IMT SCHOOL

Embedded System Interfacing

Lecture 8
Sensors

01 Introduction

Remember Transducers

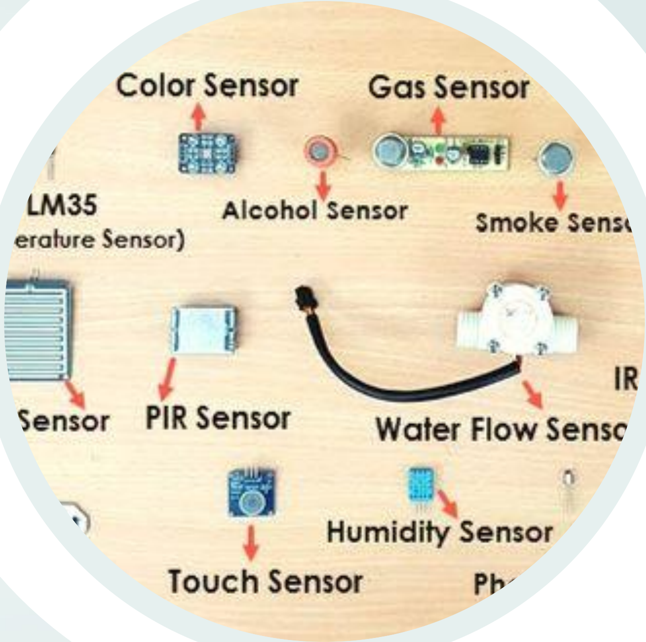
A transducer is any device that converts one form of energy into a readable signal. Many transducers have an input that is then converted to a proportional electrical signal. Common inputs include energy, torque, light, force, position, acceleration, and other physical properties.

Transducers Types:

