HCMC UNIVERSITY OF TECHNOLOGY	SOCIALIST REPUBLIC OF VIETNAM
Faculty of Transportation Engineering	Independence – Freedom – Happiness
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SUMMARY OF THESIS/CAPSTONE PROJECT
SEMESTER 242

1. Thesis/Capstone project title: Design a Magneto – Powered Capacitor Discharge Ignition System.

2. Advisor's fullname: Ph.D Tran Dang Long

3. Student's fullname: Nguyen Quoc Kiet - **ID:** 1952802

4. Thesis content:

4.1. Type: ☑ A product design ☐ A technical evaluation ☐ A scientific research ☐ Other:

4.2. Objectives & Technical requirements:

a. Objectives: Design and build algorithm of CDI (Capacitor Discharge Ignition) ignition system using magneto - powered.

b. Technical requirements:

➢ **Functions:**

- CDI ignition system uses magnetic energy, no auxiliary power required.
- Flywheel speed range: $500 - 2500\ RPM$.
- The ignition timing must be controlled according to the desired ignition angle, which can be changed by using potentiometer.
- User interface: Display the ignition advance angle and flywheel speed.
- Input signal: Receive pulse signal from Hall effect sensor (1 pulse/revolution). Capable of filtering noise and accurately measuring time.

➢ **Techniques:**

- Reverse voltage protection.
- Protect high voltage pulses from spreading back to the microcontroller.
- Ability to resist electromagnetic interference from the ignition system.

➢ **Efficiencies and Durability:**

- Compact size, suitable for mini racing car installation.
- Power-efficient design.
- Low maintenance cost, robust operation in small engines environments.

4.3. Core problems to be solved & Solving ideas/methods:

Problem 1: Accurately measure flywheel speed in real time

Solution: Use a Hall sensor mounted near the flywheel to detect magnet signal. Use an Arduino microcontroller and Input Capture Interrupt to calculate the time between two consecutive pulses → from there calculate RPM.

Problem 2: Precise ignition timing control according to desired ignition angle

Solution: Calculate the time delay between the moment the signal from the Hall sensor is detected and the ignition timing.

Use Timer/Counter in Arduino Uno to generate control pulse to trigger SCR at the right time.

Problem 3: Algorithm diagrams according to the correct sequence of embedded system design.

Solution:

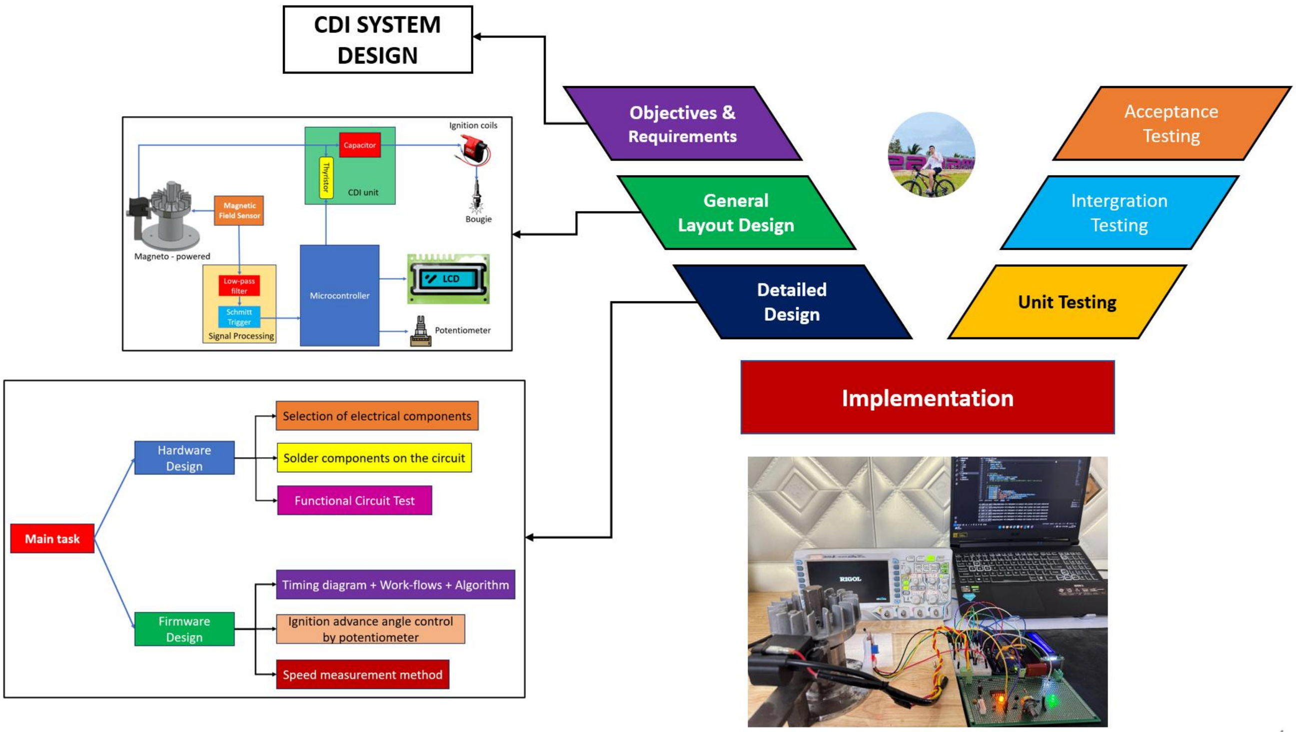


Figure 1: V-Model

4.4. Works to be done & Results:

No.	Works to be done	**Required results** *(Ex: specific data, equations, models, diagrams, parameters, charts, findings…must be achieved)*	Final results
1	- Define objective and requirements of system - Select power supplied for CDI	- Design and build algorithm control of Capacitor Discharge Ignition system using magneto - powered. - Ignition type magneto of small engine.	- Done: 100% - Figure 2
2	**General layout design:** Create system block diagram: Include magneto, capacitor, SCR, spark plug, ignition coils, signal conditioning, Hall sensor, microcontroller.	- Defined function of each block and their interconnections	- Done (100%) - Figure 3
3	**Detailed design:** + Hardware & Firmware design + SCR trigger + Timing diagram + Algorithm/Work-flows + State machine + Coding	- Full electrical schematic - Algorithm flowcharts - Preliminary code	- Done: 100% - Equation 1, 2 - Table 1,2 - Figure 4, 5, 6
4	**Unit testing:** Test individual modules: + Capacitor charging/discharging time + Speed signal from Hall sensor + Ignition signal	- Speed signals, Ignition signal - Oscilloscope waveform screenshots (Ignition pulses, speed pulses)	- Done: 100% - Figure 7
5	**System testing:** - Integrate hardware and software:	- Compare measured RPM with spark timing.	- Done: 100% - Figure 8,9

No.	Works to be done	**Required results** *(Ex: specific data, equations, models, diagrams, parameters, charts, findings…must be achieved)*	Final results
	- Verify ignition at correct timing based on RPM		
6	**Actual system:** - Test the entire design system	- Stability and spark strength assessment	- Done: 100% - Figure 10
7	**General implementation:** - Assemble complete circuit - Demonstrate working prototype	- Working system with variable speed input - Correctly timing ignition pulses	- Done: 90% - Figure 11

