

# BFF3302 SENSOR AND INSTRUMENTATION SYSTEM

## Microprocessor-based instrumentation

By

Ahmad Shahrizan Abdul Ghani ([shahrizan@ump.edu.my](mailto:shahrizan@ump.edu.my))

Nafrizuan Bin Mat Yahya ([nafrizuanmy@ump.edu.my](mailto:nafrizuanmy@ump.edu.my))

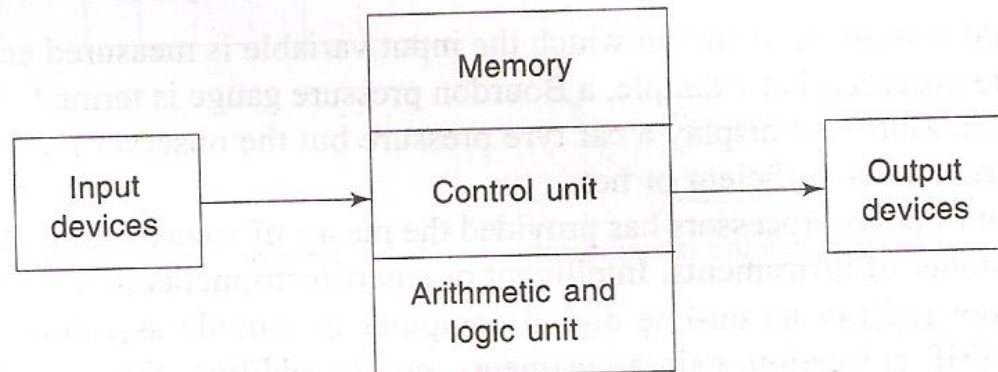
Faculty of Manufacturing Engineering (FKP)

# Chapter Description

- **Aims**
  - Obtain basic knowledge about electronic, measurement, sensors, and instrumentation
  - Able to analyse particular sensor, instrument, and measurement situation.
- **Expected Outcomes**
  - Determine general treatment of instrument elements and their characteristic
  - Analyse transducer elements, intermediate elements, and data acquisition system (DAQ)
  - Determine principles of the work and derive mathematical model of sensors for measuring motion and vibration, dimensional metrology, force, torque and power, pressure, temperature, flow and acoustics
- **References**
  - B.C.Nakra and K.K. Chaudhry, 2012. Instrumentation measurement and analysis, 3rd ed., Tata-McGraw-Hill.
  - Introduction to signal processing, instrumentation, and control : an integrative approach / Joseph Bentsman Hackensack, NJ : World Scientific Pub., 2016
  - Transducers for instrumentation / M. G. Joshi, New Delhi, India : Infinity, 2017
  - Instrumentation and measurement in electrical engineering / editor : Harinirina Randrianarisoa, New York : Arcler Press, 2017