- Sensors
- Actuators

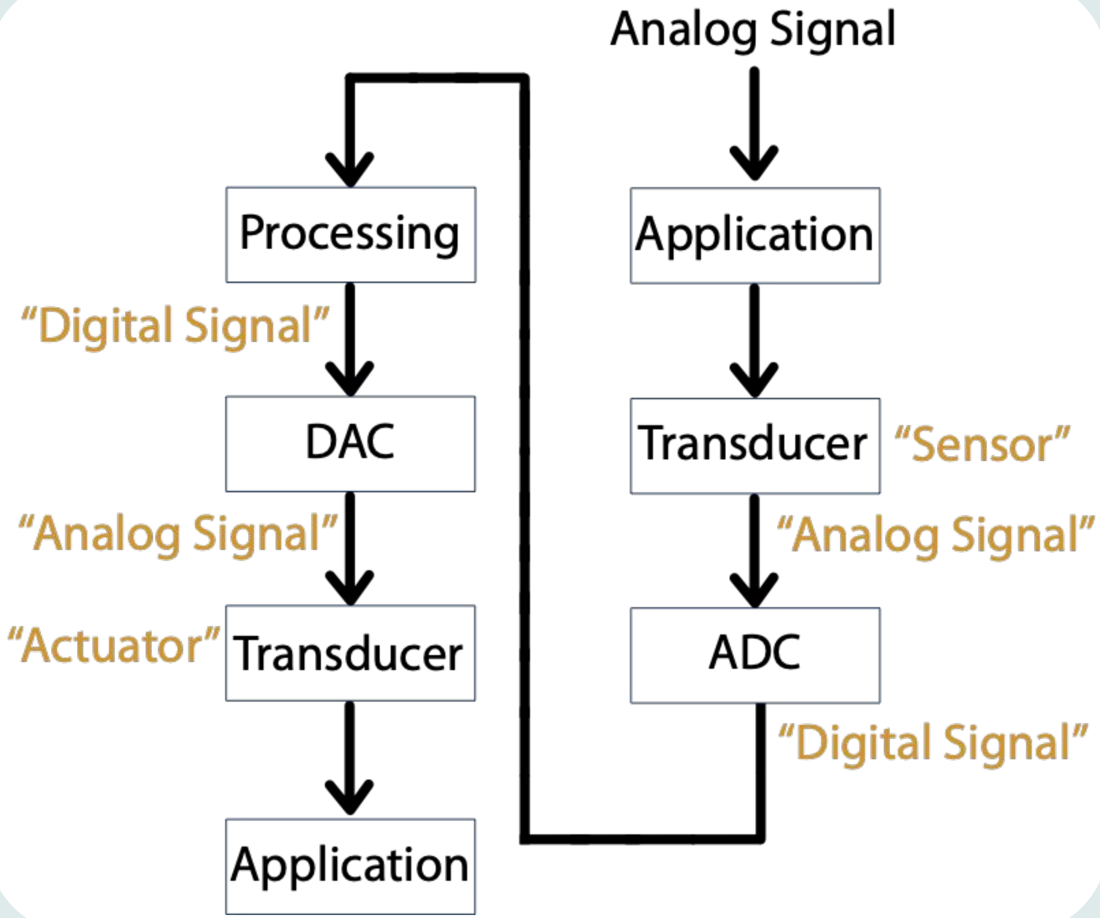
Sensors

a sensor is a device, module, machine, or subsystem whose purpose is to detect events or changes in its environment and send the information to other electronics, frequently a computer processor. A sensor is always used with other electronics.



Actuators

An *actuator* is a device that is responsible for moving or controlling a mechanism or system. It is controlled by a signal from a control system or manual control. It is operated by a source of energy, which can be mechanical force, electrical current, hydraulic fluid pressure, or pneumatic pressure, and converts that energy into motion.


Analog Signal
Processing
Application
"Digital Signal"
DAC
Transducer
"Sensor"
"Analog Signal"
"Analog Signal"
ADC
"Actuator"
Transducer
"Digital Signal"
Application

Sensors Types by Application

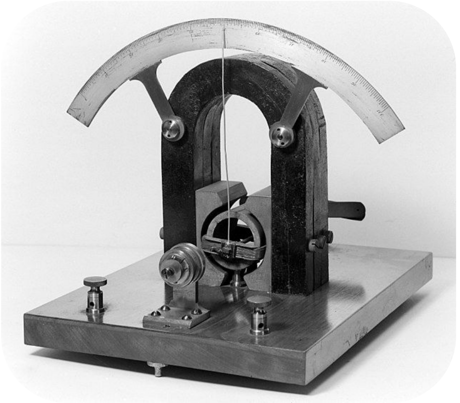
Sensors Types

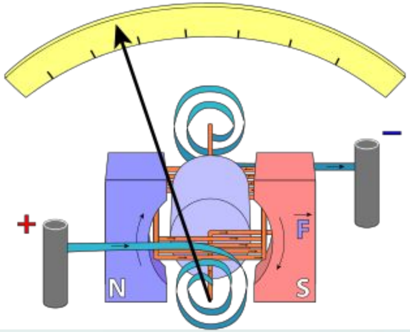
- Electro-Mechanical
- Electro-Magnetic
- Electro-Acoustic
- Radio-Acoustic
- Electro-Chemical
- Electro-Thermal
- Electro-Optical

Electro-Mechanical

Electromechanical sensors detect some form of mechanical deformation due to a variety of stimuli and translate the deformation into an electrical signal.

A galvanometer is an electromechanical measuring instrument for electric current. Early galvanometers were uncalibrated, but improved versions, called ammeters, were calibrated and could measure the flow of current more precisely. A galvanometer works by deflecting a pointer in response to an electric current flowing through a coil in a constant magnetic field. Galvanometers can be thought of as a kind of actuator.

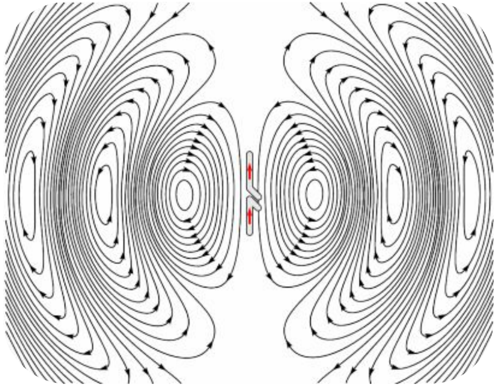




Electro-Magnetic

A moving magnetic field causes an electric current to flow through conductive material. An electromagnetic sensor can be used to measure this induced electrical current.

In radio engineering, an antenna or aerial is the interface between radio waves propagating through space and electric currents moving in metal conductors, used with a transmitter or receiver.[1] In transmission, a radio transmitter supplies an electric current to the antenna's terminals, and the antenna radiates the energy from the current as electromagnetic waves (radio waves). In reception, an antenna intercepts some of the power of a radio wave in order to produce an electric current at its terminals, which is applied to a receiver to be amplified. Antennas are essential components of all radio equipment.

