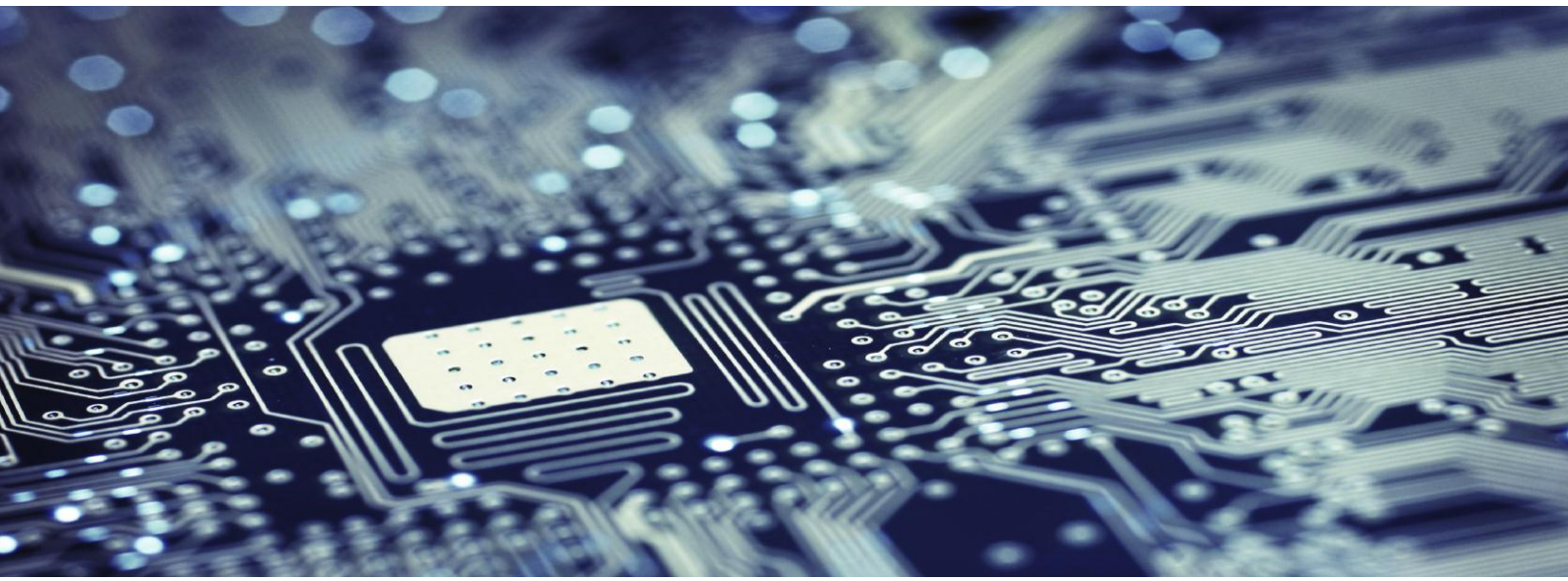
Electrotechnology
Automotive & Heavy Machinery
Aerospace
Marine
Metals
me program
THE LIVING TOOLBOX

me program

TECHNOLOGY

RESOURCES



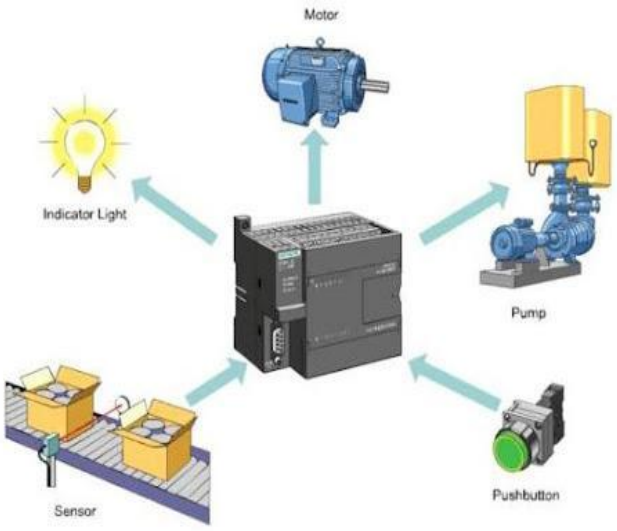
ME PROGRAM AUTOMATION AND INSTRUMENTATION ENRICHMENT DAY

Weighting: 25%

Due Date:

