Department of Civil Engineering
Curriculum (Semester 1 and Semester 2)

COURSE CONTENT

Internet of Things in Civil Engineering Systems (1-0-3)

The laboratory course will include 8 hands-on projects using sensors, which the students will perform in groups, by turn, to cover the entire semester. The data acquisition may be done using an Arduino (microcontroller board) connected to a laptop, or using an Arduino with a Raspberry Pi (microprocessor board) and a digital display unit. The examples given below suggest the use of the first method which connects the sensors to an Arduino, the code of which is uploaded from a laptop, and the data acquired by the Arduino is passed on to the laptop for display on its screen.

Project no.	Project objective	Model required	Sensor used	Data acquired
1	Monitoring a landslide prone embankment	An earth slope built in a model Perspex tank	GPS module	Latitude and longitude values are recorded with time, as the slope is made unstable by an external (dynamic) force.
2	Monitoring water quality parameters pH and turbidity	A water body built in a model Perspex tank	pH and turbidity sensors (Analog PH Sensor; Turbidity Sensor)	pH and turbidity values are recorded with time, as the parameters change on addition of acid or salt solutions.
3	Vibration analysis of a cantilever beam	A 1-m steel scale clamped to the end of a table	Accelerometer sensor (ADXL335)	Accelerations in 3 Cartesian coordinate axes recorded against time, as the beam is vibrated. Acceleration data may be analysed using an FFT code.
4	Terrain elevation mapping	A model of an undulating surface (such as the model of a river catchment)	LiDAR distance sensor (TFMini-S Micro LiDAR Distance Sensor)	The LiDAR module, pointing downward, and held above the surface measures the distance to the surface, which is recorded against different sensor position.
5	Water level measurement	A water tank with a fluctuating water level (such as in a v-notch weir)	Water level sensor (Robodo SEN18)	The water level is monitored by the sensor, as it fluctuates with time. The varying discharges (from the weir) is recorded.
6	Soil moisture level detection	A pot with soil (and a plant, which is optional)	Soil Moisture Meter (or Soil Humidity Sensor)	The soil moisture is displayed to read the current value. Could be connected to a water pump for watering the plant, as required.
7	Air quality parameter monitoring	-	Air quality sensor (DHT11/22: temperature and humidity, Q135 for gases)	The temperature, humidity and level of toxic gases are recorded with time. The data may show variation with the time of day.
8	Rainfall measurement	-	Tipping Bucket Raingauge	Rainfall recorder least count (per tip of the bucket) is 0.1mm, and the tips are counted and recorded within a given time duration. The data maybe analysed to find intensity variation with time.

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The following are some helpful videos showing the application of different sensors and interface with Arduino microcontroller module.

GPS

1. https://www.youtube.com/watch?v=VNDbhSJFhC4&t=4s

Water quality

1. https://www.youtube.com/watch?v=1fog3j9IaiA
2. https://www.youtube.com/watch?v=aRdK74fXsXI
3. https://www.youtube.com/watch?v=BYzRiIUvX6I

Vibration

1. https://www.youtube.com/watch?v=C9efrWYrVVw

   (ADXL335 Analog Accelerometer Sensor + Arduino: Calibration and application)

2. https://www.youtube.com/watch?v=C1yDvOF-VJQ

Body movement and servomotor

1. https://www.youtube.com/watch?v=5iuODJ5YA5U&t=281s

FFT of vibration

1. https://www.youtube.com/watch?v=534miBv5ut0

LiDAR sensor

1. https://www.youtube.com/watch?v=Q9uYFp1jrN8

Water level sensor

1. https://www.youtube.com/watch?v=GnD-hRnWFLA&t=21s
2. https://www.youtube.com/watch?v=A7NmeybxWMI

Soil moisture

1. https://www.youtube.com/watch?v=wAjkSj3ZjLs
2. https://www.youtube.com/watch?v=haONy1NLKYs

