation have been used and technical language has been accurately used	
	• communication has taken place in familiar and unfamiliar contexts	
	• the communication is appropriate for familiar and unfamiliar audiences and appropriate media have been used	

DISTINCTION

• use critical reflection to evaluate own work and justify valid conclusions	• conclusions have been arrived at through synthesis of ideas and have been justified	
	• the validity of results has been evaluated using defined criteria	
	• self-criticism of approach has taken place	
	• realistic improvements have been proposed against defined characteristics for success	
• take responsibility for managing and organising activities	• autonomy/independence has been demonstrated	
	• substantial activities, projects or investigations have been planned, managed and organised	
	• activities have been managed	
	• the unforeseen has been accommodated	
	• the importance of interdependence has been recognised and achieved	
• demonstrate convergent/lateral/ creative thinking	• ideas have been generated and decisions taken	
	• self-evaluation has taken place	
	• convergent and lateral thinking have been applied	
	• problems have been solved	
	• innovation and creative thought have been applied	
	• receptiveness to new ideas is evident	
	• effective thinking has taken place in unfamiliar contexts	

Feedback Comments:

This Assessment brief has been internally verified by .....Date .....

Grade Awarded:

Tutor Signature Date: .....

The script has been internally verified by ..... Date .....

HARDWARE AND BASIC CIRCUITS

Part 1 is made from a series of worksheets that enable you to demonstrate knowledge and ability of hydraulic hardware and circuits. It also includes some work on pneumatics.

You should have each worksheet verified and marked as soon as you complete them. On completion of all the work, you should present all the worksheets to your lecturer in a portfolio for grading. Guidelines of grading are also given on each worksheet where appropriate.

THE WORKSHEETS BELOW HAVE BEEN INCORPORATED IN THE TUTORIALS AS SELF ASSESSMENT EXERCISES

W.S.1 INTRODUCTION TO FLUID POWER

W.S.2 HYDRAULIC PUMPS AND MOTORS

W.S.3 DIRECTIONAL CONTROL VALVES

W.S.4 ACCUMULATORS

W.S.5 CYLINDERS

W.S.6 FILTERS, FLUIDS, SEALS AND POWER PACKS

W.S.7 INTRODUCTION TO PNEUSIMPRO

WORKSHEETS

This document contains seven worksheets on Fluid Power that are integrated into the whole unit and should be completed at the appropriate time when prompted in the tutorials.

The worksheets require access to appropriate hardware and software in many cases and should be done under supervision. This should be sufficient to assess outcome 2. A suggested form for verification is given first.

VERIFICATION SHEET FOR USE WITH WORKSHEETS

Student _____ Date _____

Worksheet Title_____

Context College based assessments using equipment specified in the worksheets.

	W.S.1 Basic Circuit	W.S.2 Pumps and Motors	W.S.3 Directional Control Valves	W.S.4 Accumulators	W.S.5 Cylinders	W.S.6 Filters and Power Packs	W.S. 7 Control Circuit Design
Date Completed							
Passed							

Tutor's signature _____ Student's signature. _____

WORKSHEET 1

INTRODUCTION TO BASIC CIRCUITS

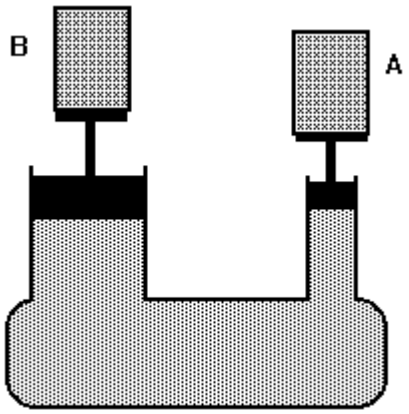
PART 1 – SIMPLE JACK

A good starting point in understanding hydraulic circuits is the simple jack similar to that used to lift cars off the ground.

Examine the diagram of a simple hydraulic jack. Piston A is pushed down by a weight and piston B is pushed up raising another weight.

1.a. Which moves the most A or B? _____

1.b. Which is the heaviest weight A or B? _____



2. The next diagram shows a simple jack. Write down what happens to NRV1, NRV 2 and piston 2 when piston 1 is pushed in (the answer is either open or shut in each case).

NRV 1_____ NRV 2_____ Piston 2_____

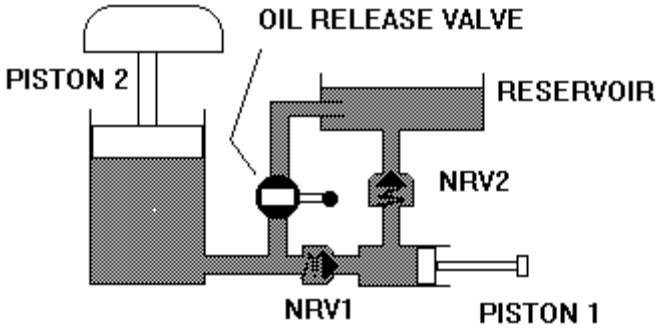
Write down what happens when piston 1 is pulled out.

NRV 1_____ NRV 2_____ Piston 2_____

What is the purpose of the oil release valve?