THE PROGRAMMABLE LOGIC CONTROLLER (PLC)

The central component in today's activities is the PLC (Programmable Logic Controller). This component is central to most industrial and engineering control applications. It is the electronic component that allows us to "program" the machinery to perform the tasks we design.



http://www.acsindustrial.com/plc-repair.php

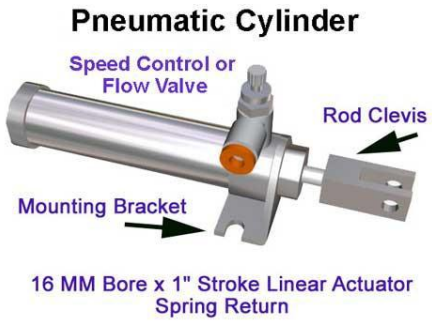
http://automationlive.blogspot.com.au/2011_03_01_archive.html

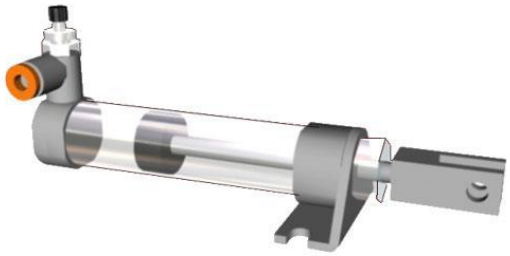
The PLC we are using is made by "Rockwell Automation - Allen Bradley". They are housed in a durable polymer case that has numerous inputs and outputs, so we can build and control a number of different systems.

PNEUMATICS

The term “Pneumatics” refers to using air (pressure and flow) to achieve a mechanical result – static or dynamic. For example : Pneumatic tyres – inflate the tyre (static) and provide suspension (spring and dampening) when driving (dynamic) effects.

Pneumatics are similar to hydraulics in industrial usage: Pneumatics use air and hydraulics use a fluid – usually an oil – eg brake fluid.





The central equation for air PRESSURE in a pneumatic cylinder is:

$$P = \frac{F}{A}$$

Force in Newtons (N) , Area in Square Metres and Pressure in Pascals
http://www.gearseds.com/curriculum/learn/lesson.php?id=101&page=4

Pressures for pneumatic cylinders are often given in **BAR** or **PSI** (pounds per square inch) or **KPa** (alternatively, atmospheres may be used (atm).

Conversions are;

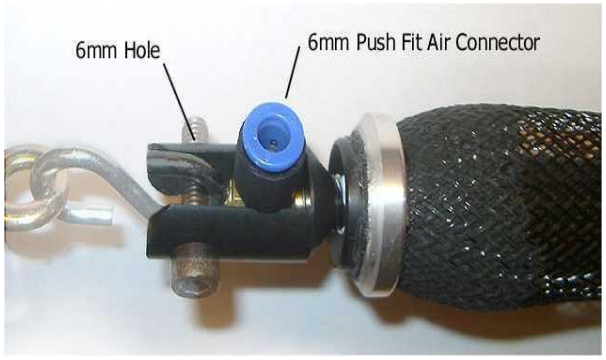
Bar	Kpa	Psi	Atm
1	100	14.5	0.986

An advanced use of Pneumatics

- Pneumatic Muscle:

http://machinedesign.com/article/pumping-iron-0727

http://hackedgadgets.com/2007/07/25/tactile-robotic-hand-with-air-muscles/



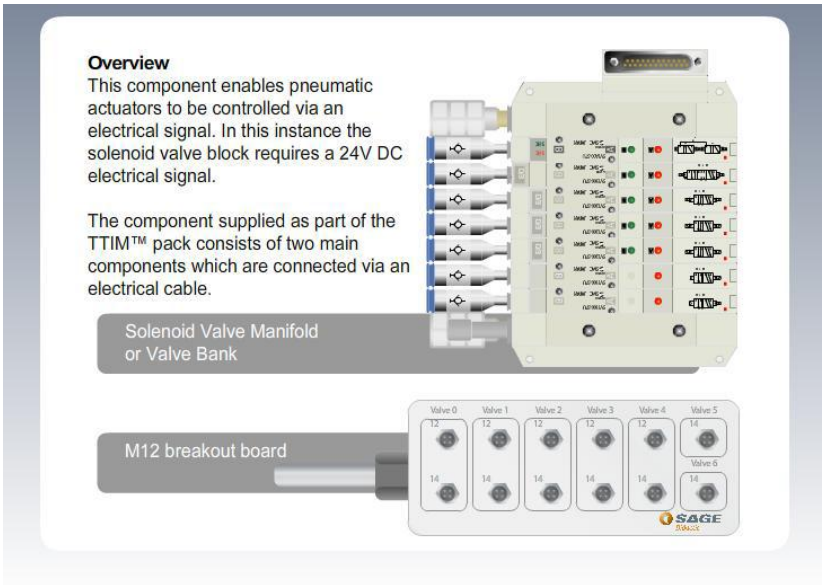
ELECTRO-PNEUMATICS

To control the air flow into and out of a cylinder, you can open and close a valve manually or better still, turn on and off an electrical switch that opens the valve. A convenient mechanism that can be operated by a switch and that opens and closes a valve is a solenoid (refer to the following section on solenoids). A pneumatic solenoid uses an electromagnetic force on a plunger to close a valve.

A bank of these solenoid valves is called a manifold, and looks like:

Each valve has an air hose connected to it and a voltage supply (24V) to turn it on (open or close)

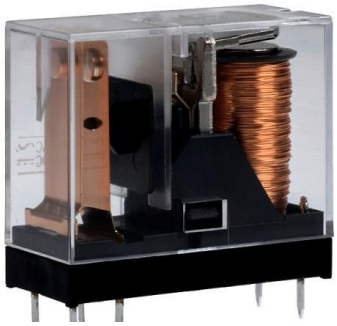
http://www.directindustry.com/prod/festo/pneumatic-solenoid-valves-4735-430418.html


Overview
This component enables pneumatic actuators to be controlled via an electrical signal. In this instance the solenoid valve block requires a 24V DC electrical signal.
The component supplied as part of the TTIM™ pack consists of two main components which are connected via an electrical cable.
Solenoid Valve Manifold or Valve Bank
M12 breakout board
Valve 0
Valve 1
Valve 2
Valve 3
Valve 4
Valve 5
Valve 6
SAGE

ELECTROMAGNETISM

There are a number of applications of electromagnetism in the equipment we are using today:

- Relays
- Solenoids
- Near Infra-Red Sensors (called “optical” sensors)
- Capacitive sensors (electric field)
- Inductive sensors (electromagnetic induction)

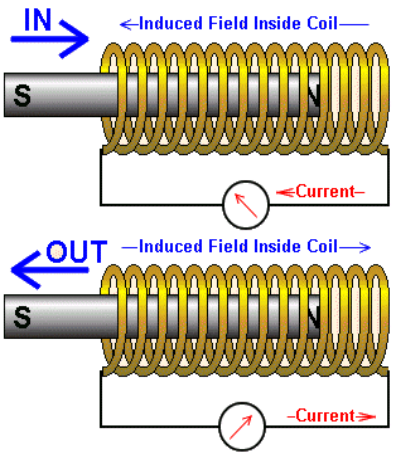


RELAYS are on the relay board at the end of the bench – these will be treated in later activities. They are used in almost all machinery that uses electrical voltage to switch machinery on or off. A small electromagnet pulls a spring loaded switch on or off.

http://www.mcuexamples.com/PIC-Relay.php

SOLENOIDS

Solenoids use a coil of wire to produce an electromagnetic force that pulls (or pushes) an iron “plunger” or “core” in and out.