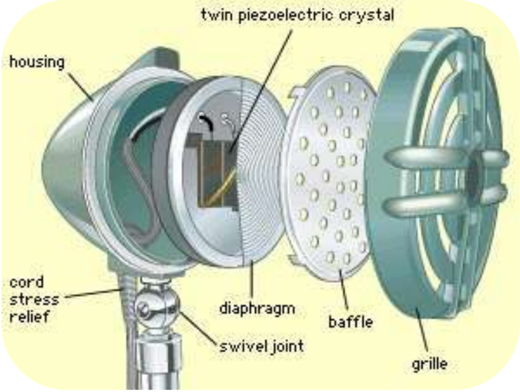


Electro-Acoustic

An electroacoustic transducer may convert electrical signals to acoustic signals or vice versa.

Microphone, a device for converting acoustic power into electric power that has essentially similar wave characteristics. While those on telephone transmitters comprise the largest class of microphones, the term in modern usage is applied mostly to other varieties.

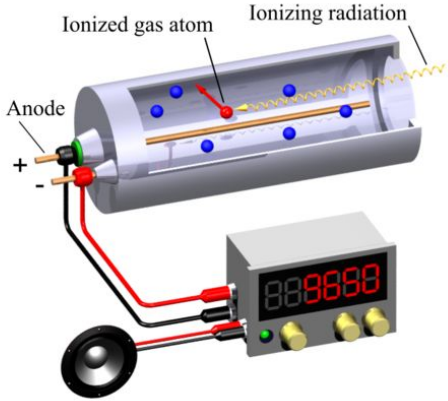
Apart from telephone transmitters, microphones are most widely applied in hearing aids, sound-recording systems (principally magnetic and digital tape recorders), dictating machines, and public-address systems.



Radio-Acoustic

A radio acoustic sounding system is a system for measuring the atmospheric lapse rate using the backscattering of radio waves from an acoustic wavefront to measure the speed of sound at various heights above the ground.

The Geiger–Müller tube or G–M tube is the sensing element of the Geiger counter instrument used for the detection of ionizing radiation. It is named after Hans Geiger, who invented the principle in 1908, and Walther Müller, who collaborated with Geiger in developing the technique further in 1928 to produce a practical tube that could detect a number of different radiation types.



Electro-Chemical

Electrochemical transducer reports changes in form of an electrical signal which is directly proportional to the concentration of the analyte.

A pH meter is a scientific instrument that measures the hydrogen-ion activity in water-based solutions, indicating its acidity or alkalinity expressed as pH.[2] The pH meter measures the difference in electrical potential between a pH electrode and a reference electrode, and so the pH meter is sometimes referred to as a "potentiometric pH meter". The difference in electrical potential relates to the acidity or pH of the solution.

Electro-Thermal

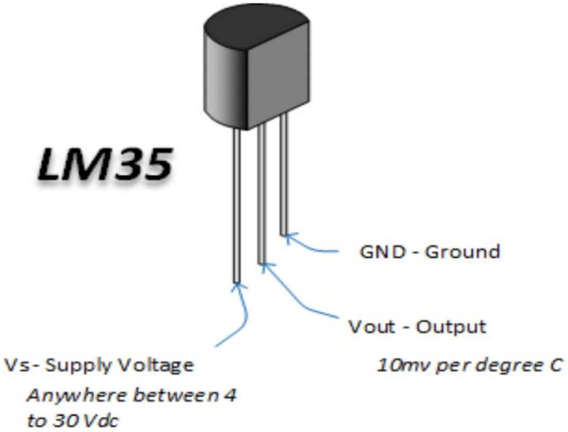
Electro-thermal devices are devices that convert thermal energy into an electrical (electrons) signal.

A thermistor is an abbreviation for Thermal Resistor, it is a resistor that changes its resistance value by changing the ambient temperature.

- **Positive Temperature Coefficient** Temperature and Resistance are directly proportional. When temperature increases the resistance increases.
- **Negative Temperature Coefficient** Temperature and Resistance are inversely proportional. When temperature increases the resistance decreases.