Air quality

1. https://www.youtube.com/watch?v=JCmsTtJKzW4

Website: “Circuit Digest” for other ideas with sensors and Arduino

https://www.youtube.com/@Circuitdigest/videos

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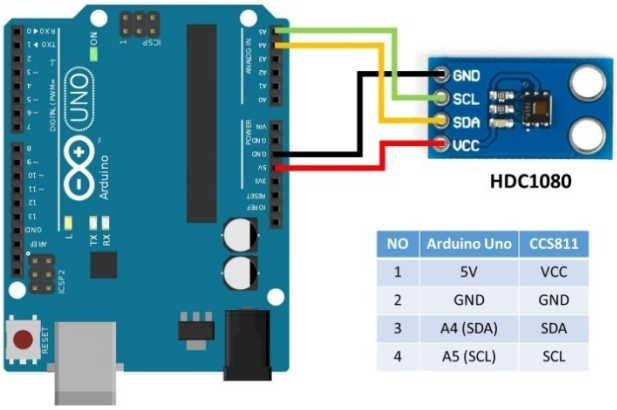
Arduino coding

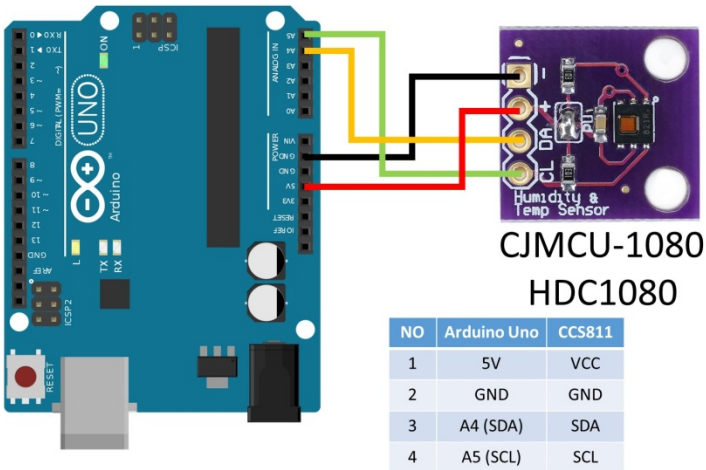
https://www.youtube.com/watch?v=BLrHTHUjPuw

Arduino with active humidity sensor (HDC1080)

https://www.youtube.com/watch?v=zQzpZziufUs



NO	Arduino Uno	CCS811
1	5V	VCC
2	GND	GND
3	A4 (SDA)	SDA
4	A5 (SCL)	SCL



NO	Arduino Uno	CCS811
1	5V	VCC
2	GND	GND
3	A4 (SDA)	SDA
4	A5 (SCL)	SCL

Honeywell

Miniature Low Pressure Sensors

24PC Series, Uncompensated/Unamplified

0.5 psi to 250 psi

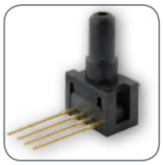
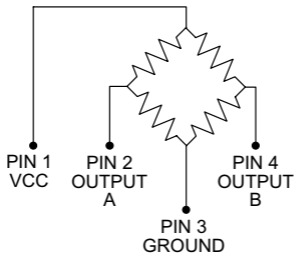


Figure 1. Circuit Diagram



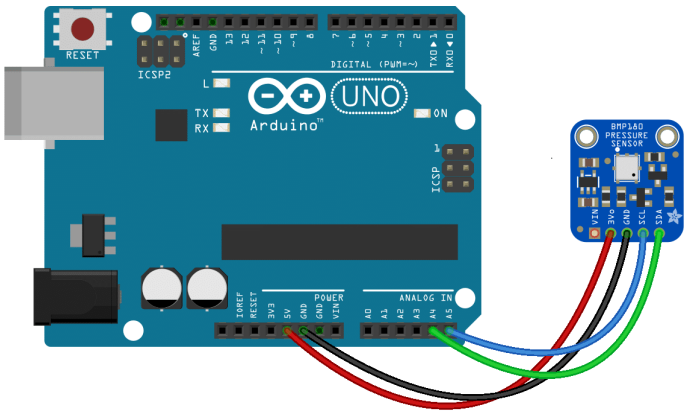
Output “A” increases as P2 pressure increases.

Output “B” deceases as P2 pressure increases.

