Arduino_Frequency_Counter -- Overview

Mukesh Soni
Researcher / PhD Student
Mechanical Engineering Department
The University of Melbourne

THE UNIVERSITY OF MELBOURNE

Frequency Counting Using Arduino

Objectives:

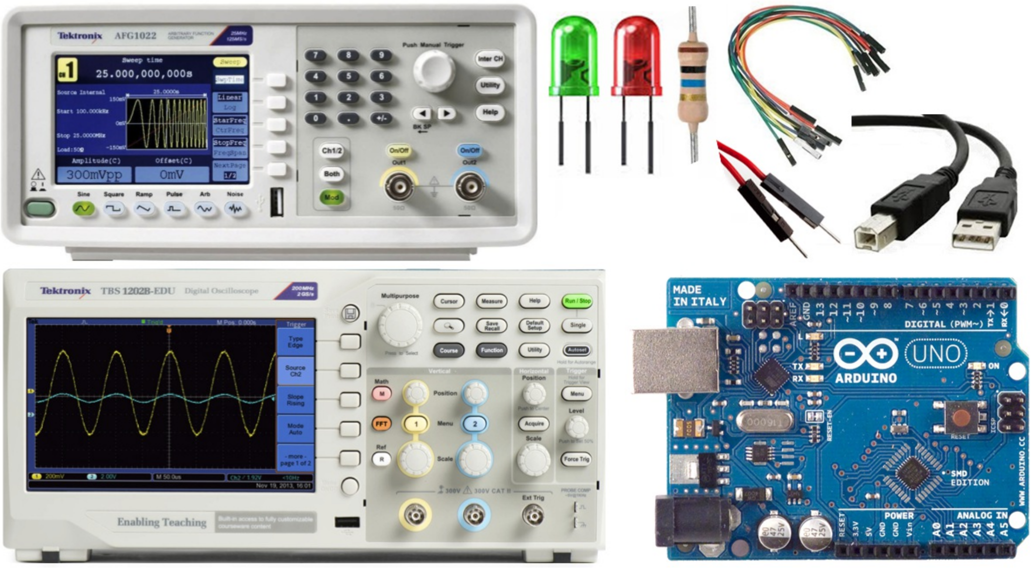
After performing this lab exercise, learner will be able to:

- Work with Arduino IDE
- Program Arduino board as a simple frequency counter
- Practice working with measuring equipment and laboratory tools like digital oscilloscope and signal generator
- Use digital oscilloscope to debug/analyze the circuit

Equipment:

To perform this lab experiment, learner will need:

- Digital Storage Oscilloscope (TBS1000B-Edu from Tektronix or any equivalent)
- Signal generator (AFG1000 from Tektronix or equivalent) for providing AC input to circuit
- Arduino Uno or equivalent board (could be any other openSource Arduino clone) with its USB cable
- Electronic Components
  - Resistor (10K and 470 ohms)
  - Switche (Push-to-on)
  - LED
- BNC cables
- Breadboard and connecting wires



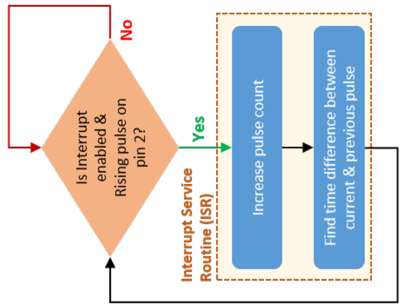
Theory / Key Concepts:

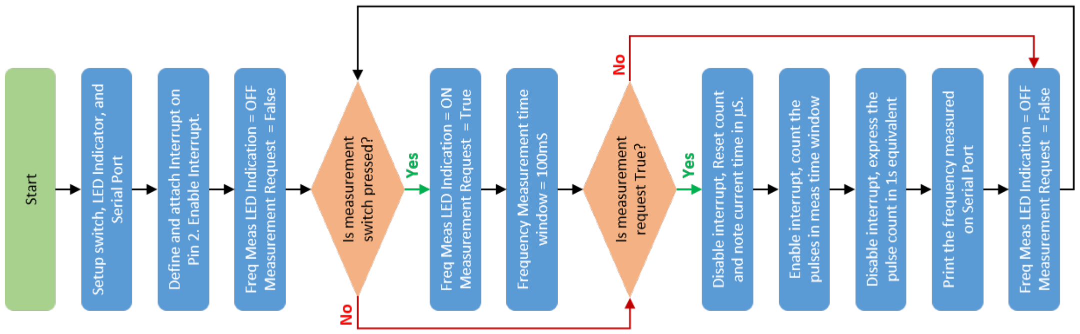
Before performing this lab experiment, it is important to learn following concepts:

- Arduino is a popular open-source microcontroller board that support rapid prototyping of embedded systems.
- Arduino also provide a custom, easy-to-use programming environment (or IDE) for developing a program and flashing it on the Arduino board. For more details, refer - www.arduino.cc
- Arduino can be programmed as frequency counter:
    - Frequency input can be applied to pin # 2 of Arduino board. This pin corresponds to interrupt 0 of the controller.
    - An Interrup Service Routine (ISR) can then be used to count the number of pulses in a given time window.
    - Alternatively, we can find the period between successive pulses and estimate frequency of the input signal.
    - A switch can be used to initiate 'counting' of the frequency input applied to pin # 2.
- The frequency estimated can be shown on the serial monitor.

Flowchart / Program:

Learner can understand the logic of frequency counter code using given flowchart:





Arduino_Frequency_Counter -- Procedures

Step 1

Check Your Understanding:

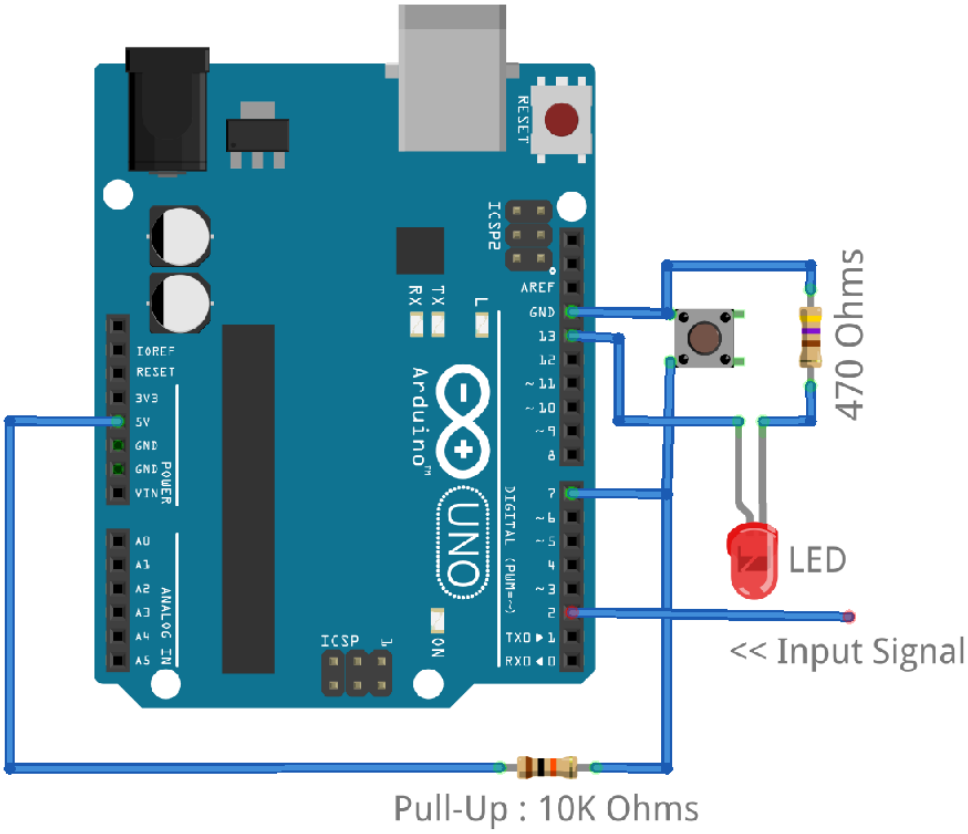
Before performing this lab experiment, learners can check their understanding of key concepts by answering these?

- What is the command / instruction for enabling interrupt in Arduino sketch (program)?
  - attachInterrupt
  - noInterrupts
  - yesInterrupts
  - interrrupts
- For a pulse count of 12 in a measurement window of 10mS, what will be the frequency of input signal?
  - 12 Hz
  - 120 Hz
  - 1200 Hz
  - 12000 Hz
- What will happen to frequency counter if the signal input (pulse, square wave or sinewave) has amplitude swing from 0 to 2V:
  - it will normal
  - it will report frequency as double of actual value
  - it will not work as signal amplitude is less than 2.5V
  - it will work intermittently