Electro-Thermal LM35

The **LM35** series sensors are precision integrated circuit temperature sensors whose output voltage is linearly proportional to the Celsius temperature.
It means that the LM35 integrates the Thermistor and the voltage divider circuit as its output is a voltage directly. It outputs **10mv** for each degree of Celsius temperature

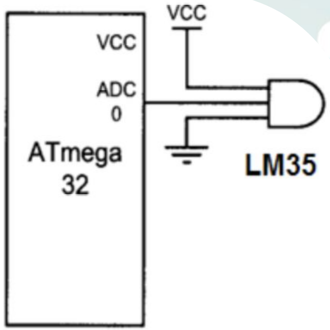


LM35 Temperature Sensor Series Selection Guide			
Part	Temperature Range	Accuracy	Output Scale
LM35A	-55 C to +150C	+1.0 C	10 mV/C
LM35	-55 C to +150C	+1.5 C	10 mV/C
LM35CA	-40 C to +110C	+1.0 C	10 mV/C
LM35C	-40 C to +110C	+1.5 C	10 mV/C
LM35D	0 C to +100C	+2.0 C	10 mV/C
Note: Temperature range is in degrees Celsius.			

Electro-Thermal LM35

Connecting **LM35** output to the microcontroller ADC, for example channel 0 (Pin A0).

The following example code for converting the ADC value to temperature reading:




```
/* Get ADC Reading in 8 bit */
ADC_Reading = GetAdcValue();

/* Convert ADC to mv */
mv_Value = (ADC_Reading * 5000) / 256;

/* Convert mv to temperature */
Temperature_Value = (mv_Value / 10);
```

LAb 1

LAP

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Welcome LAP

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Implement a system that reads the ambient temperature and do the following:

1- if the temperature is less than 20 degree Celsius, turn on Green LED.

2- if the temperature is more than 20 and less than 40 degree Celsius, turn on Yellow LED.

3- if the temperature is more than 40 degree Celsius, Turn on Red LED and turn on a buzzer for indicating a dangerous.

Time To Code

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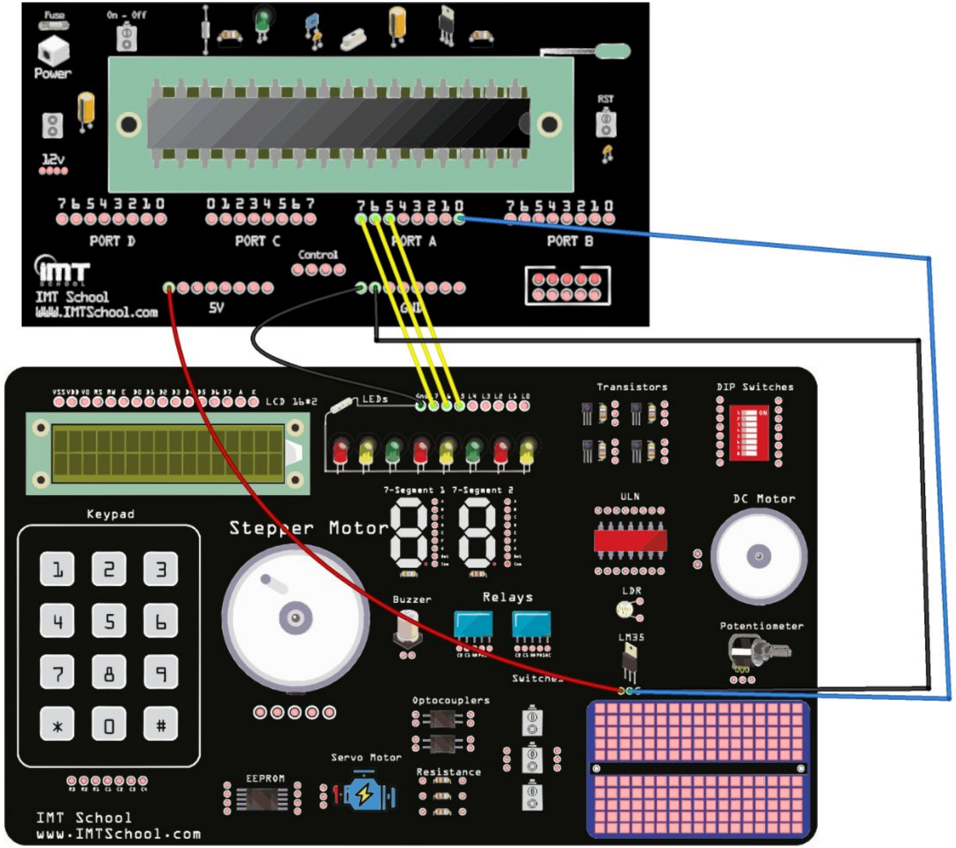