Symbol	Description
Vcc	supply
OUTPUT A	bridge positive output
GROUND	ground
OUTPUT B	bridge negative output

Barometric pressure sensor BMP180

https://www.youtube.com/watch?v=6wjmbB_T4L0



Other sensors

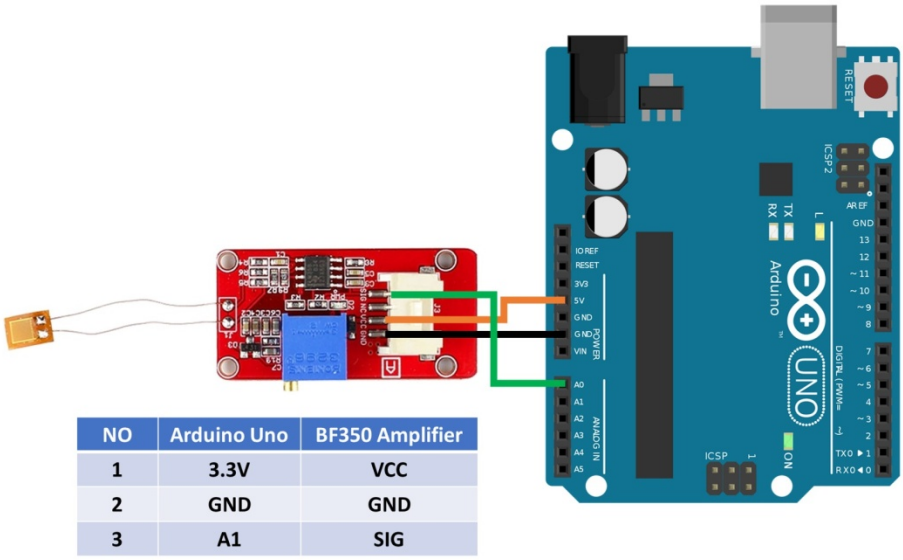
https://www.youtube.com/watch?v=6wjmbB_T4L0

Strain Gauge Sensor

https://innovatorsguru.com/strain-gauge-sensor/

BF350-3AA Arduino

BF350 sensor should be used in a Wheatstone bridge configuration to get change in resistance accurately. To use it with Arduino we are using our HX711 digital bridge sensor interface module. *HX711* is a precision 24-bit analog- to-digital converter (ADC) designed for weigh. Alternatively, if we need only relative measurements that are required then we need a **strain gauge amplifier** that includes BF350-AAA sensor and can be connected directly to a Arduino microcontroller ADC input.



NO	Arduino Uno	BF350 Amplifier
1	3.3V	VCC
2	GND	GND
3	A1	SIG

BF350 Arduino Code

The sample code at the beginning includes setting the pin number and creating variables to store the results.

In the setup subroutine, only the serial line is set to 9600 baud to print the measured data to the computer.

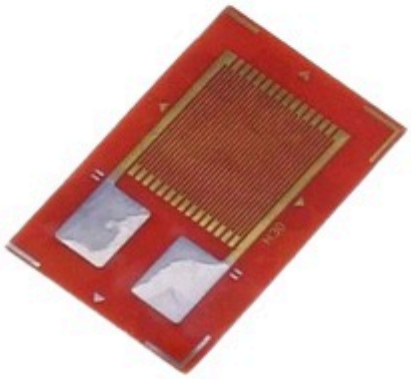
In the infinite loop in the first step, we read the analog value from the set pin into the variable and then recalculate to percent. This conversion is done using the map function, converting the input range

0 to 700 to the range 0 to 100. The value of input 700 corresponds to approximately 3.42 Volts, with a maximum of 1023 corresponding to 5 Volts.

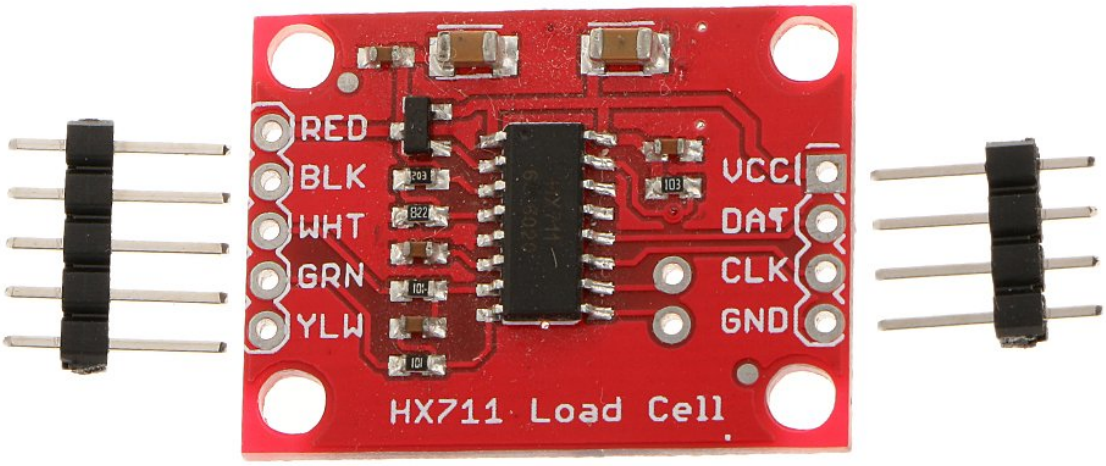
When the conversion is complete, print both data on the serial line and wait for 500 ms before the new program is run.