Step 2

Circuit diagram / Connection Details

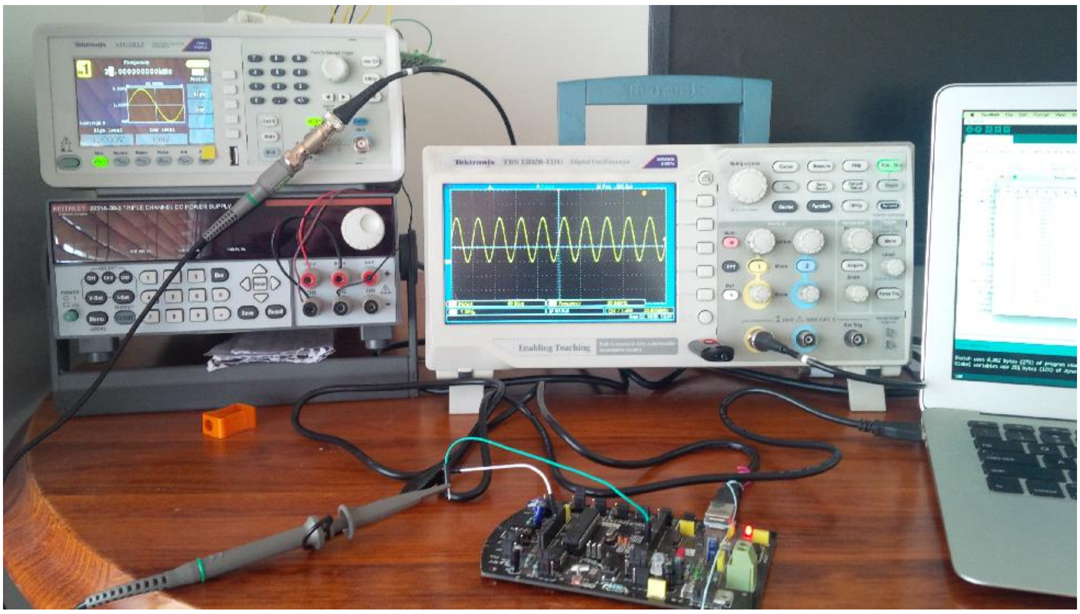
- Using the jumper / connecting wires prepare the circuit as shown below - Choose R_{pullup} = 10K & R_{LED} = 470 ohm.
- Feed the output from AFG / Signal Generator to pin 2 of the Arduino



Step 3

Experiment Setup

- Make the arrangement as shown in figure below (Arduino clone is being used here) -



- PC is connected to Arduino via USB cable
- Use AFG to generate a square wave and connect AFG output to pin 2 of Arduino
- Connect oscilloscope channel 1 to AFG output so that same signal is viewable on oscilloscope (that is fed to Arduino)

Step 4

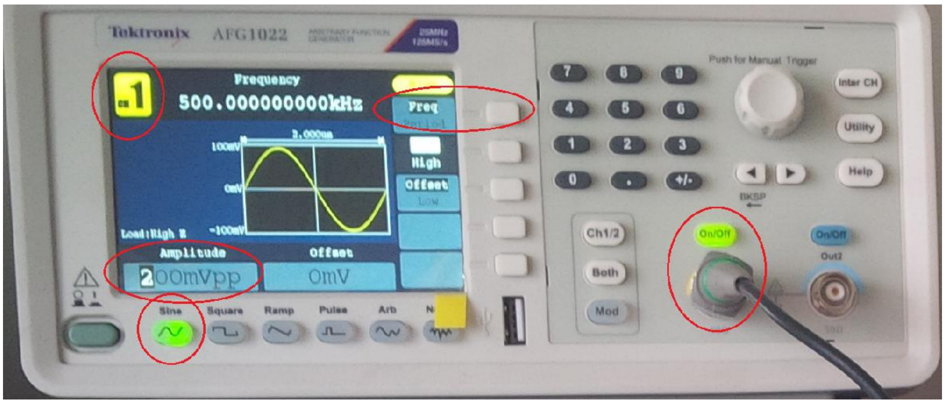
Make the Circuit Work

- Flash the code on Arduino
- Use signal from AFG/signal generator to feed at Pin 2 of Arduino
- Set square wave from channel 1 of the AFG
  - amplitude = 0 - 3V
  - frequency = 1K Hz
- Autoset the oscilloscope to see this waveforms
- Press the button on Arduino pin 7 - You should see the measurent LED getting ON for a moment and frequency value appearing on Serial Monitor on PC.