_____

_____



PART 2BASIC HYDRAULIC CIRCUIT.

Study the simple hydraulic system shown below and fill in the answers to the questions.

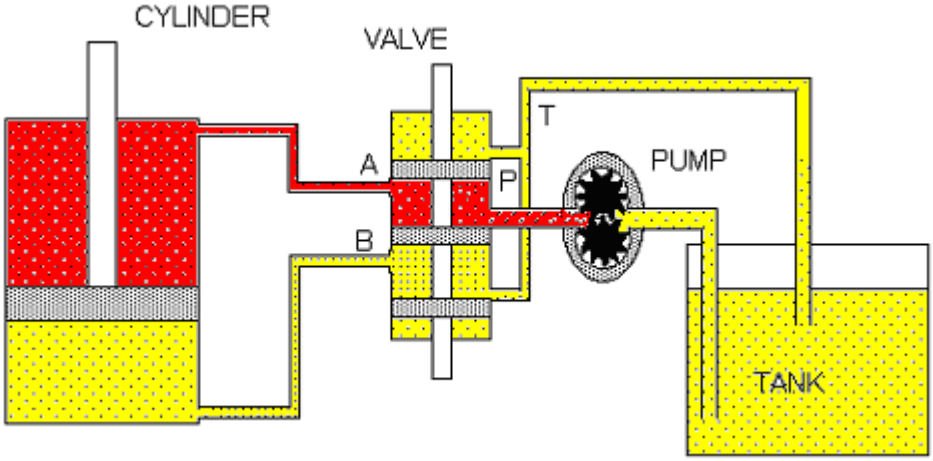


Figure 3

3. With the valve in the position shown, which way is the cylinder piston moving, UP or DOWN?

_____

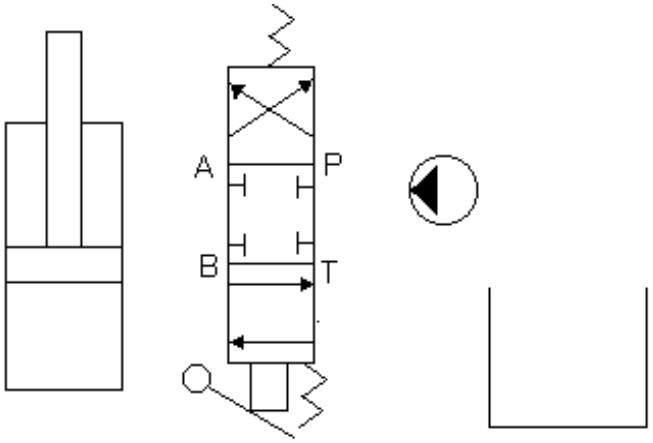
4. Which way must the valve be moved in order to reverse the motion of the load cylinder, UP or down?

_____

5. What will happen to the pressure on the outlet of the pump when the load piston reaches the end of the travel? Will it INCREASE or DECREASE?

_____

6. The simple hydraulic circuit shown represents the system in figure 3. The circuit diagram should be drawn using symbols from British Standard 2917 and these are laid out below. Using solid pencil lines, draw in the pipe line connections to complete the circuit.



WORKSHEET 2

HYDRAULIC PUMPS AND MOTORS

PART 1 - PUMP CHARACTERISTICS

The simple circuit shown is to enable a pump to be tested by measuring the flow rate and pressure.

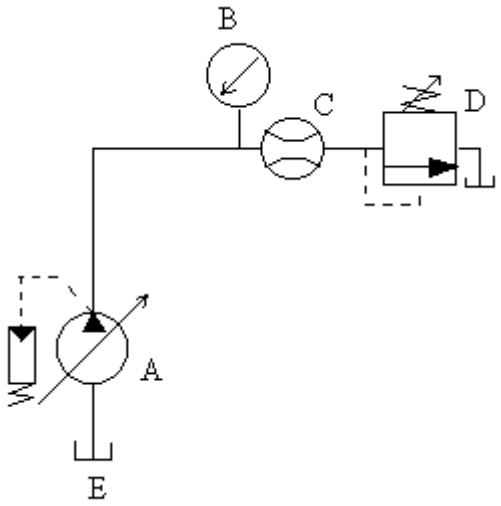
A flow meter is connected in series with the pump and the flow from the pump will be controlled by a pressure relief valve as shown.

Identify by name the item represented by each symbol.

A _____B. _____

C _____D. _____

E _____



The results of the test are given below. Plot a graph with Flow vertically and pressure horizontally.

Flow l/min	6	5	4	3	2	1	0
p bar	10	40	50	50	50	50	50

Explain why the flow suddenly falls away at a certain pressure.