Figure 2: The figure ignition magneto of lawn mower

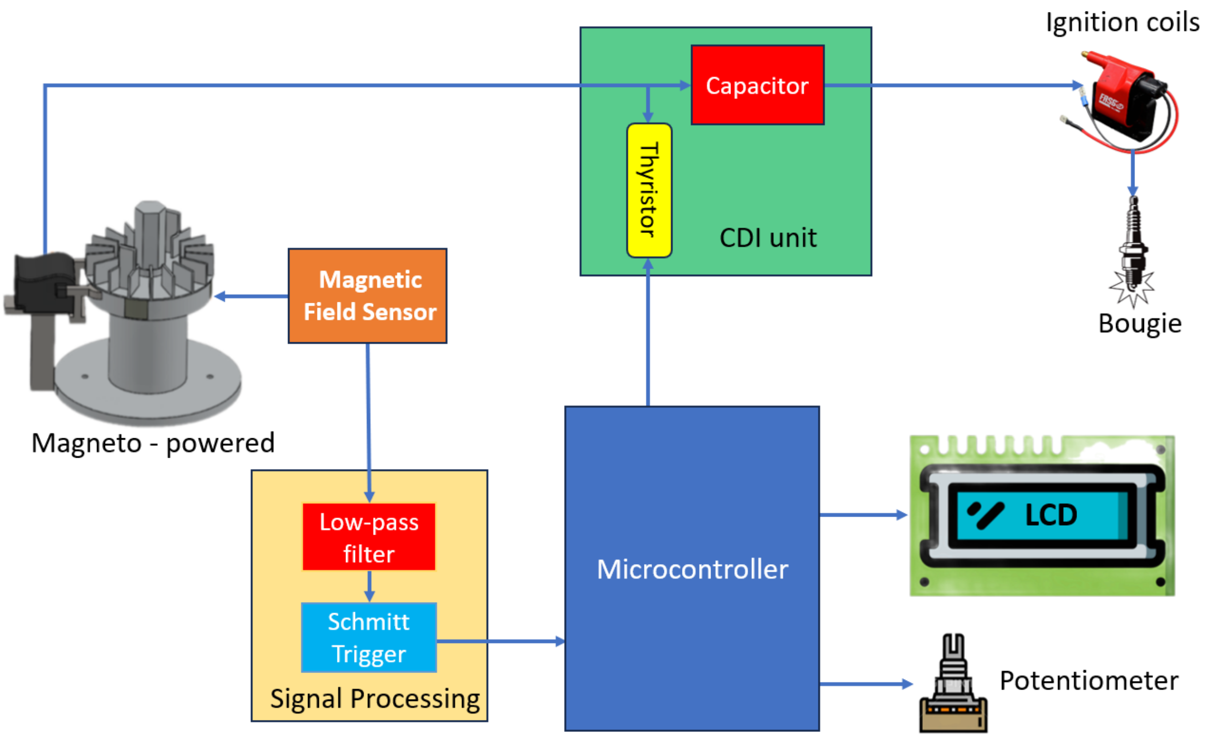


Figure 3: The figure general layout design

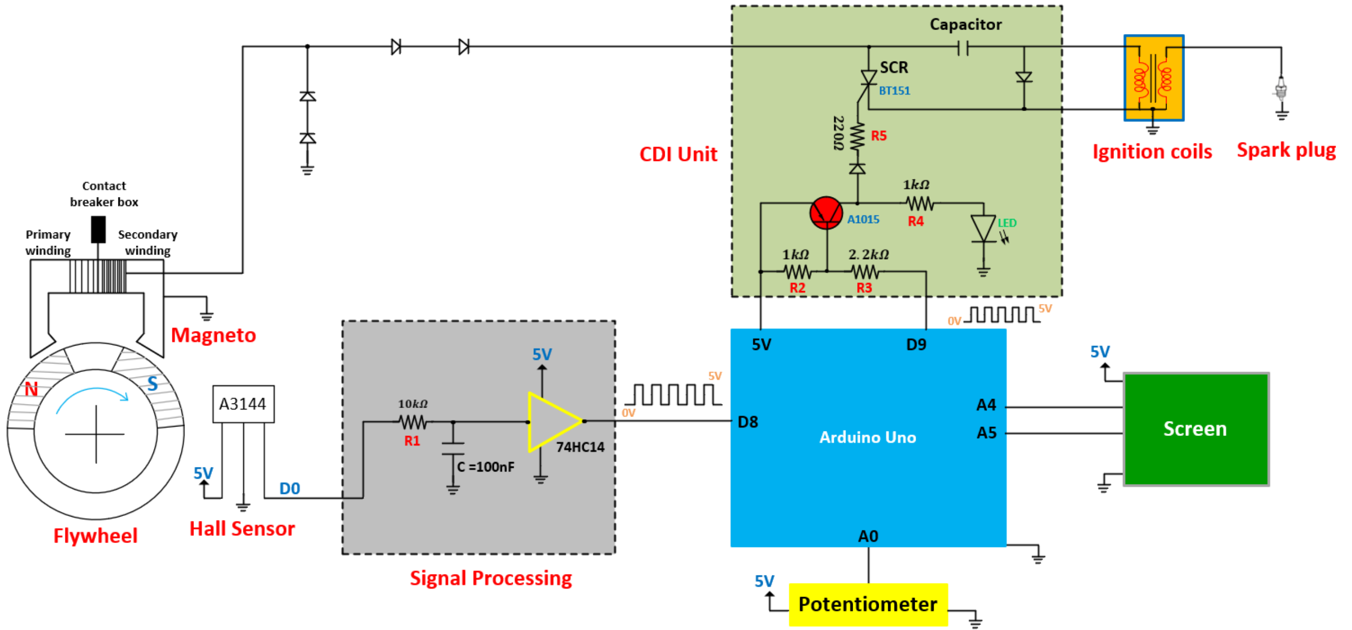


Figure 4: Wiring diagram

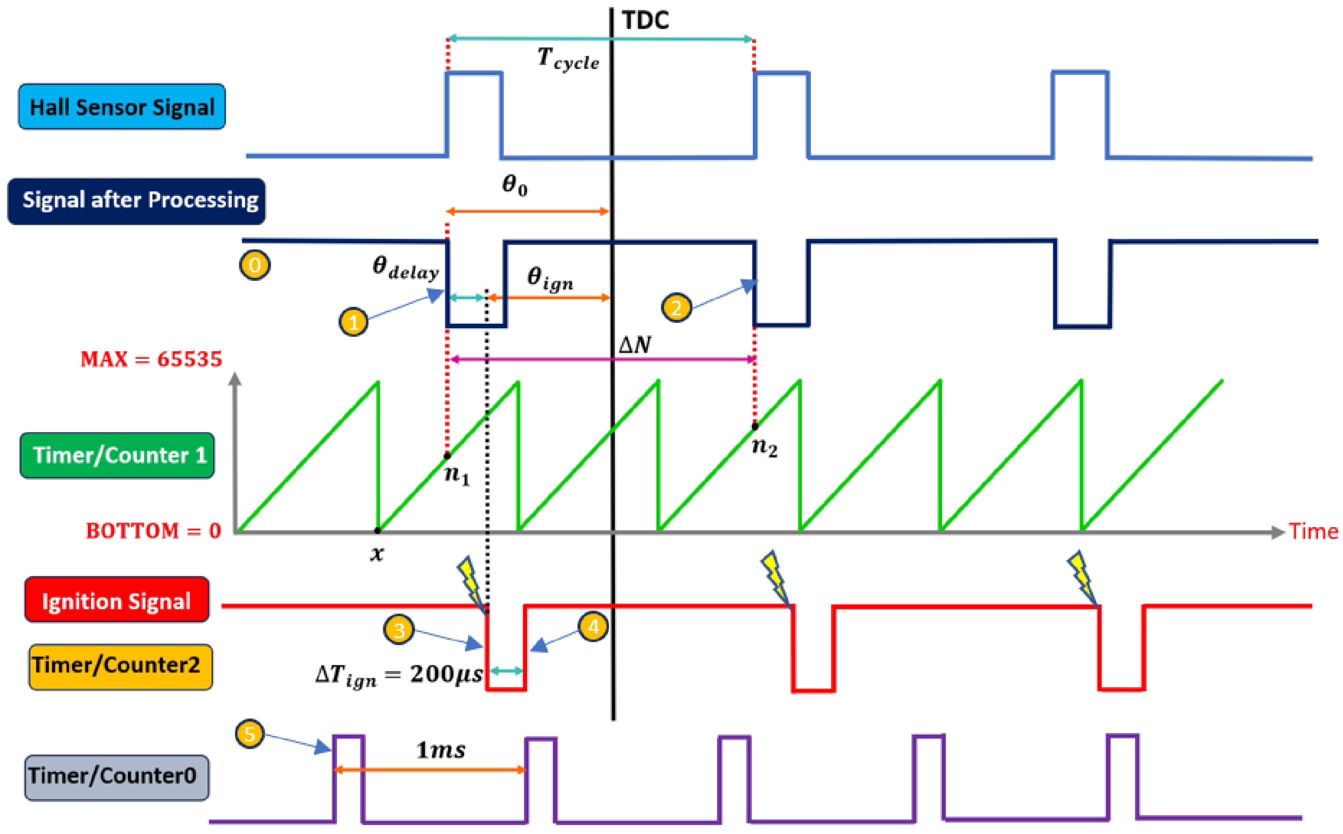


Figure 5: Timing diagram

Event	0	1	2	3	4	5
Time	Start Program	First Falling edge	Next Falling edge	Delay timeout T_{delay}	Timeout ΔT_{ign}	Every 1ms
Work	- Declare variables, I/O - Set up Timer 0 - Set up Timer 1 - Setup Time2	- Update: $n_2 = Timer1$ - Timer 2 = T_{delay} - CAPT_flag = 1	- CAPT_flag = 0 - $T_{cycle} = \frac{(\Delta N + x \times \mathrm{MAX}) \times 64}{16\ MHz}$ - Calculation