# Microprocessor-based instrumentation

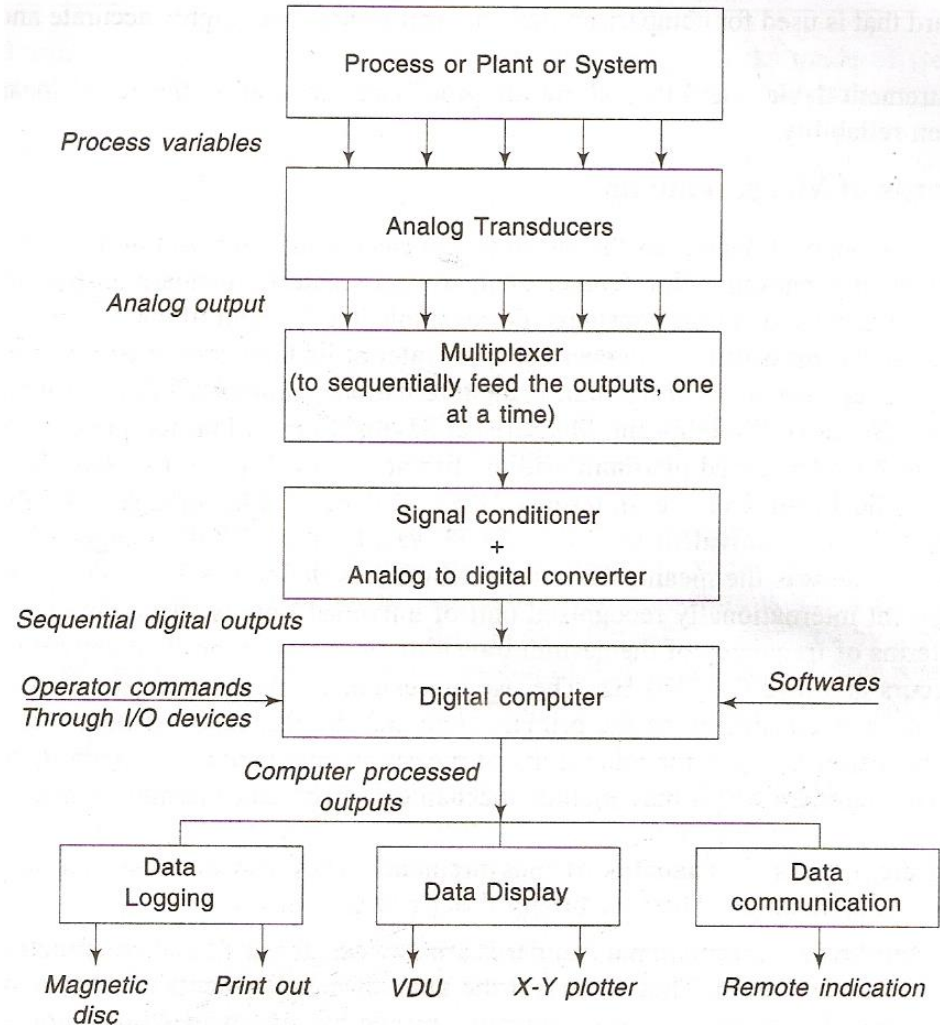
- The microprocessor - auxiliary functional elements.
- Micro = micro-miniature size/dimensions, processor signifies its vast potential to perform complex computations at high speeds
- With pre-programmed logic/software - enhances the capabilities & effectiveness of the instruments.
- Microprocessor = an operational computer.
- It incorporated:
  - memory
  - input/output devices to shape it in the form of a digital computer.




B.C.Nakra and K.K. Chaudhry, 2012. Instrumentation measurement and analysis, 3rd ed., Tata-McGraw-Hill.

# Microprocessor-based instrumentation

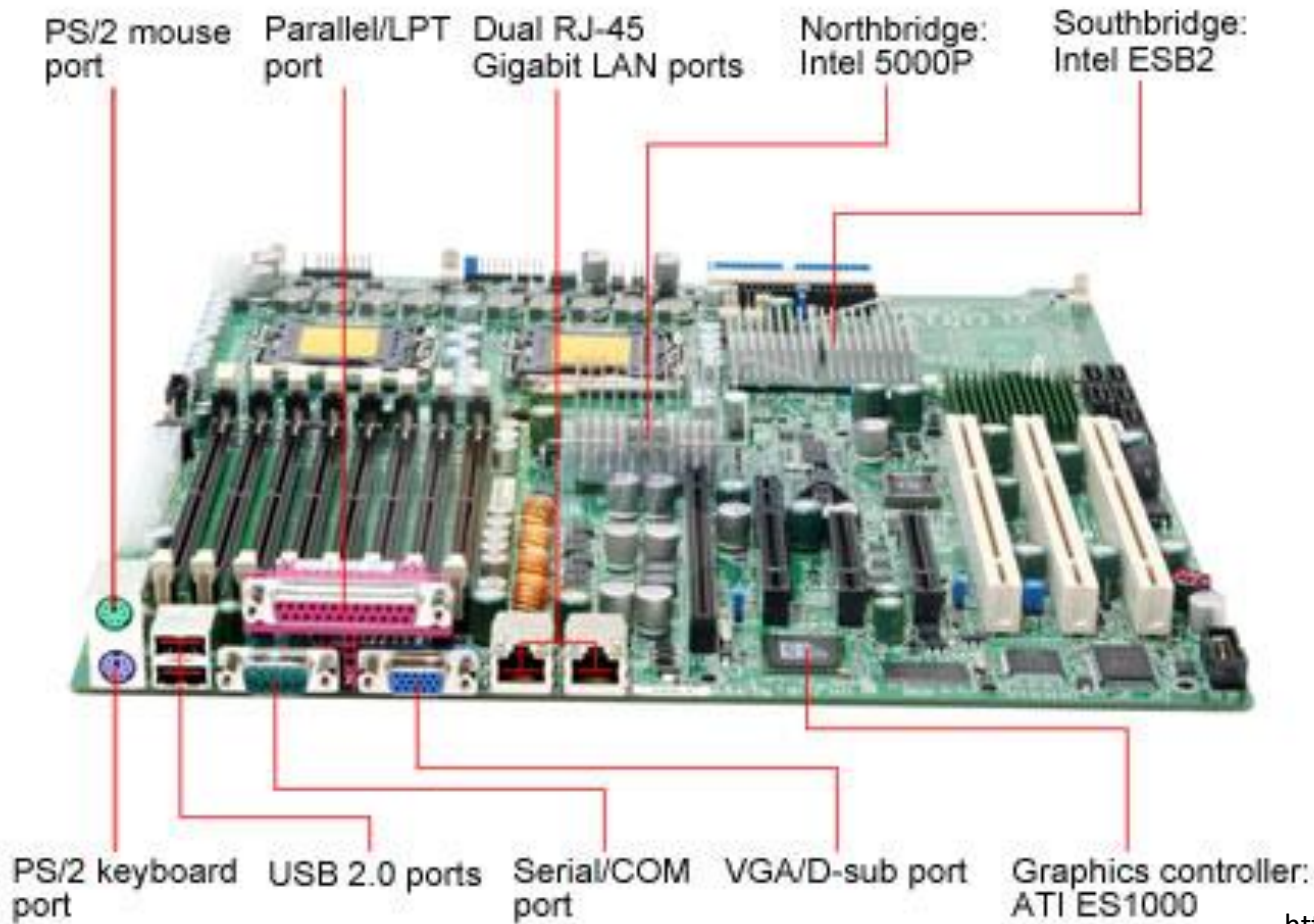
- A typical digital computer-based measurement system.
- A process or a plant or a system may have to simultaneously measure multiple variables like pressure, temperature, velocity, viscosity, flow rate etc.
- A computer-based measurement system has the capability of processing all the inputs and present the data in real time.