_____

_____

_____

_____

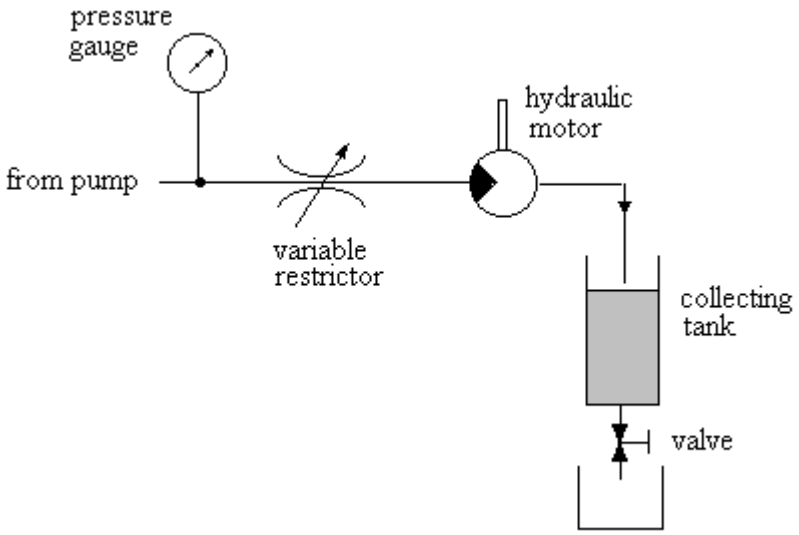
The speed of the pump is 1420 rev/min. Calculate the nominal displacement based on the flow rate at low pressure.

_____

PART 2 - HYDRAULIC MOTORS

SPEED - FLOW RATE CHARACTERISTIC

Set up the following circuit to measure the flow of oil through a motor.



- ***Control the speed of the motor with the variable restrictor.***
- ***For each speed, collect a known volume of oil and time the collection with a stop watch.***
- ***Calculate the flow rate in cm^3/min for each result.***
- ***Calculate the nominal displacement for each result.***
- ***Plot the results on a sheet of graph paper with flow rate vertically and speed horizontally.***

Speed rev/min	100	200	300	400	500	600	700	800	900	1000	1200
Volume litres											
Volume cm^3											
Time taken seconds											
Flow cm^3/min											
Nominal displacement cm^3/rev											

On a separate sheet of paper, explain the following.

1. How did you calculate the nominal displacement? Show the formula and a sample calculation.

2. What is the name of the instrument used to measure the speed?

3. Explain the basic principle of the instrument?

4. Your graph should be a straight line going through the origin. If this is the case, how would you describe the relationship between flow rate and speed?

5. If the motor was forced to work and needed high pressure to force it to go round, the flow rate would not be as high as that measured. Explain why.

WORKSHEET 3

DIRECTIONAL CONTROL VALVES

The object is to familiarise yourself with the symbols and designs of hydraulic directional control valves. You should read your class notes and the computer simulation to help you.

The accompanying page shows 5 variations on the design of a 3 position 4 port d.c.v. The design shown uses pistons or spools sliding in a body to make connections between the pressure port (P), the tank port (T) and the two ports which connect to the cylinder or motor (A and B). Remember that the oil always comes from P and goes to T.

Note that for hydraulic valves the two T ports are connected internally to make one port and for pneumatic they are not be joined but have two separate T ports as shown in the diagram.

Explain why this is so

_____

_____

Most modern valve designs simply have holes on the bottom for the ports. The valves are connected to a base with matching holes. The base has threaded ports which connect to the valve and these may be on the top or the bottom. The size and position of the holes must conform to ISO or CETOP standards.

What is the advantage of having bases instead of connecting the pipe work directly to the valves?

_____

All the valves shown have 3 positions so the symbol has 3 boxes. In all cases the left box must show what the internal connections will be when the piston slides to the right.

Which port will P connect to? _____

Which port will be connected to T? _____

The right hand box shows the connections when the piston is slid to the left. This will reverse the connections and make the cylinder or motor go the other way. The middle box is the normal position so the external pipes are shown connected to it. The box must show the internal connections. These may be connections to each other or they may be blocked off. If a port is blocked a T symbol is used.

The left and right hand boxes will be the same for all 5 valves. Only the middle one will change.

If the pump port (P) is blocked off in the normal position, the valve is said to have a CLOSED CENTRE. If the valve was put into this position, the pump would try to pump oil into a dead space and the pressure would rise to a level where damage would occur.

What would you do to protect the pump?

_____

_____

_____

A closed centre valve is essential if several valves are connected to one pump. if any valve is placed in the middle position, the pressure is still on the system for the other valves to use.

If the pressure port (P) is connected to the tank port (T) in the normal position, the valve is said to have an OPEN CENTRE. In this case, the pump would be connected to the tank and no pressure would exist in the system. This takes the strain off the pump but you would only use for applications where it is the only valve connected to the pump.

Explain why an open centre valve would be used for a car lift comprising of one valve and one cylinder to move it.