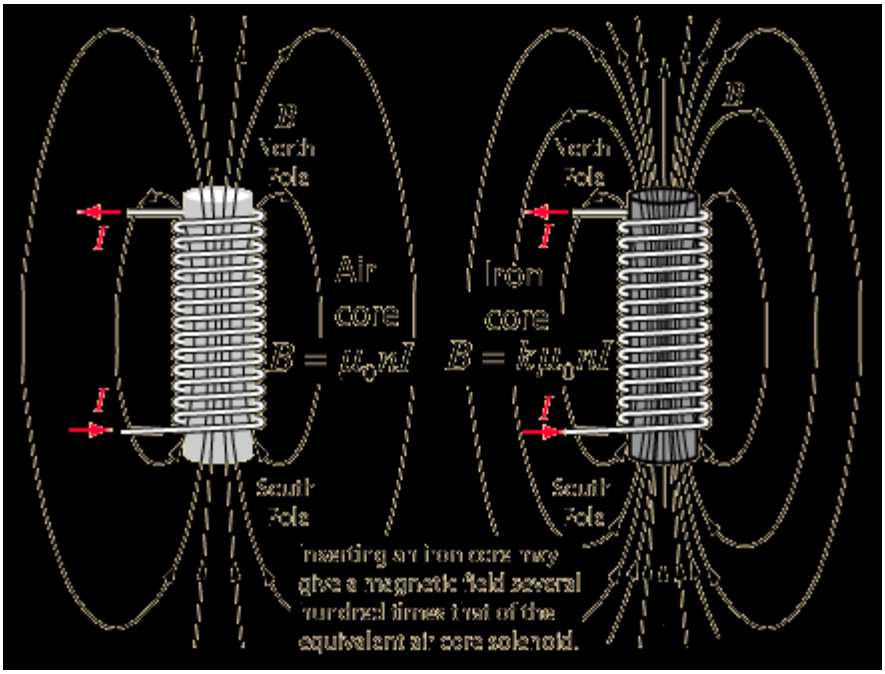


http://www.societyofrobots.com/actuators_solenoids.shtml

The mechanical action of the plunger can be used to:

- Latch a door lock
- Open or close an air (pneumatic) valve.

The field lines (B) are shown below:



http://hyperphysics.phy-astr.gsu.edu/hbase/magnetic/elemag.html

Note the direction of the current in the coil and the resulting direction of the magnetic field (B)

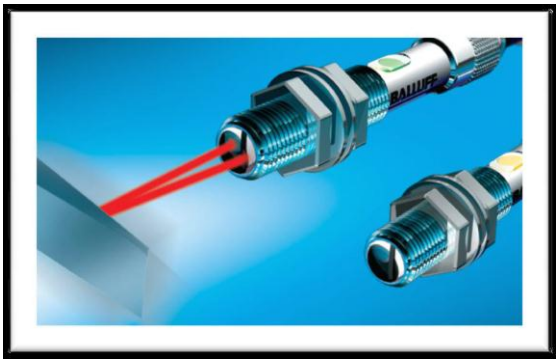
SENSORS

Sensors are an important part of any control system. All computer controlled systems require the sequence: **INPUT – PROCESS – OUTPUT.**

The input can be a switch being turned on, some data being entered on a keyboard, or a voltage from a **sensor**.