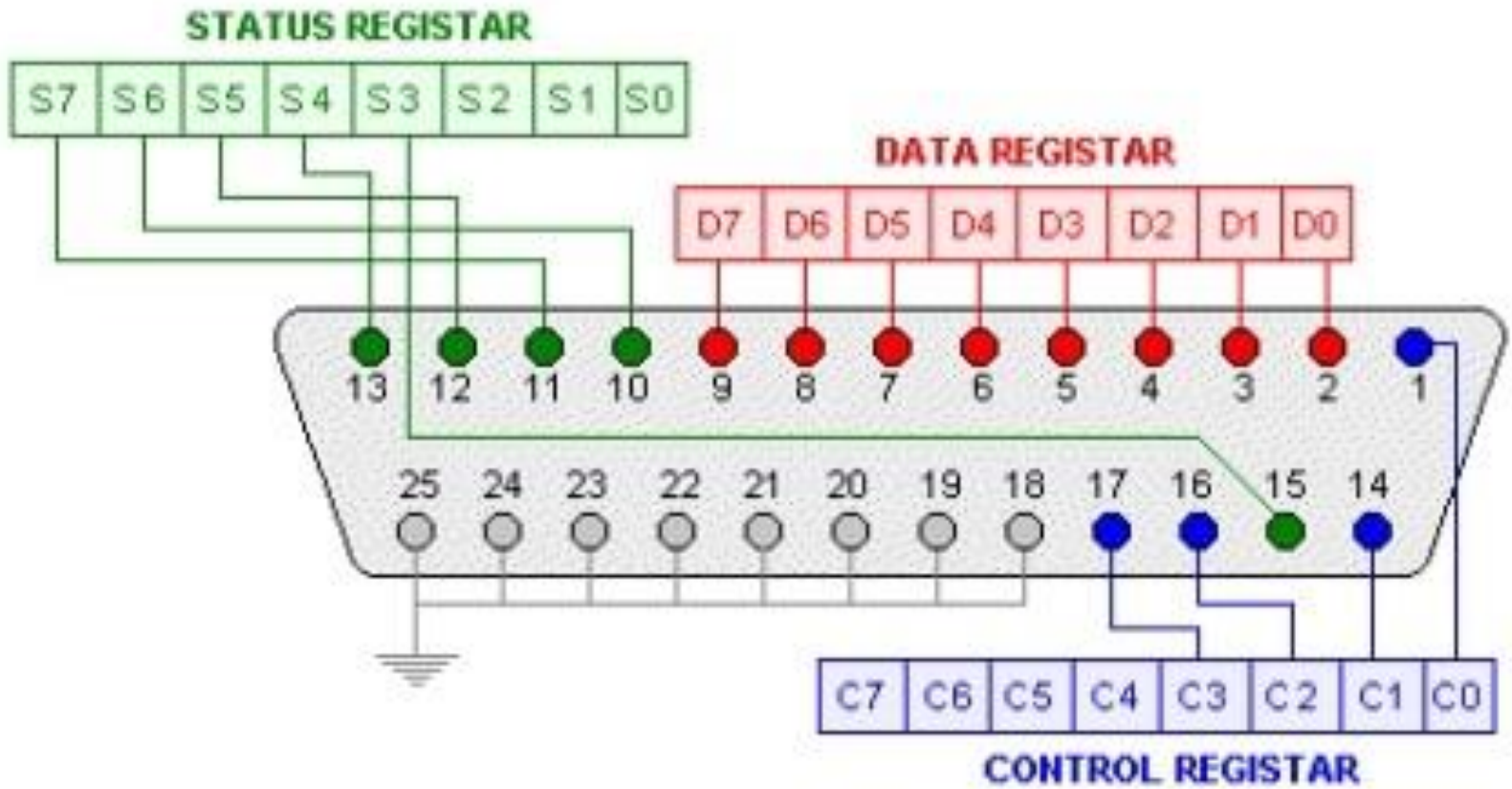
B.C.Nakra and K.K. Chaudhry, 2012.  
Instrumentation measurement and analysis, 3rd ed.,  
Tata-McGraw-Hill.