_____

_____

_____

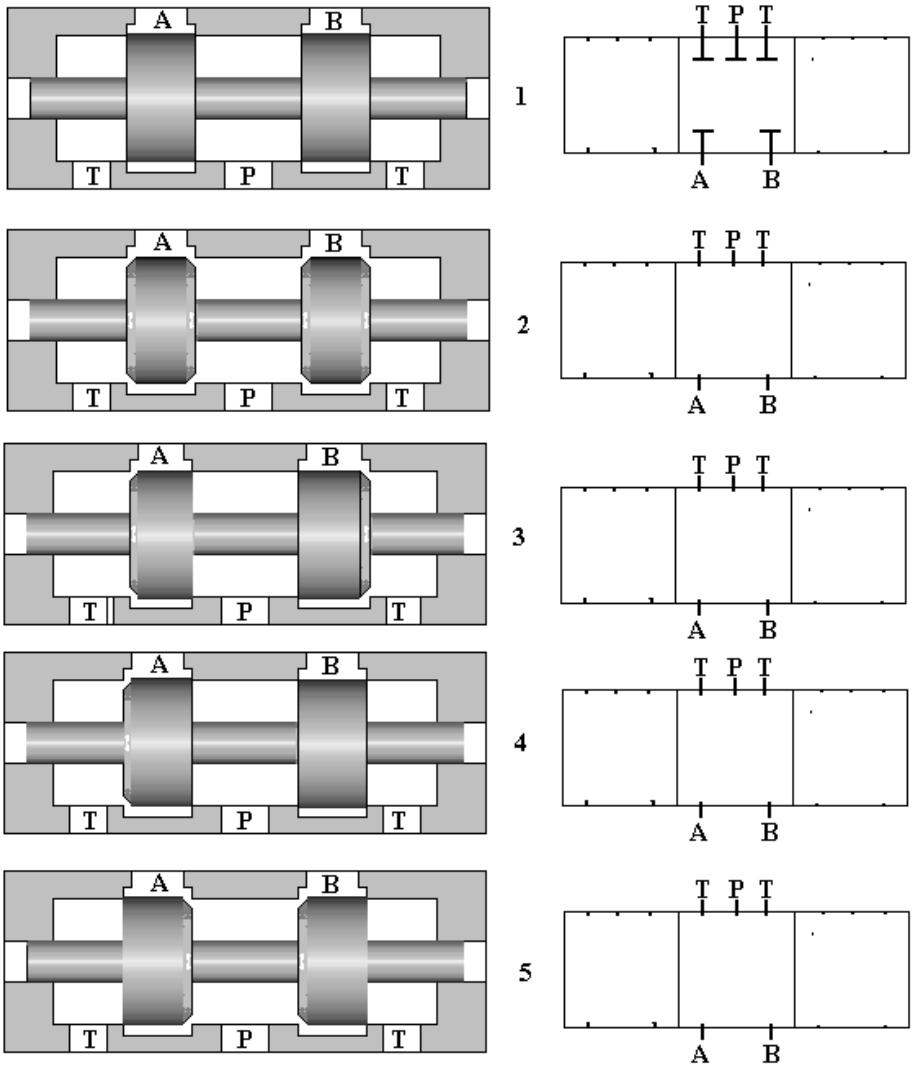
Explain why closed centre valves would be used for a JCB

_____

_____

_____

Complete the symbols for all 5 valves. Use your sheet of standard symbols to help you. The centre block of the first symbol is already completed.