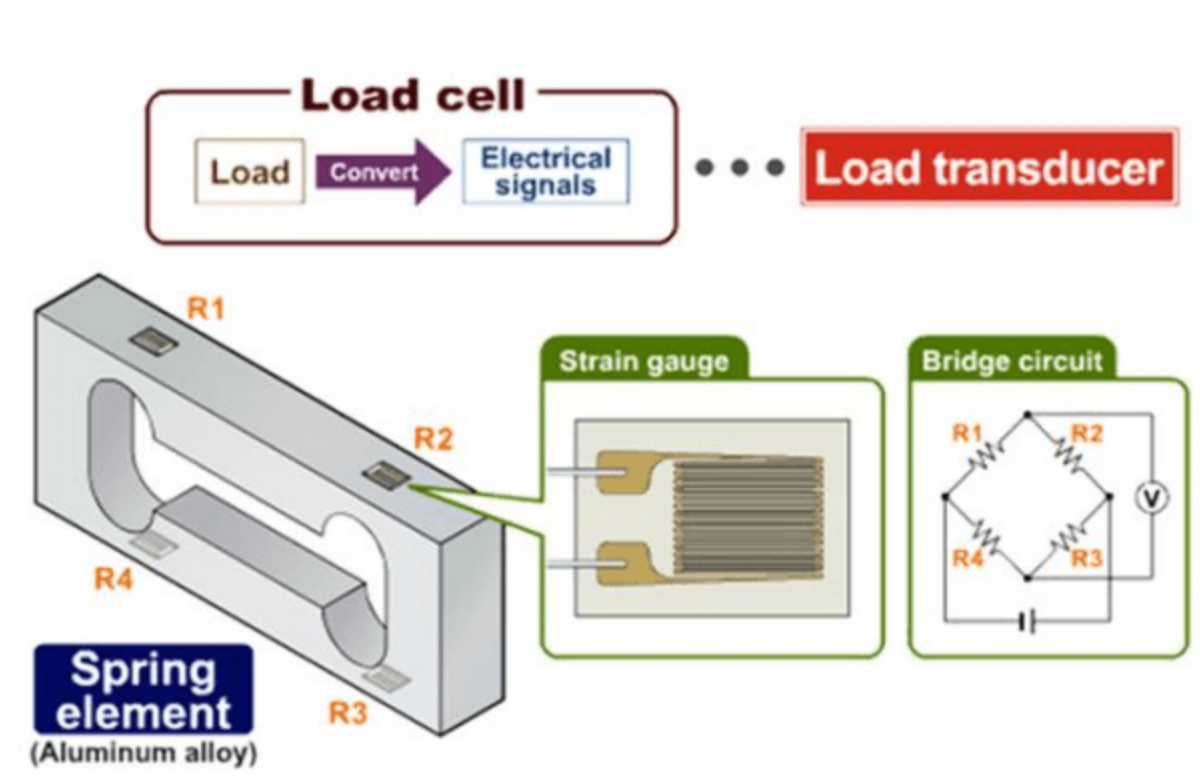
```
// BF350-3AA Arduino Code
#define SensorPin A0
int aSignal = 0;
int aSignalPercent = 0;
void setup()
{
Serial.begin(9600);
}
void loop() {
aSignal = analogRead(SensorPin);
aSignalPercent = map(aSignal, 0, 700, 0, 100);
Serial.print("aSignal: ");
Serial.print(aSignal);
Serial.print(" | ");
Serial.print(aSignalPercent);
Serial.println("%");
delay(500);
}
```

BF350-3AA Strain Gauge Sensor 350 Ω



HX711 Load Cell Weighing Sensor 24-bit A/D Conversion Module for Arduino




Load cell
Load
Convert
Electrical signals
Load transducer
R1
R2
R4
R3
Spring element
(Aluminum alloy)
Strain gauge
Bridge circuit
R1
R2
R4
R3
V