- 
- A digital computer is fed with a ‘sequential list of instructions’ termed as a **computer program** for suitable processing/manipulation of the data.
  - **Artificial intelligence (AI)** e.g, fuzzy logic, artificial neural network, swarm intelligence may be incorporated.
  - With this, the tasks of **decision-making** in various processes are usually done by the computer itself and not by any human operator.

# I/O ports of computer architecture



<https://www.newegg.com/Product/Category/IntelligenceArticle.aspx?articleId=181>



<https://www.codeproject.com/Articles/441038/Segment-Display-Multiplexing-Control-with-Parall>

# Advantages & disadvantages of computer-based instrumentation systems

## Advantages:

1. programmed to **automatically** carry out the mundane tasks of drift correction, noise reduction/elimination, non-linearity correction, gain adjustments, range and span adjustments, automatic calibration, etc.
2. Include signal conditioning and display which are **compact**, rugged and reliable.
3. **Built-in diagnostic subroutines** - detect the fault and correct the problem. If not, it generates a suitable alarm.
4. The measurement, processing & data display of the process variables → **real time**.
5. **Adjusted/programmed** → with a remote control.
6. **Lower costs, higher accuracy** and more flexibility.
7. Portable, low power consumption, user-friendly.



# Advantages & disadvantages of computer-based instrumentation systems

## Disadvantages:

1. Could not replace the computer programmer/designer of the instruments. (could not modify the programme themselves).
2. These number crunching machines invariably need the processing data in the **digital form**.
3. Software become **obsolete** very fast & periodically updating → involves more expenditure.
4. Prone to **virus problems** → sick and inoperative.