speed - Update $n_1 = n_2$ - $T_{delay} = \frac{T_{cycle} \times \theta_{delay}}{360}$	- PB9 = 0 - $\Delta T_{ign} = 200\mu s$	- PB9 = 1	-Display_flag = 1 -Display on LCD

Table 1: The table for describe the event and work of timing diagram

Equation for calculation flywheel speed:

$$\Delta N = n_2 - n_1 \tag{1}$$

$$\text{Speed} = \frac{60 \times \text{F\_CPU}}{\text{prescaler} \times (\Delta N + x \times \text{MAX})} \tag{2}$$

Where:

Speed: engine speed (rpm)

$\mathbf{T_{cycle}}$: the period of hall sensor signal.

Prescaler: frequency divider (= 64);

F_CPU: clock speed of Arduino ($= 16$ MHz)

$\boldsymbol{n_1}$: count value of Timer/Counter 1 at the rising edge of the hall sensor signal.

$\boldsymbol{n_2}$: count value of Timer/Counter1 at the next rising edge of the hall sensor signal.

ΔN: count value of Timer/Counter1 that counted from n_1 to n_2

$\boldsymbol{x}$**:** number of overflow.

	θ	T (s)	N (Ticks)
Cycle	360°	$T_{cycle} = \frac{60}{Speed}$	$N_{cycle} = \frac{F \times T_{cycle}}{prescale}$
Ign	θ_{ign}	$T_{ign} = \frac{T_{cycle} \times \theta_{ign}}{360}$	$N_{ign} = \frac{F \times T_{ign}}{prescale}$
delay	$\theta_{delay} = \theta_0 - \theta_{ign}$	$T_{delay} = \frac{T_{cycle} \times \theta_{delay}}{360}$	$N_{ign\_delay} = \frac{F \times T_{delay}}{prescale}$