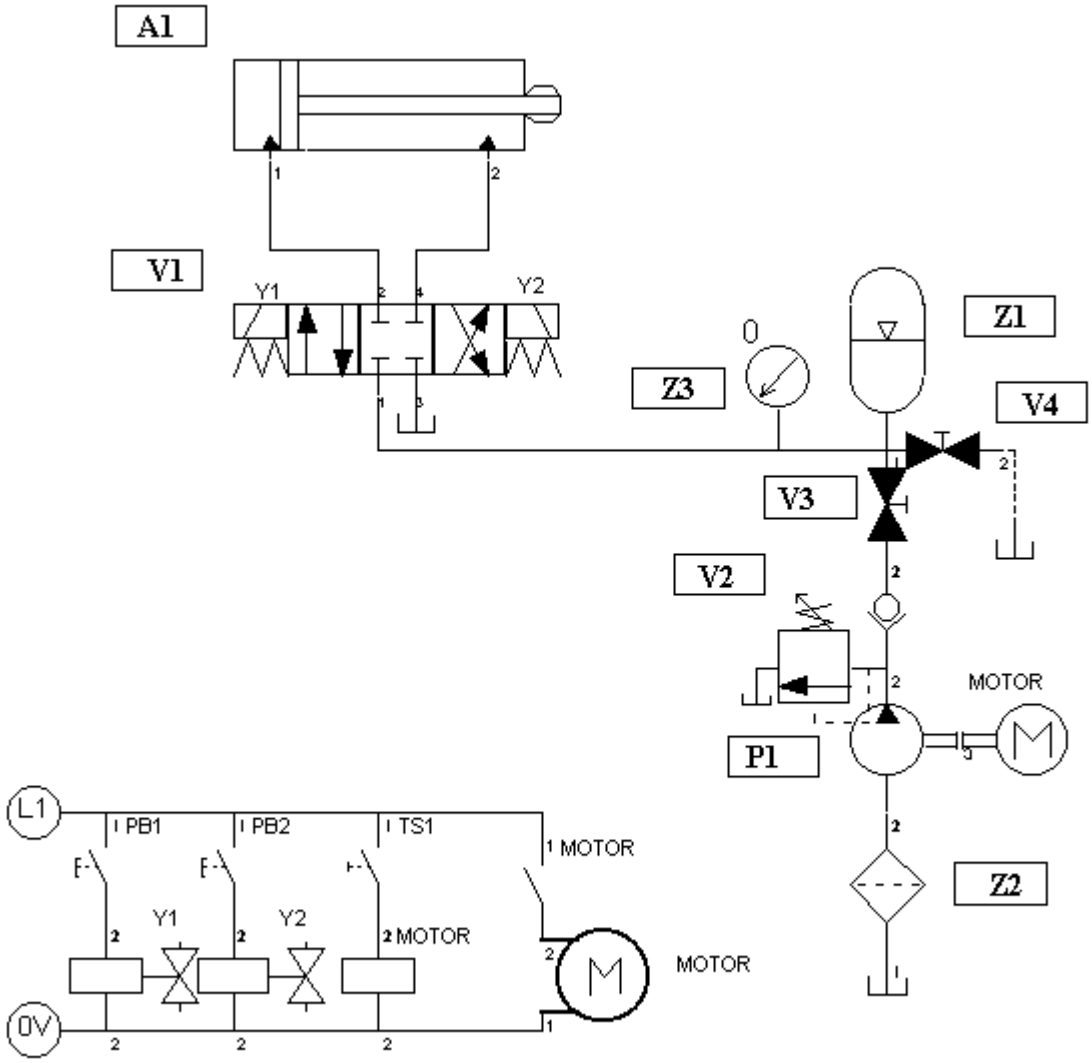


WORK SHEET 4

ACCUMULATORS

This self assessment is in the form of a worksheet to be completed by the student.

Study the circuit diagram of a hydraulic system below along with the electric wiring diagram. If you have access to the software Pneusim Pro™ you might construct it and test it on your computer.



The relief valve V2 is set to 100 bar. Switch TS1 starts the pump motor. The system pressure is monitored with the pressure gauge Z3. The actuator is controlled by solenoids and switches PB1 and PB2 are used to switch the solenoids Y1 and Y2 on or off.

1. To what pressure should the accumulator be initially charged? _____

2. If the hand valve V4 is opened, what happens to the pressure? _____

3. If PB1 is pressed, what happens to the actuator A1?

   _____

4. State the gas that is normally used in accumulators? _____

5. Identify and explain the purpose of component V3 and V4._____

_____

6. Why is it important that V1 has a closed centre? _____

_____

7. State two reasons for using an accumulator in a system.

_____

_____

WORK SHEET 5

CYLINDERS

This self assessment is in the form of a worksheet to be completed by the student.

PART 1 CONSTRUCTION OF A PNEUMATIC CYLINDER

Identify by name the parts of a typical pneumatic cylinder shown on the diagram.