Step 5

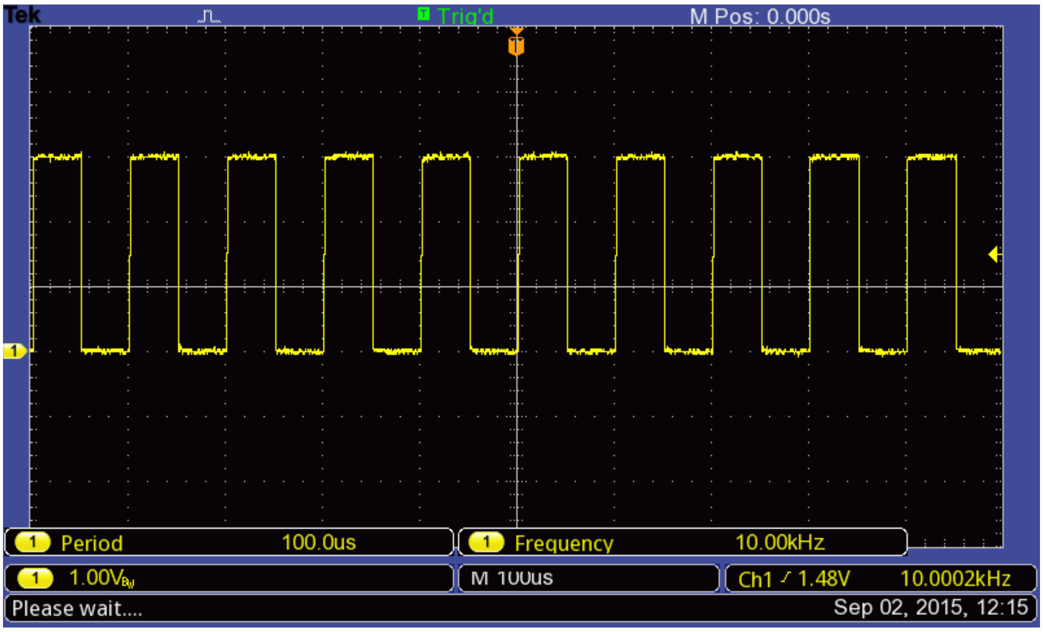
Taking the Measurements

- Set input
  - Square wave, 0-3V peak-to-peak amplitude
  - 100 Hz frequency
  - Continous mode (on AFG)
  - enable the channel 1 output on AFG



- Autoset the oscilloscope to optimally see the signal
- Set up following measurements:
  - On Ch1 - Frequency and Period
- Keeping the amplitude of the square wave input fixed, vary its frequency from 1Hz to 20kHz.
- Measure frequency on oscilloscope
- By pressing the push button, get measurements from Arduino, for each input set.
- Tabulate the measurements. You can also capture screenshot

for each measurement set.