PHOTO-ELECTRIC SENSORS

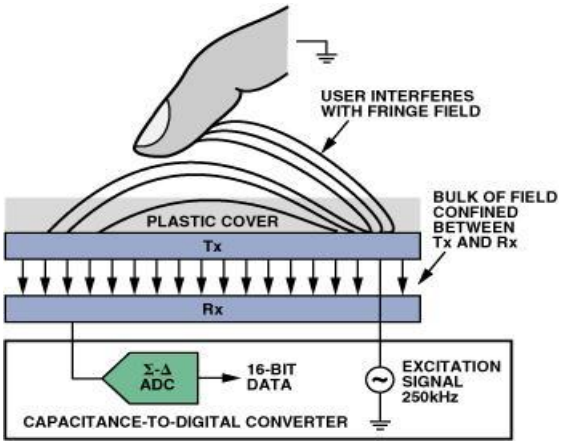
Infra red (IR) sensor ("optical")



http://www.balluff.com/Balluff/us/NewsChannel/Press+Releases/en/Balluff+announces+new+Optoprox+sensor.htm

An optical sensor will detect the level of electromagnetic radiation in the optical part of the electromagnetic spectrum. The word optical is used a little loosely here, as the near Infra red (NIR) sensors we are using are just at the end of the optical spectrum (approximately 750-850 nanometers) but are not detected by human eyes.

CAPACITIVE SENSORS



http://www.supplierlist.com/product_view/jasmine84/25935/100526/Capacitive_Proximity_Sensor.htm

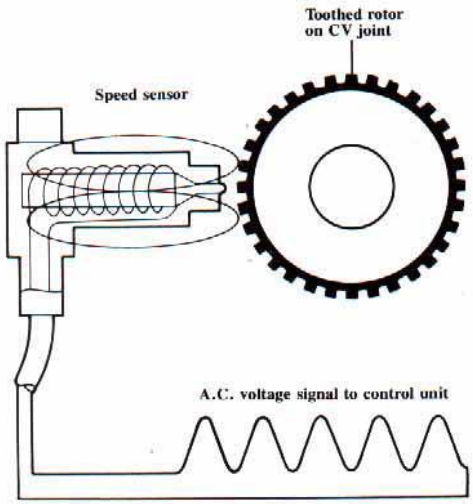
http://www.analog.com/library/analogDialogue/archives/40-10/cap_sensors.html

Capacitive sensors utilise the **electric field** near the end of the sensor (called a "fringe field in the previous image). The change in the field affects the capacitance and this causes a small change in the voltage produced in the sensor.

These sensors are used to detect any object in close proximity, so they are called proximity detectors.

NB: Capacitive Touch screens are used on Smartphone's and tablets.

INDUCTIVE SENSORS



http://www.supplierlist.com/product_view/jasmine84/51046/100526/Rotary_Encoder_ibestchina.htm

http://www.sjmautotechnik.com/trouble_shooting/brake.html

Inductive sensors utilise the **electromagnetic field** around the sensor. The sensor has a coil of wire inside, which produces a magnetic field (electromagnet). Objects nearby disturb the field and cause a small change in the voltage produced in the sensor. These sensors are used to detect any object in close proximity, so they are called proximity detectors. The example above shows an inductive sensor close to a rotating gear wheel. As the gear rotates, the long gear teeth close to the sensor cause the inductor voltage to vary, and so you get a measure of rotation rate.

The difference between capacitive and inductive sensors is that the inductive responds mainly to metallic objects, capacitive to any object.

VOLTAGE SUPPLY

Ohms Law

$$V=IR$$

Voltage (Volts) = Current (Amps) x Resistance (Ohms)

The control system we are using has an industrial standard **24 Volt** DC (direct current) supply.

This Voltage is connected through the system with cables that connect to inputs or outputs.

These cables are specified as M8 or M12.

http://www.smcpneumatics.ie/pages/new-products/april-2009.php

When a switch is turned on or a sensor is “triggered” , the 24 Volt “signal” is connected to the attached cable and a current is sent through the cable to another part of the system.

For example, 24 Volts could be applied to turn on a relay that supplies current to a solenoid, that opens a valve in the pneumatic system.

PROGRAMMING LANGUAGES

To achieve computer control of any system, we a need a language to allow communication, just like a spoken language, or a mathematical language. These computer languages are called programming languages.