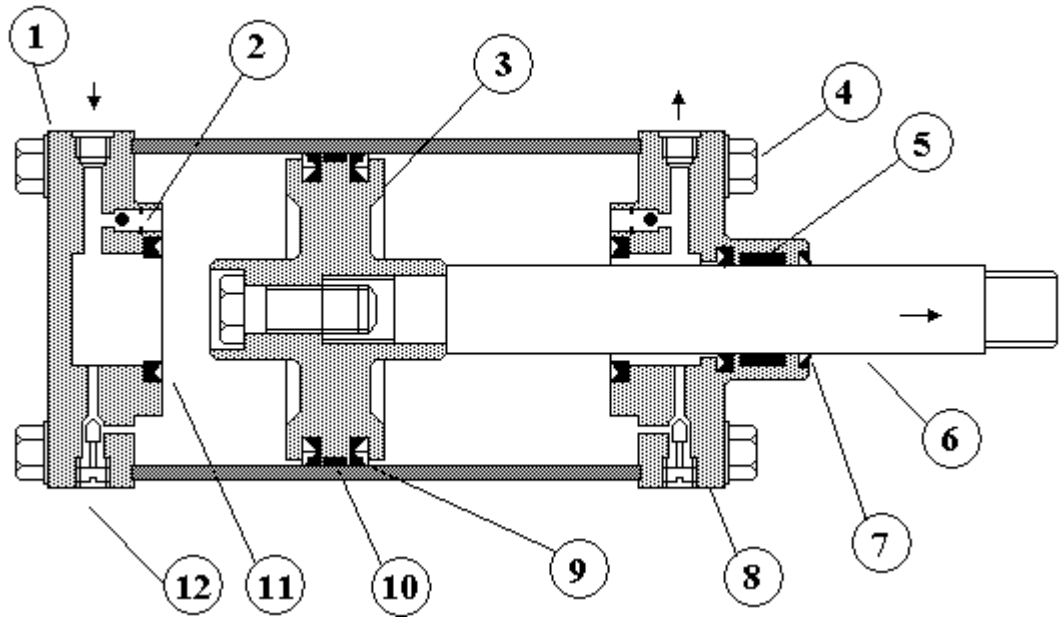


Figure 11

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____

PART 2 QUESTIONS

1. Draw the symbol for a single acting cylinder.

2. Draw the symbol for a double acting cylinder with cushioning.

3. Explain in one sentence why pneumatic cylinders are used at low pressures and hydraulic cylinders at high pressures.

_____

_____

_____

_____

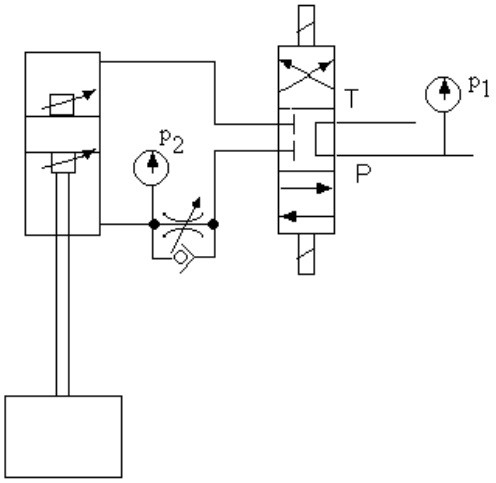
_____

PART 3 HYDRAULIC CYLINDER CIRCUIT

If you have access to suitable test rig or simulation software, you should construct this circuit and try out the following demonstration.

A hydraulic cylinder is mounted vertically and has a large weight on the rod that is lifted when pressure is applied to the annular side of the piston.

This demonstration is to show that pressures higher than the operating pressure can be generated on a hydraulic cylinder with a restricted outlet.



Operate the load up and down and adjust the restrictor to give slow descent.

Note the system pressure p_1._____ Note the pressure on the bottom p_2. _____

Explain why p_2 is larger than the system pressure.

_____

_____

_____

Demonstrate that you can stop the piston half way. Explain how the directional valve enables this to happen.

_____

_____

PART 4 CUSHIONING

Adjust the cushioning on the bottom of the cylinder and demonstrate various degrees of cushioning. Explain in a few words what the purpose of cushioning is.

_____

_____

_____

WORKSHEET 6

FILTERS AND POWER PACKS

Name _____ Date _____

On completion of these training exercises you should be able to do the following:

- Explain the purpose of filtration in a hydraulic system.
- Explain the types and construction of filters.
- Explain filter size and efficiency.
- Change a hydraulic filter.
- Explain the purpose of hydraulic fluids.
- Explain a typical power pack with reference to a circuit diagram.

PART 1

You must read the notes supplied on filters and fluids. When you have done this answer the following questions.

1. List 6 typical contaminants found in hydraulic fluids.

_____

_____

_____

_____

_____

_____

2. An oil sample has an ISO4406 contamination rating of 20/14. How many particles are there larger than 5 microns in a millilitre sample?

_____

3. How much contaminant should be removed by a 30 micron filter using absolute rating?

_____

4. List the materials commonly used for surface and depth filters.

SURFACE TYPE	DEPTH TYPES

5. Draw the symbol for a full flow hydraulic filter with an automatic bypass.

6. State an important consequence of letting a filter become clogged.

_____

7. Describe two methods of indicating the state of a filter to the plant operator.

_____

_____

PART 2

Examine the 4 filters on the table labelled A,B,C and D. Identify them by writing the letter next to the correct description below.

Full flow mono metal filament surface type. _____

Full flow cellulose surface filter cartridge. _____

Mono metal filament surface filter for extra protection of a valve. _____

Examine the LARGE GREEN POWER PACK on the main fixed test rig. The circuit diagram of the power pack is attached. Study the features of the power pack with the aid of the circuit.

How is the oil cooled ? _____

_____

What are the thermostats on the oil tank for ? _____

_____

How is a clogged filter indicated? _____

What features are incorporated in the filler cap ? _____

_____

How is the level of oil in the tank indicated ? _____

PART 3

Study the circuit diagram of the power pack. Identify each item and state its purpose. The first answer is already completed to show you what to do.

A . Suction filter or strainer to remove course dirt at suction to the main pump.