Table 2: The table for calculate ignition delay

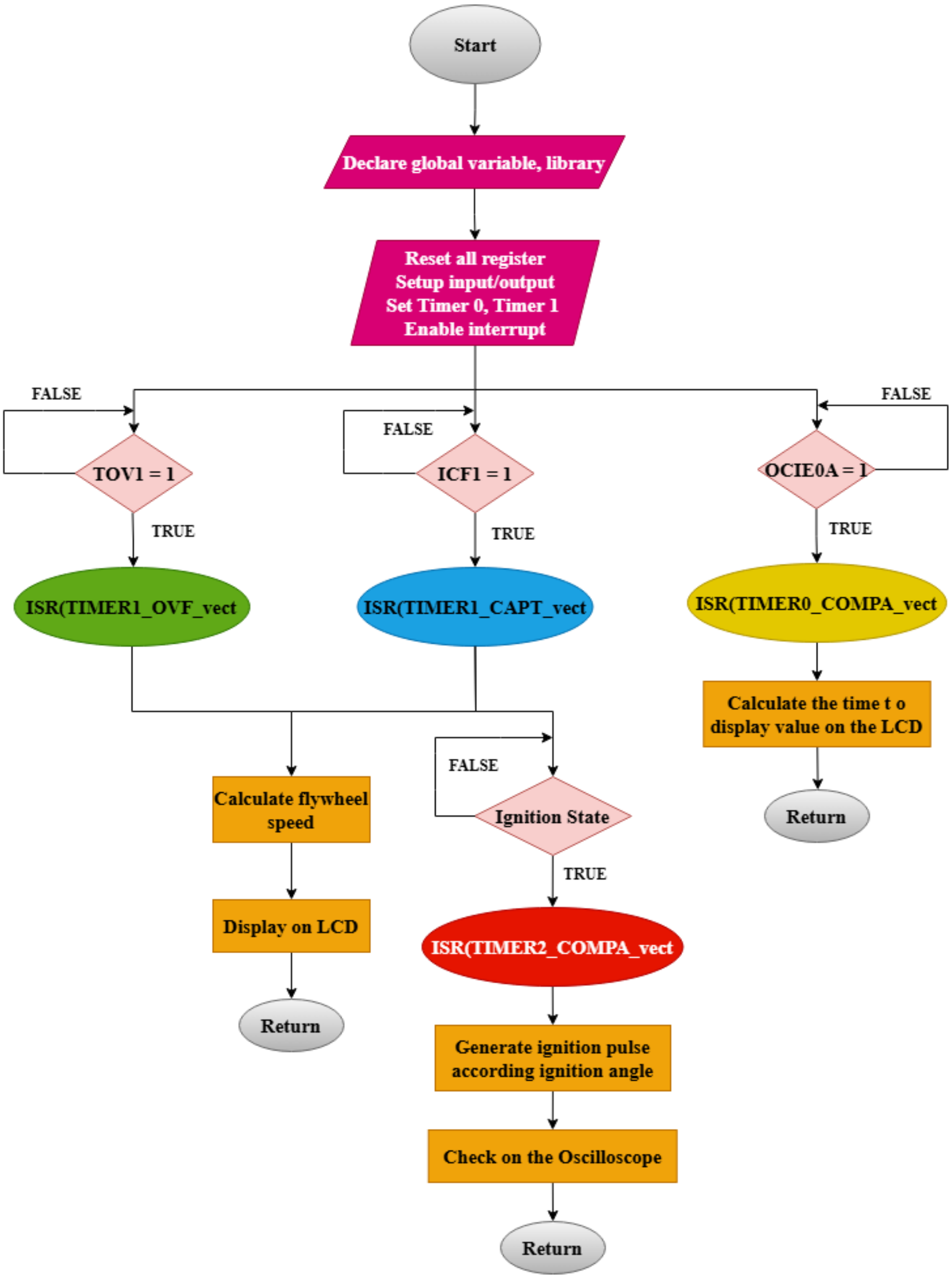
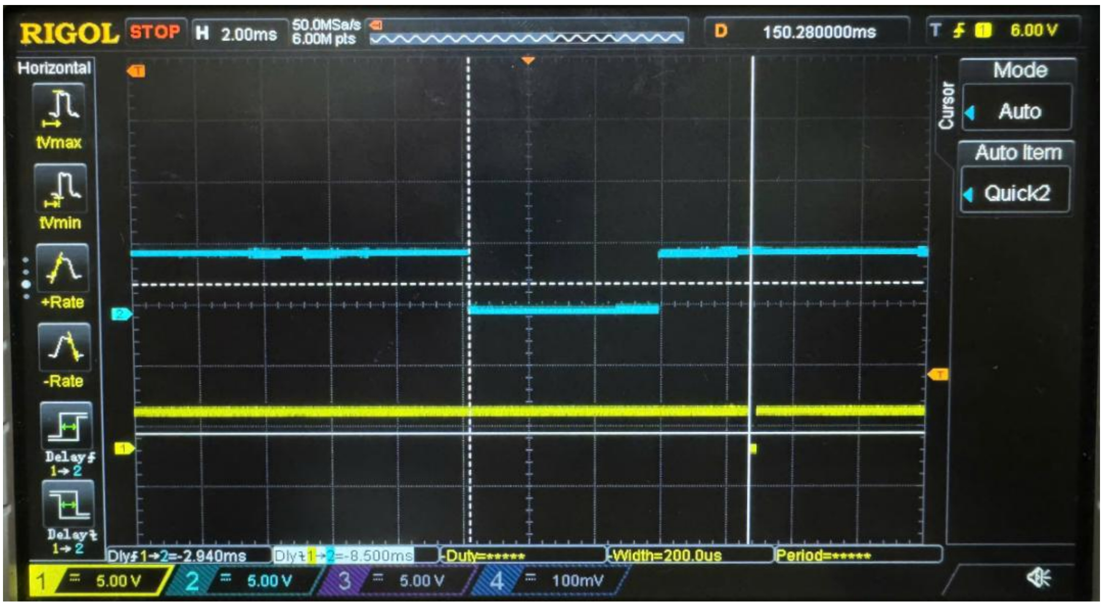