For example, we are all familiar with web pages. They are written in HTML (Hypertext Mark-up Language). An example of HTML would be:

Language "CODE"	Result on the screen – the output device
<html> <body> This text is bold This text is strong <big>This text is big</big> This text is emphasized This text is italic This text is small This is_{subscript} and ^{superscript} </body> </html>	This text is bold This text is strong This text is big This text is emphasized This text is italic This text is small This is subscript and superscript

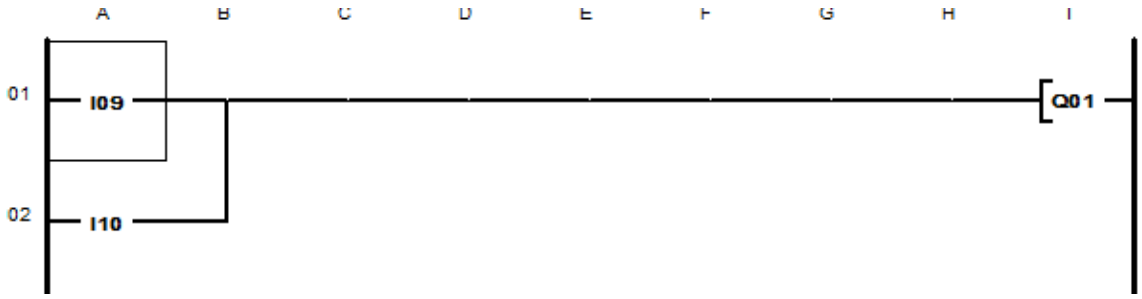
To see a list of programming languages (some historical), go to
http://en.wikipedia.org/wiki/List_of_programming_languages

To communicate with a machine, using the **PLC** (Programmable logic controller) we use a language called **"LADDER LOGIC"**

http://en.wikipedia.org/wiki/Ladder_logic
This language uses "rungs" showing inputs and outputs, instead of lines of text as shown above in HTML for example.

LADDER LOGIC

Ladder logic is used in the system we are using today, as we are writing programming “code” to control the various pieces of equipment in the system. An example of ladder logic is shown on the right.

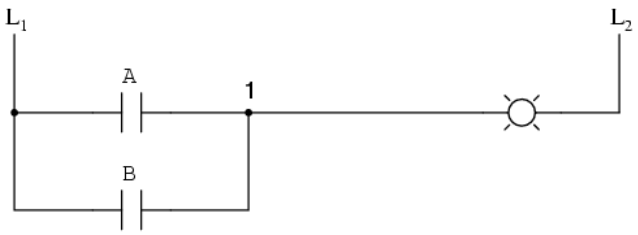


DIGITAL LOGIC

To understand how the various parts of the system interpret the “code” or the instructions we create in the programming language, we need to understand some basic logic, in particular the logic of computers, called **DIGITAL LOGIC.**

The three figures on the right show three different ways of describing the following sentence (a lamp is turned on): http://www.allaboutcircuits.com/vol_4/chpt_6/2.html

“If A **OR** B is switched on, then the output will be turned on”



A	B	Output
0	0	0
0	1	1
1	0	1
1	1	1

These figures are a) **LADDER LOGIC CODE** (top), b) **TRUTH TABLE** (bottom left) and c) **OR Gate Symbol** (bottom right)

In digital logic there are three logical conditions we will use:

- **AND**
- **OR**
- **NOT**

The above example use the **OR** condition.

LATCHES

A latch is a means of keeping a condition on after the initial signal is turned off. This will become easier to understand when we do our first problem.

In this situation, after I9 is initially turned on, the output stays on, regardless of what I9 subsequently does. The output is being fed back to the input.

PLC-TIMERS

The ladder logic program allows the use of timers.

We can either delay the “on”, or delay the “off” switching.

There are various other parameters on the timer, but we will experiment.

The basic layout of a timer “rung” in the ladder logic is:

- Activate the timer as an output
- Use the timer output as an input to turn on an output.

MARKERS

A marker in your program allows you to transfer the result of one step to elsewhere in the program. For example, instead of turning on an output, you could turn on a marker. The “on” value of that marker can then be used elsewhere to turn on an output. It can be used as an intermediate state between input and output. The value of the marker is retained until it is reset.