Fuse
On - Off
Power
12v
RST
7 6 5 4 3 2 1 0
PORT D
0 1 2 3 4 5 6 7
PORT C
7 6 5 4 3 2 1 0
PORT A
7 6 5 4 3 2 1 0
PORT B
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LDR
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LM35
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LAb 2

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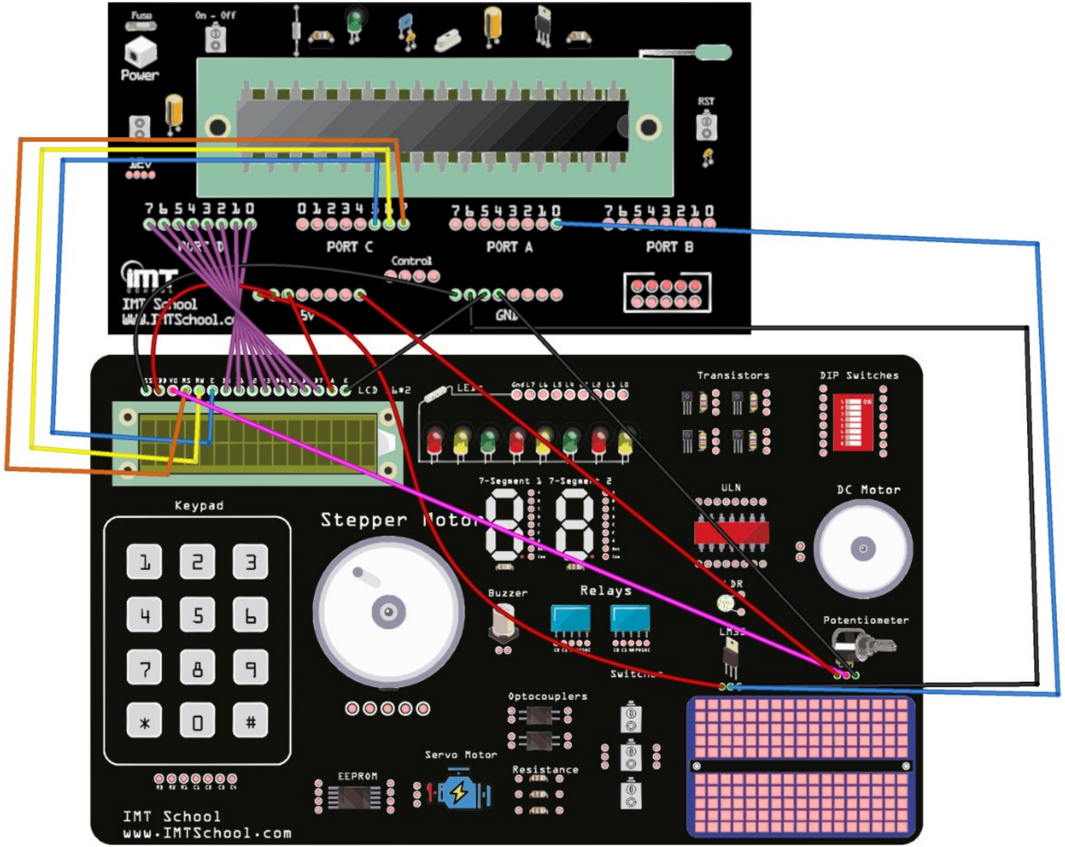
1

Implement a system that display the ambient temperature on LCD and update it every 1 second

Time To Code


Power
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7-Segment 2
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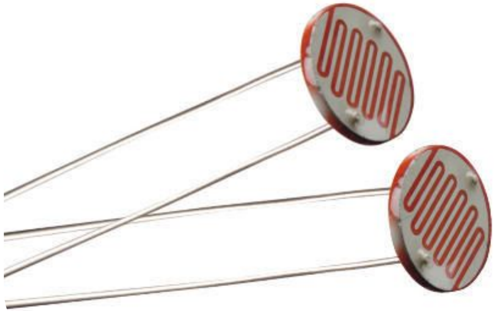
Electro-Optical

Light Sensors are photoelectric devices that convert light energy (photons) whether visible or Infra-red light into an electrical (electrons) signal.