B

_____

_____

C

_____

_____

D

_____

_____

E

_____

_____

F

_____

_____

G

_____

_____

H

_____

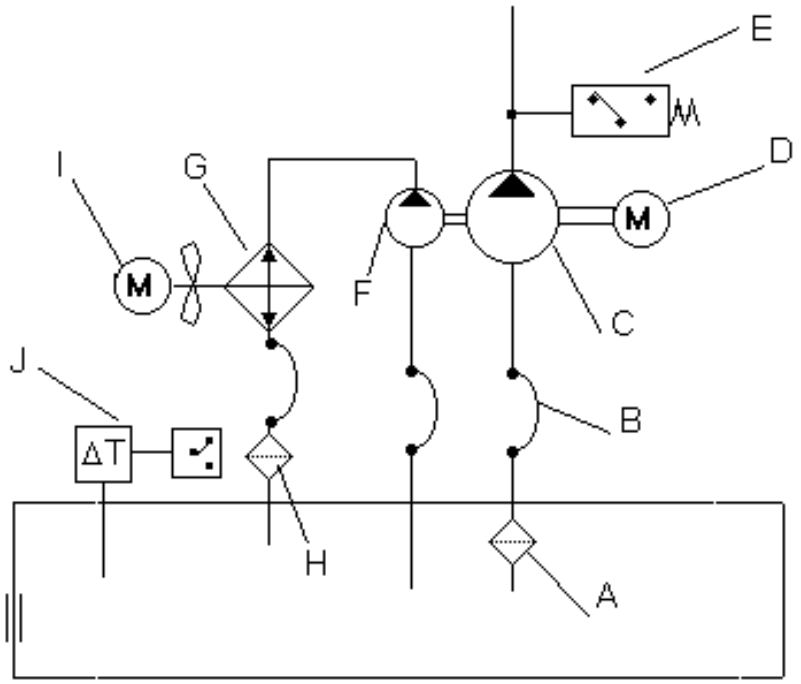
_____

I_____

_____

J_____

_____



WORKSHEET 7 EXERCISE

Introduction to PneuSim Pro™

PneusimPro is a professional software package that enables you to construct various forms of circuits, programme them and test them by simulation.

PART 1 BASIC MANUAL PNEUMATIC CIRCUIT

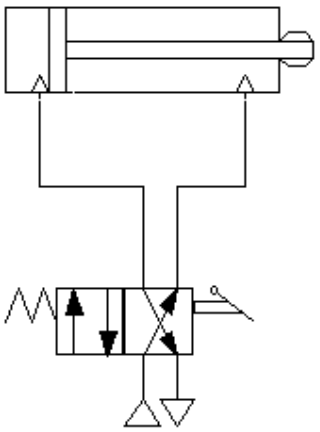
Although you may not be familiar with the symbols used in pneumatic circuits, you should be able to construct the circuit below under instruction from your lecturer.

Open the pneumatic library. Choose Actuators – double acting cylinder and drag the symbol onto the screen.

Choose directional valves 4/2 (14) and drag the symbol onto the screen. Add the lever and spring as directed.

Choose lines and select exhaust and pressure source symbols and add them to the valve. Select pressure lines and connect the symbols as instructed.

Under tools select verify connections. There should be none. Click on the green button and run your simulation. Use the hand to operate the valve and you should be able to make the cylinder go in and out.



ACTUATORS - DOUBLE ACTING CYLINDER

DIRECTIONAL VALVES - 4/2(14)

On the tool bar select document – page layout – documentation. Click border, map locator, title block and bill of materials. Re-position your diagram if necessary – ask how.

Using the text tools, add your name in the appropriate box – ask how.

Print off a copy of the drawing.

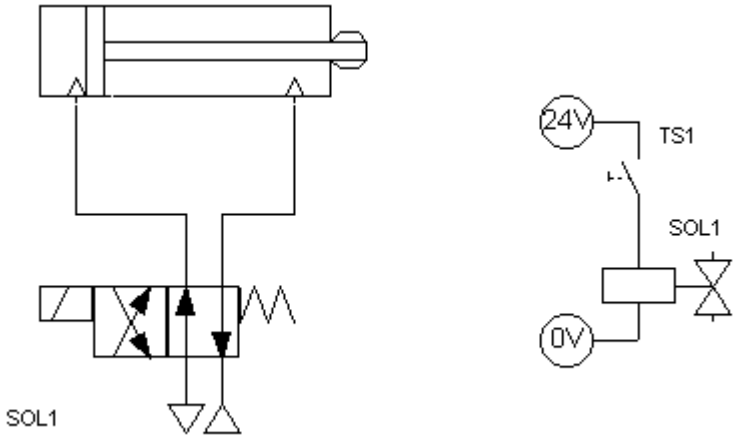
PART 2 ELECTRO-PNEUMATIC CIRCUIT

Modify your circuit as follows.

Double click on the valve and delete the lever and spring. Add the spring and solenoid. Enter SOL1 as the tag name of the solenoid.

Open the workshop electrical control (Europe).
Construct the electrical circuit as shown using power supplies – 24 V and 0V, switches –toggle switch NO (Normally Open) and output components – Solenoid.

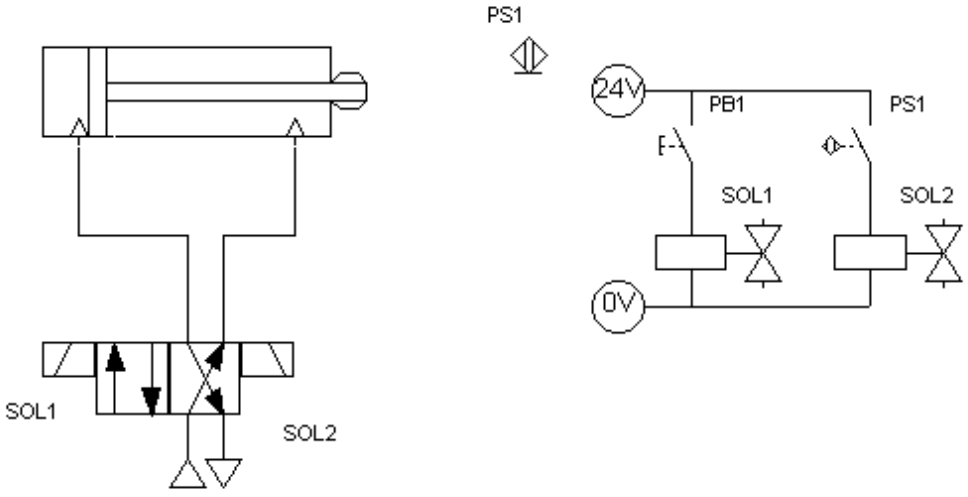
Give the toggle switch the tag name TS1 and the solenoid SOL1.