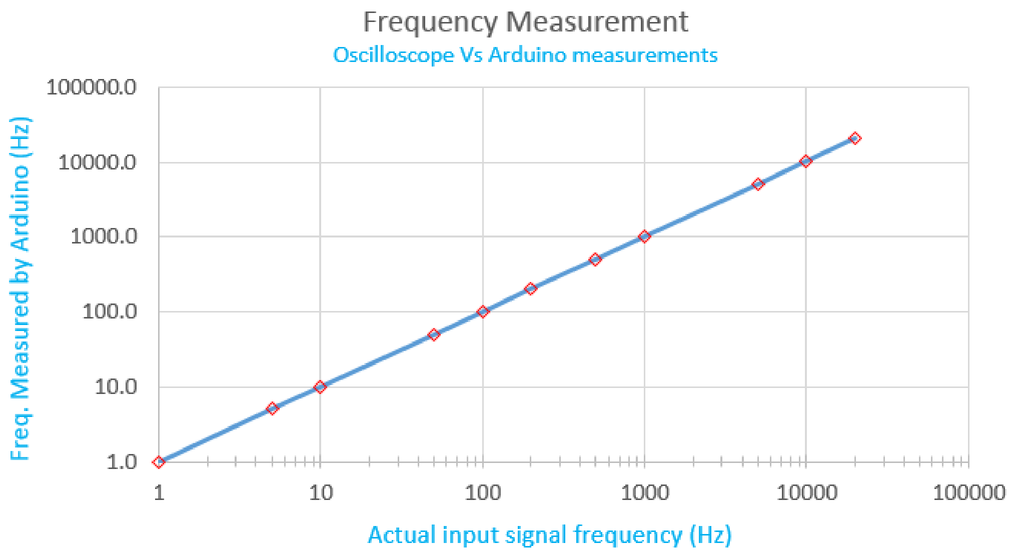
Step 6

Analyzing the Result

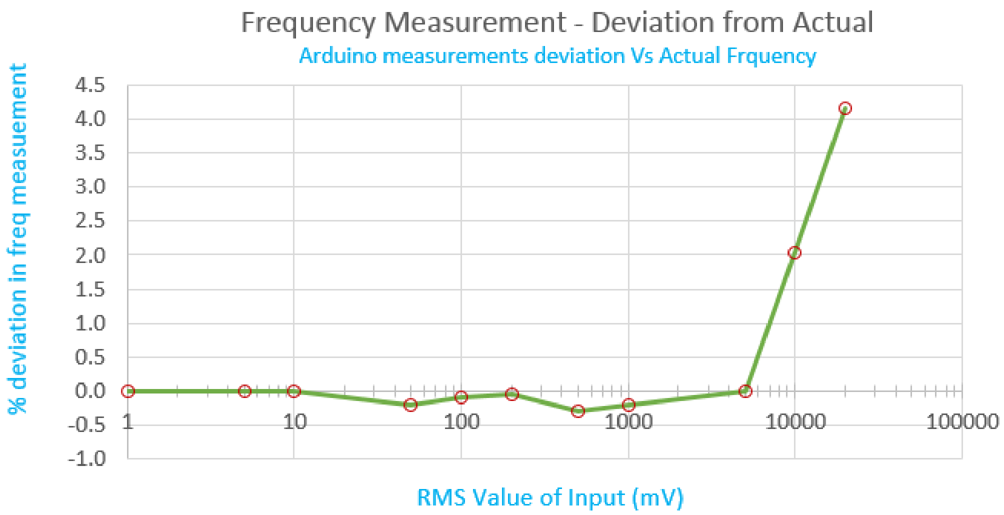
- The observation table would look like as shown below. Calculate the % deviation of frequency measured by Arduino from actual.

#	INPUT	FREQUENCY (Hz) MEASURED BY		PERIOD (uS) MEASURED BY		DEVIATION	
	freq (Hz)	Oscillosocpe	Arduino	Oscillosocpe	Arduino	Frequency	Period
1	20,000	20,000	20833.0	49.99	48	4.17	-0.04
2	10,000	10,000	10204.0	100.00	98	2.04	-0.02
3	5,000	5,000	5000.0	200.00	200	0.00	0.00
4	1,000	1,000	998.0	1,000.00	1002	-0.20	0.00
5	500	501	499.5	2,000.50	2002	-0.30	0.00
6	200	200	199.9	5,001.00	5002	-0.04	0.00
7	100	100	99.9	10,000.00	10002	-0.10	0.00
8	50	50	49.9	20,000.00	20002	-0.20	0.00
9	10	10	10.0	1,00,000.00	100002	0.00	0.00
10	5	5	5.0	2,00,000.00	200002	0.00	0.00
11	1	1	1.0	10,00,000.00	1000018	0.00	0.00

- Create a plot of Arduino Vs Actual frequency values



- Plot the % deviation with respect to actual frequency values



- Can you guess why the deviation increases to 4% for 20kHz signal?

Step 7

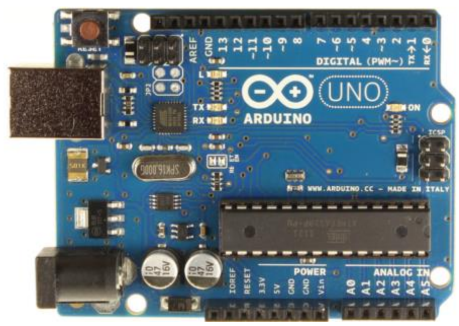
Conclusion

The analysis of the observed results confirm that (As expected):

- The Arduino can be used for frequency counter application
- Frequency measured by Arduino system matches the actual frequency value of the input
- Deviation increases as the input frequency is increases beyond 10KHz