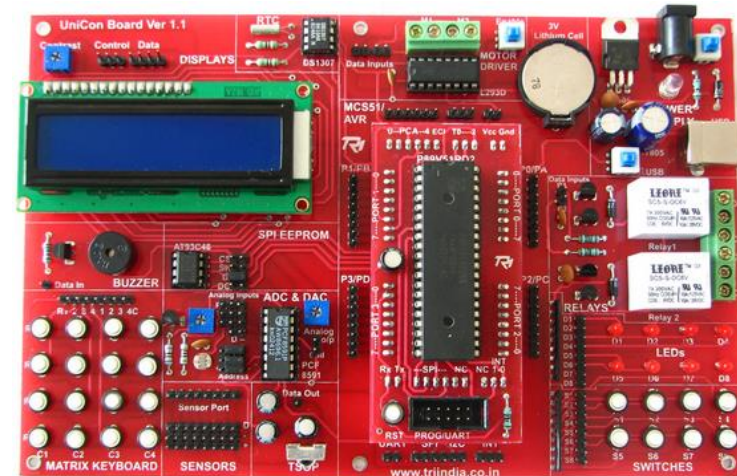
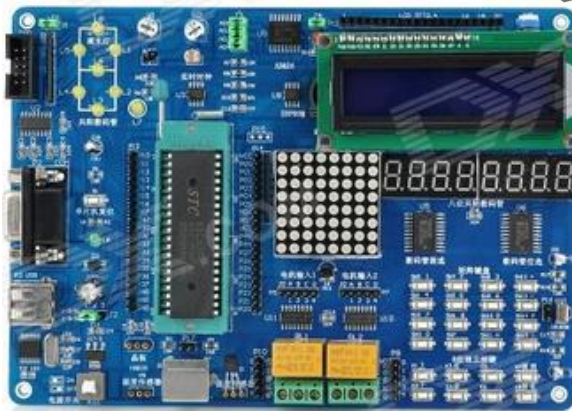
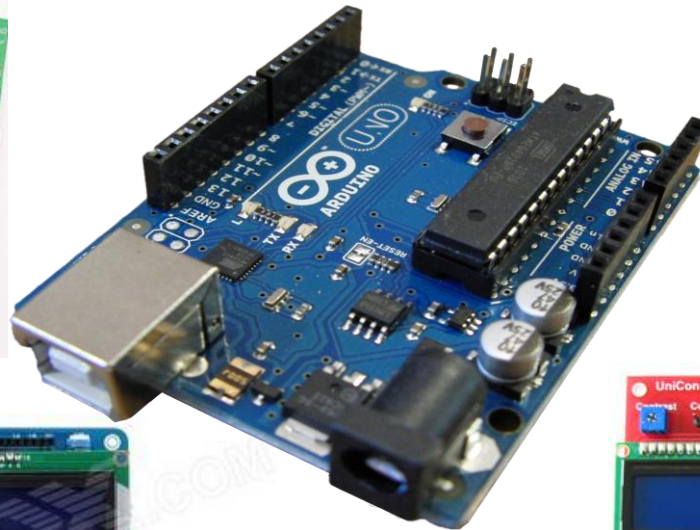
# Introduction to Arduino microcontroller



# C/C++ PROGRAMMING WITH MICROCONTROLLER

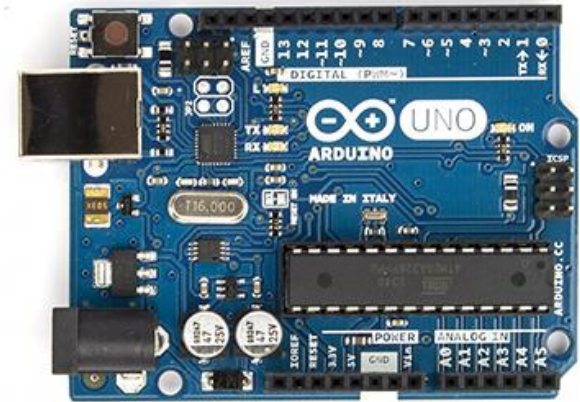
Variety of brands and design in the market:

By: Internet; JotaCartas



# ARDUINO MICROCONTROLLER

- An open source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board.