Light Dependent Resistor (LDR) is a simple device that has the characteristic of changing its resistance based on the amount of light that hits it. Its resistance will be lower when a light is shone on it. When the light is removed the resistance will be at it's highest. The LDR will not give you an accurate reading to the amount of light but it will enable you to detect a transition between the amount of light that is available.

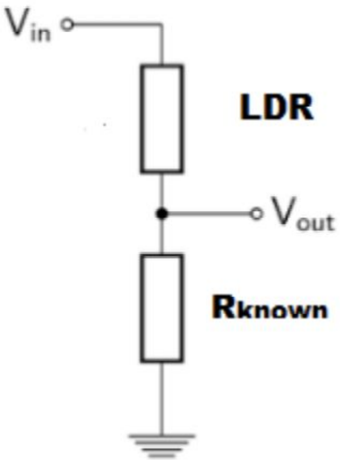


Similar to what has been done in thermistor interfacing, we will use a voltage divider circuit to read the value of the LDR.

Electro-Optical

Applying ohm's law:

$$\mathbf{LDR} = \frac{\mathbf{R}_{known}\,\mathbf{V}_{in} - \mathbf{R}_{known}\,\mathbf{V}_{out}}{\mathbf{V}_{out}}$$



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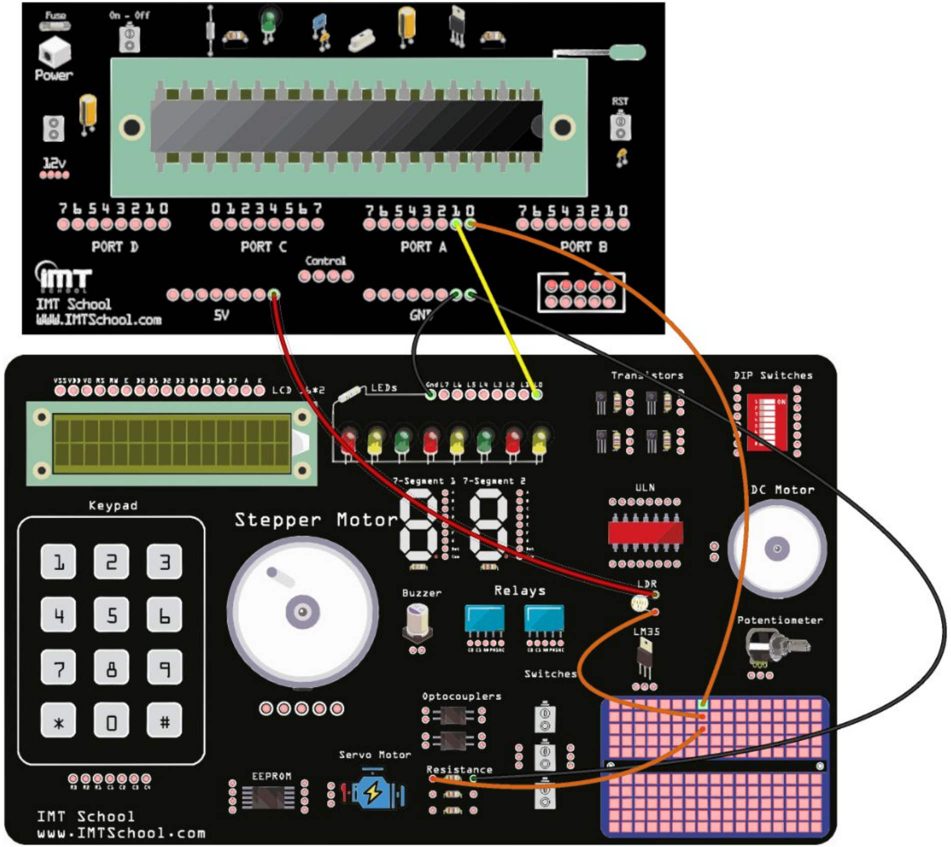
LAb 3

Using LDR, implement a system that turns on a LED when it gets dark, and turns the LED off when it gets bright.

Time To Code



Fuse
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12v
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01234567
76543210
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PORT D
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Control
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The End

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