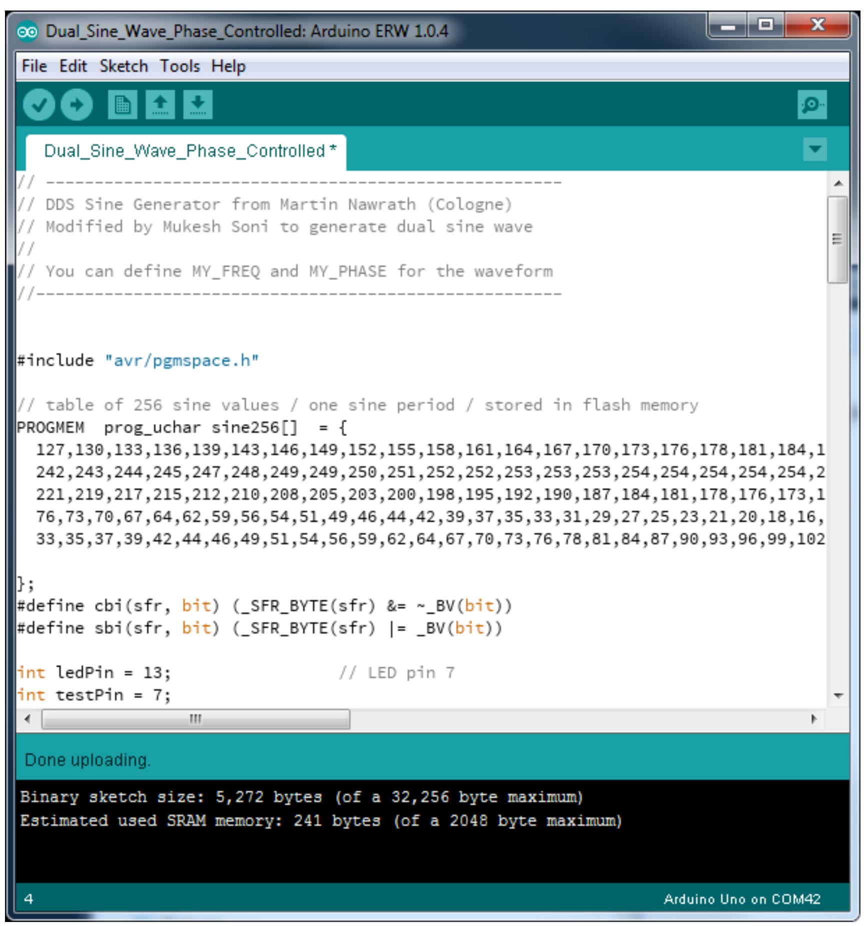
How to program Arduino?

STEP: 1. Obtain Arduino board (preferably Uno, Duemilanove or Leonardo model)

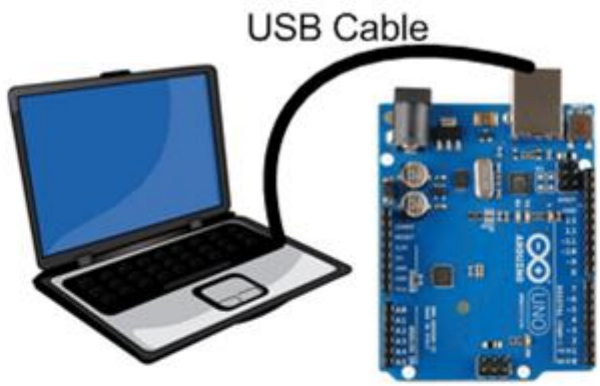


STEP: 2. Download the IDE from - http://arduino.cc/en/Main/Software - that is suitable for your PC operating system (to program your Arduino board).