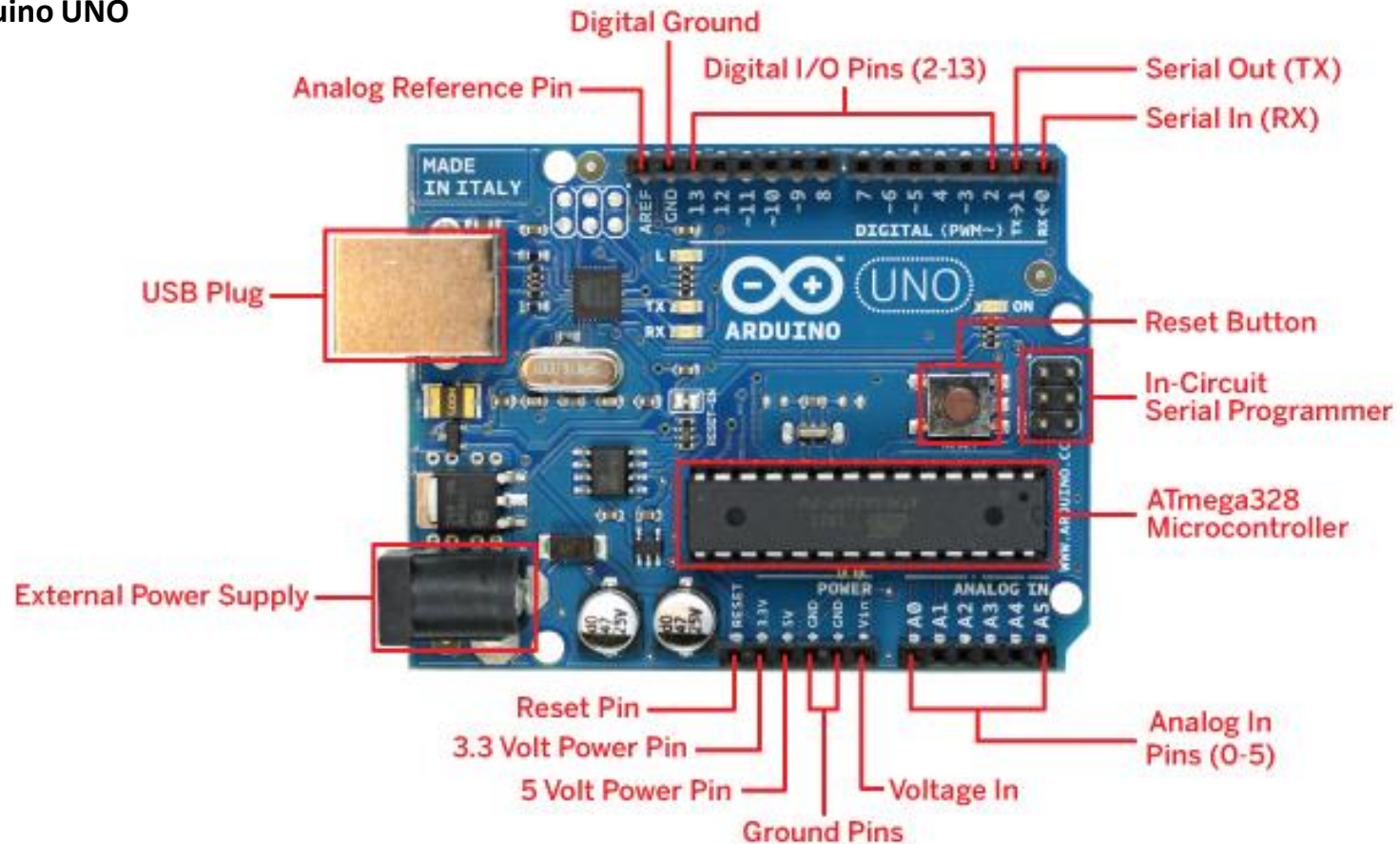
## *Advantages of Arduino:*

- **Inexpensive**
- **Cross platform** – The software runs on Windows, Macintosh OSX and Linux operating system.
- **Simple & clear programming environment** – easy to use for beginners
- **Open source and extensible software**