Run the simulation and operate TS1 with the hand to make the actuator go in and out.

PART 3 AUTOMATIC ELECTRO-PNEUMATIC CIRCUIT

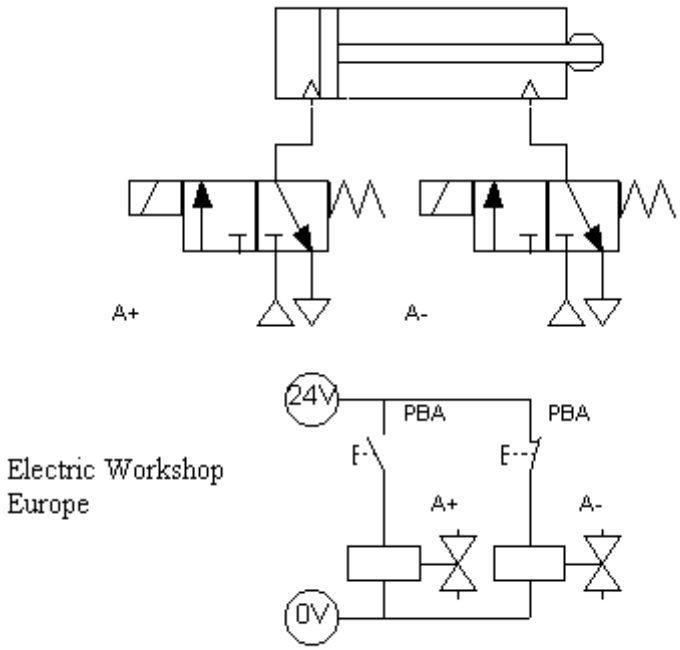
Modify your circuit by adding SOL2. Change the switch to a push button N/O (PB1). Add the proximity sensors PS1 to both parts of the circuit. Look in sensors.



Run the simulation and when you momentarily operate PB1 the cylinder should extend and when PS1 is activated it should automatically return.

Using the text tools, complete the title block and print off a copy of your drawing. This must be attached for marking.

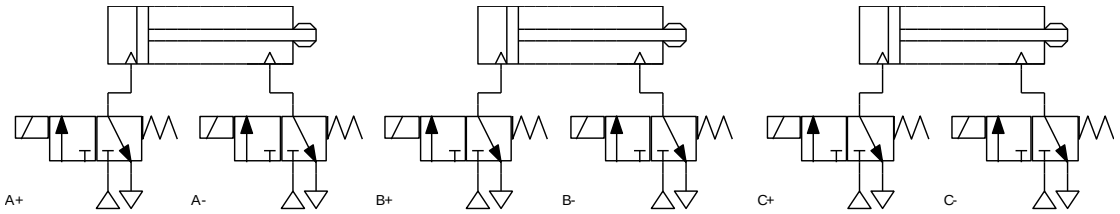
PART 4 **INTERFACING TO A REAL SYSTEM**

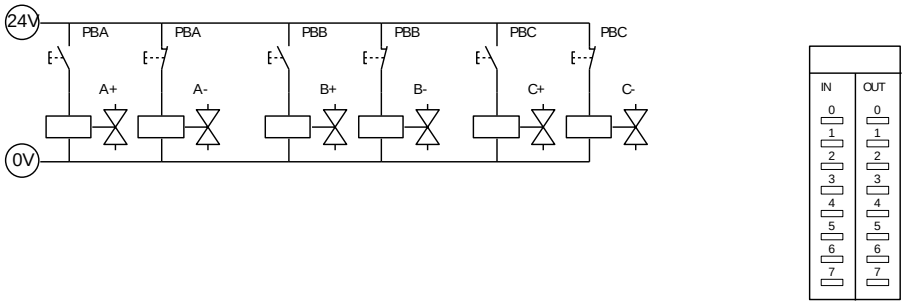


Electric Workshop
Europe

Construct the circuit as shown. Run the simulation to show that operating the button makes the cylinder go out (+) and in (-)

Now modify your circuit using copy and paste to produce three identical circuits but one will use the tag A, the next B and the third C. This is an actual representation of a pneumatic circuit that you can see by the computer. The computer is connected to solenoids by a cable and interface. When you operate the simulation, not only will you see it working on the screen but also in reality. The interface gives real control over real pneumatics.





Add the interface from the interface workshop. Double click on it and label OUT 0 as A+, OUT 1 as PBA, OUT 2 as PBB and OUT 3 as PBC. This will tell the interface which connection is which in the real world. Run the equipment and simulation and demonstrate it working. Print off a copy of your drawing as evidence. Make sure that your tutor signs here to verify that you have done the work.