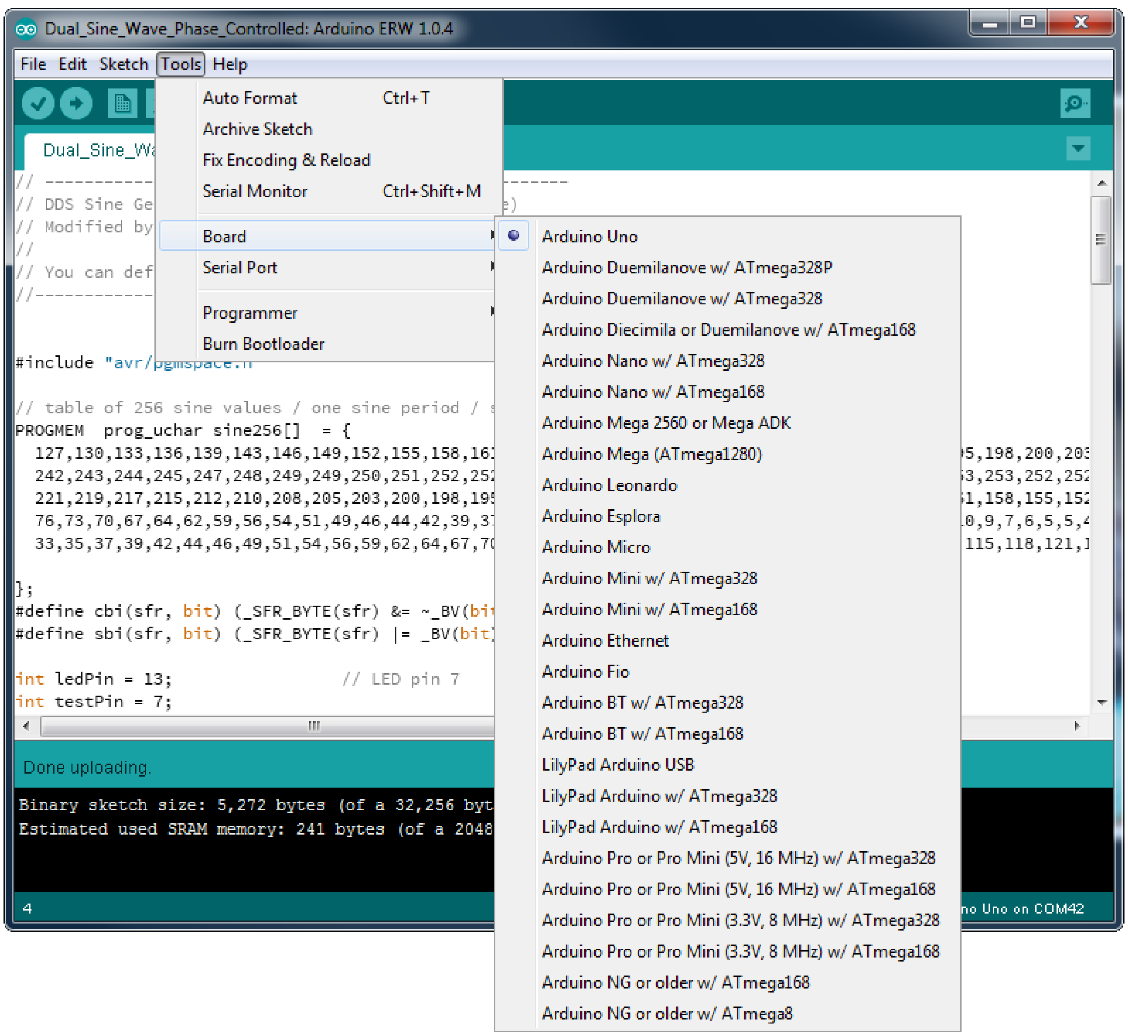
STEP: 3. Install the Arduino IDE software on your PC. This is how IDE would look like:



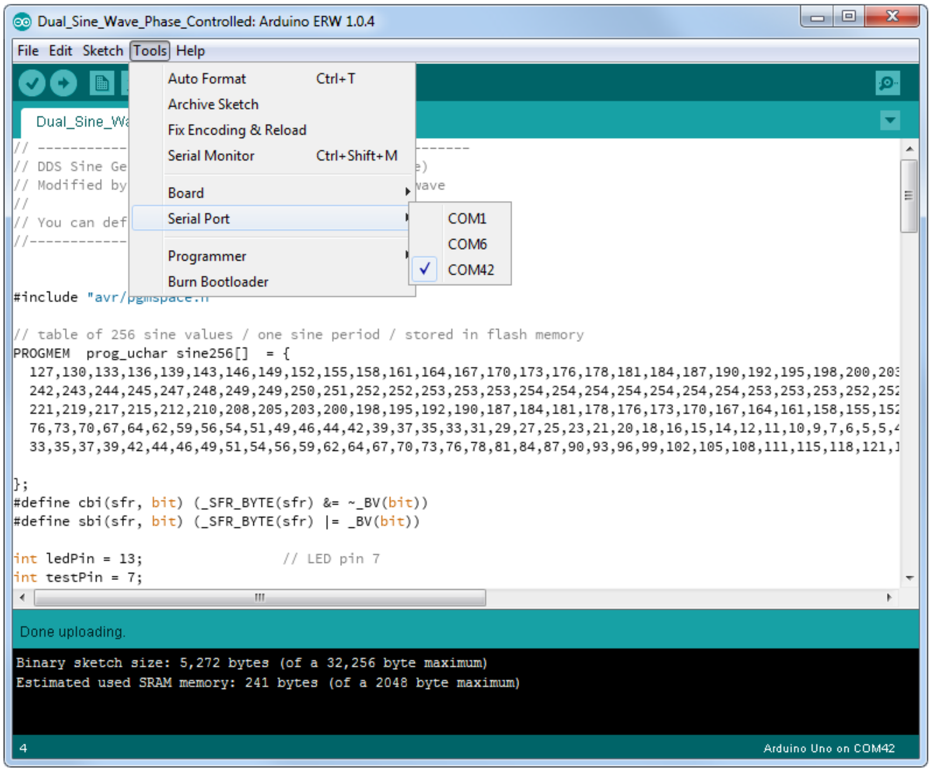
STEP: 4. Connect the Arduino board using USB cable provided to your PC. Wait till the necessary drivers are installed and device is recognized as COM port.