From: <https://www.arduino.cc/>

# ARDUINO MICROCONTROLLER

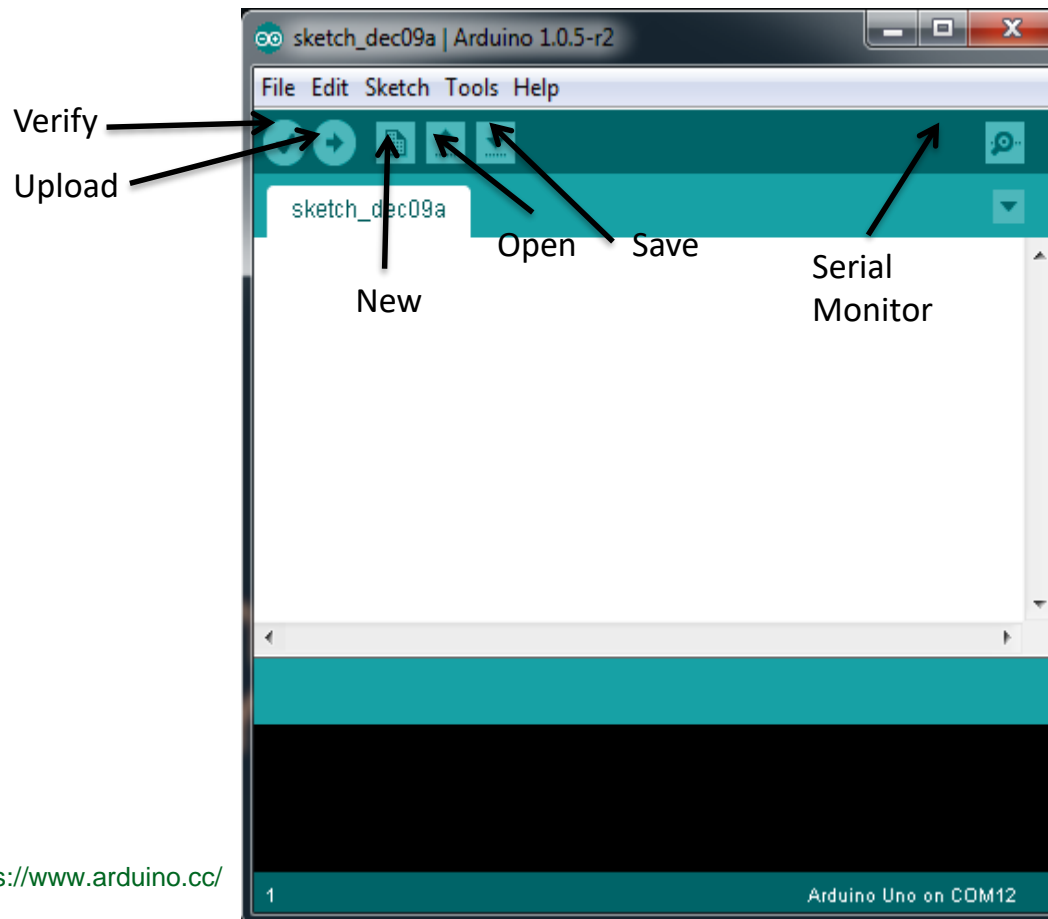
## Arduino UNO



<http://www.studentcompanion.co.za/getting-started-with-flowcode-for-arduino/>

# ARDUINO SOFTWARE

Arduino IDE software – download free from arduino.cc



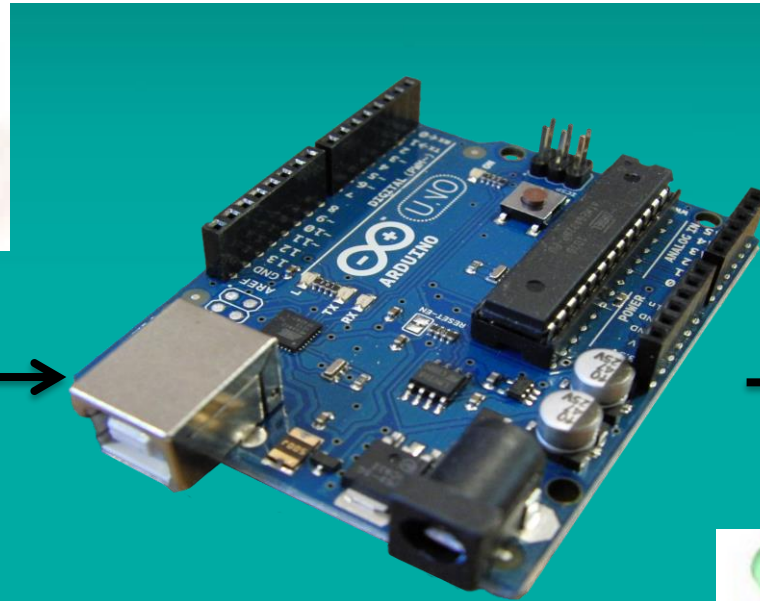
From: <https://www.arduino.cc/>

## ***ARDUINO LANGUAGE REFERENCE***

<http://arduino.cc/en/Reference/HomePage>



Analog potentiometer



**Control LED via  
adjusting the potentiometer**