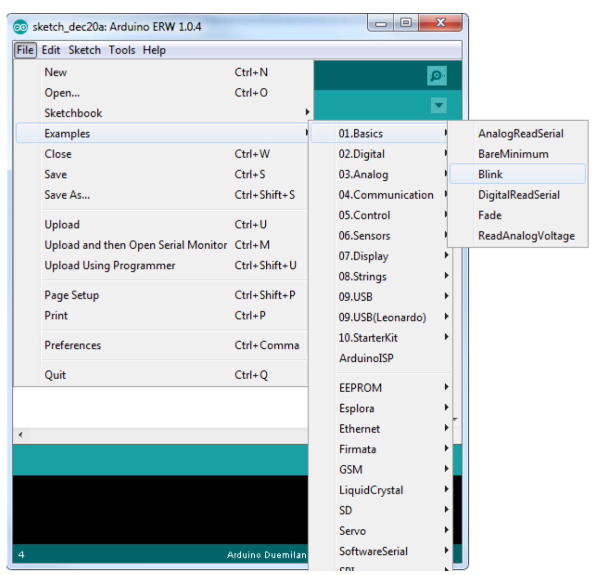
STEP: 5. Select the correct Arduino Board type as show below: **Tools > Board >**



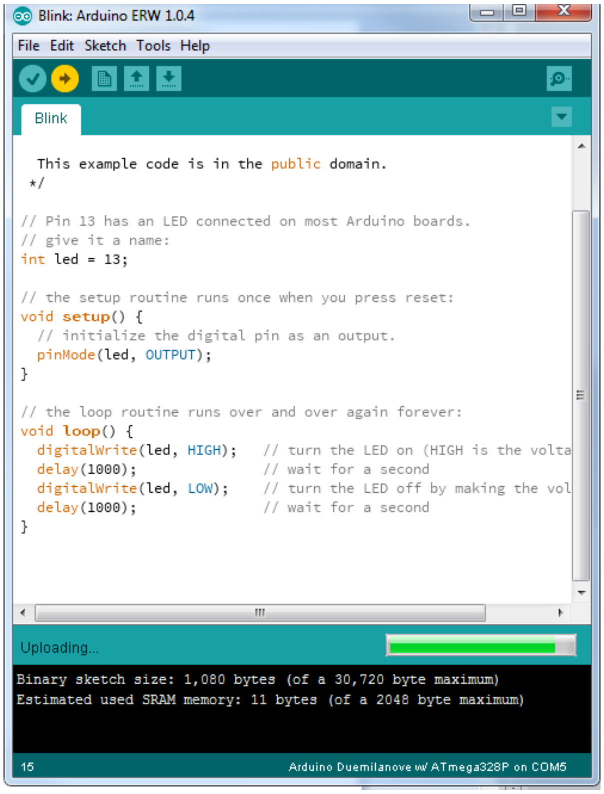
STEP: 6. Ensure that COM Port identified for your Arduino board is correct. You can also change / select appropriate COM Port your Arduino is connected as from following menu: **Tools > Serial Port >**

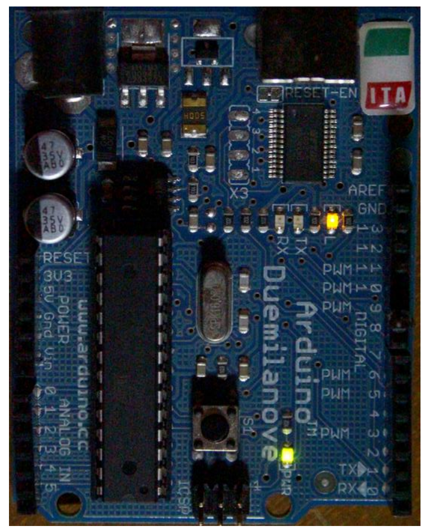


STEP: 7. Once the setting is complete, we are ready to download the program on Arduino board. We can test the setup by programming Arduino bard with an example code (sketch). Go to : **File > Examples > 01.Basics > Blink**



STEP: 8. Click on the Right Arrow button (highlighted in orange color in the image below) to compile and upload the binary to Arduino board. Once the upload is done, you will see 'orange LED' on board flashing – on for 1 second and off for 1 second.





STEP: 9. Now that setup is successfully completed and tested, open the relevant program (.ino file as specified by the lab experiment) using menu option – **File > Open**

STEP: 10. Using UPLOAD button (circular button with arrow pointing to right) we can compile the program and upload the compiled binary file to Arduino board.

STEP: 11. Once the board is programmed, it will start generating signals at specified pins. The board is ready to probe (or to connect external RC circuits) as per lab needs.