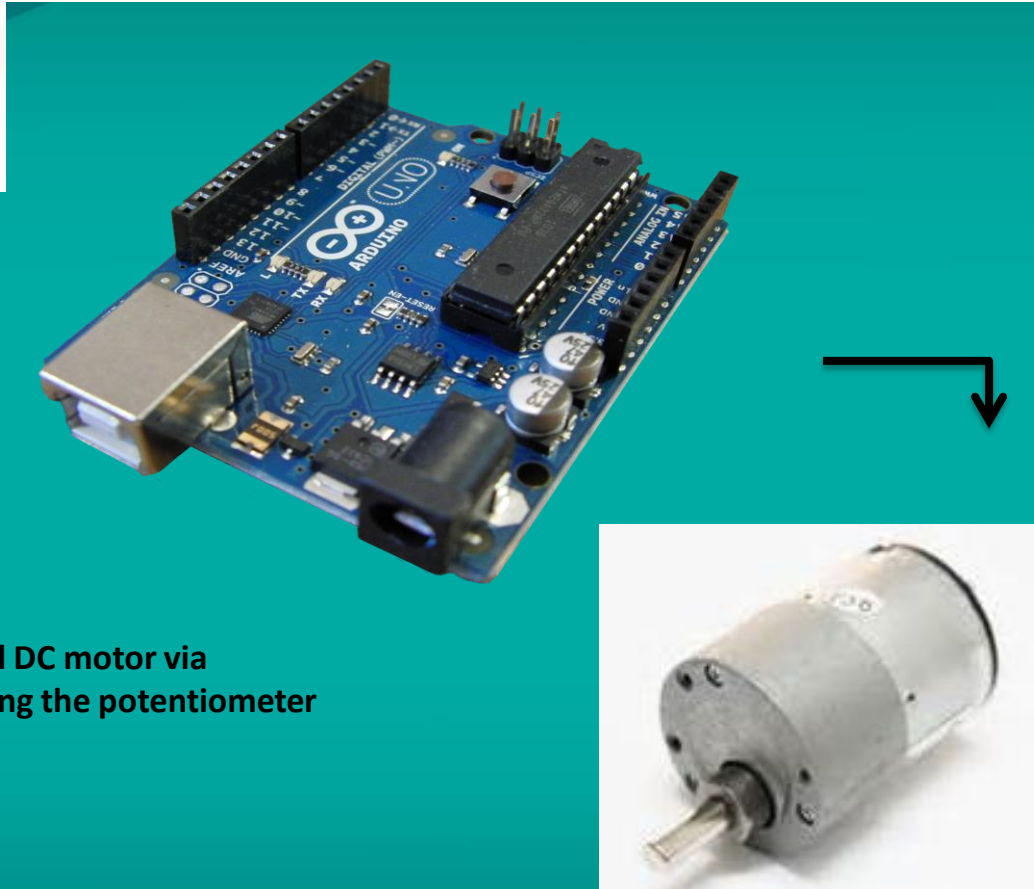


By: lainf; JotaCartas





Analog potentiometer



By: Iainf; JotaCartas

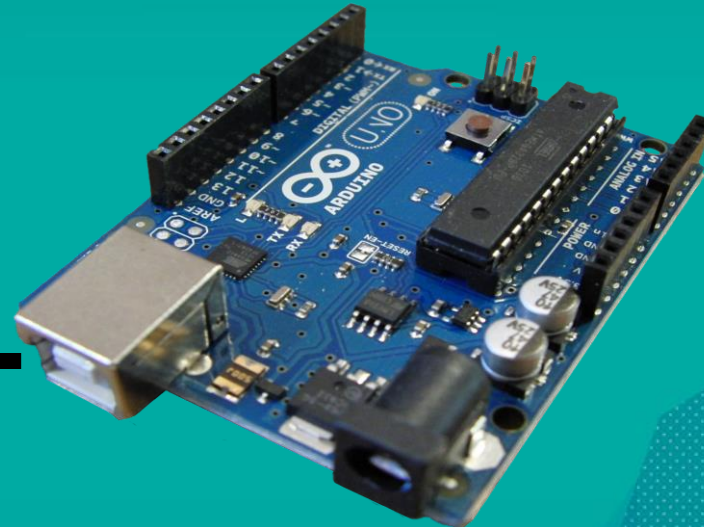
Control DC motor via  
adjusting the potentiometer



DC motor driver &  
DC motor



## Control two DC motors via pushbuttons



By: Iainf; JotaCartas

# Conclusion

- Determine general treatment of instrument elements and their characteristic
- Integrate sensor/instrument using microcontroller
- Determine principles of the work and derive mathematical model of sensor/transducer.