Figure 6: Main algorithm



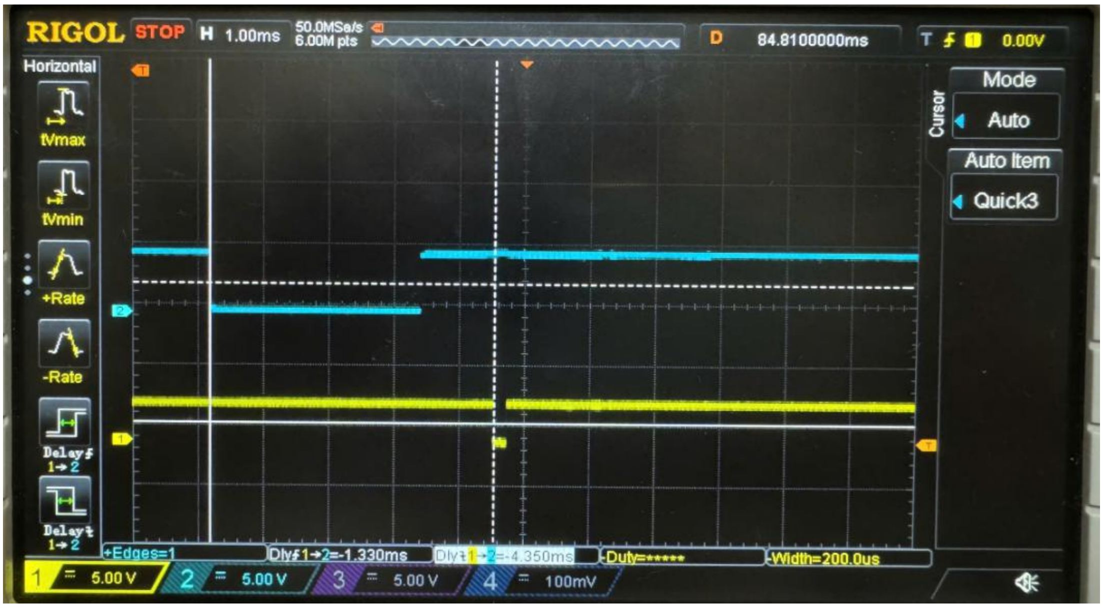


Figure 7: The figure osilloscope waveform speed signal, SCR pulse

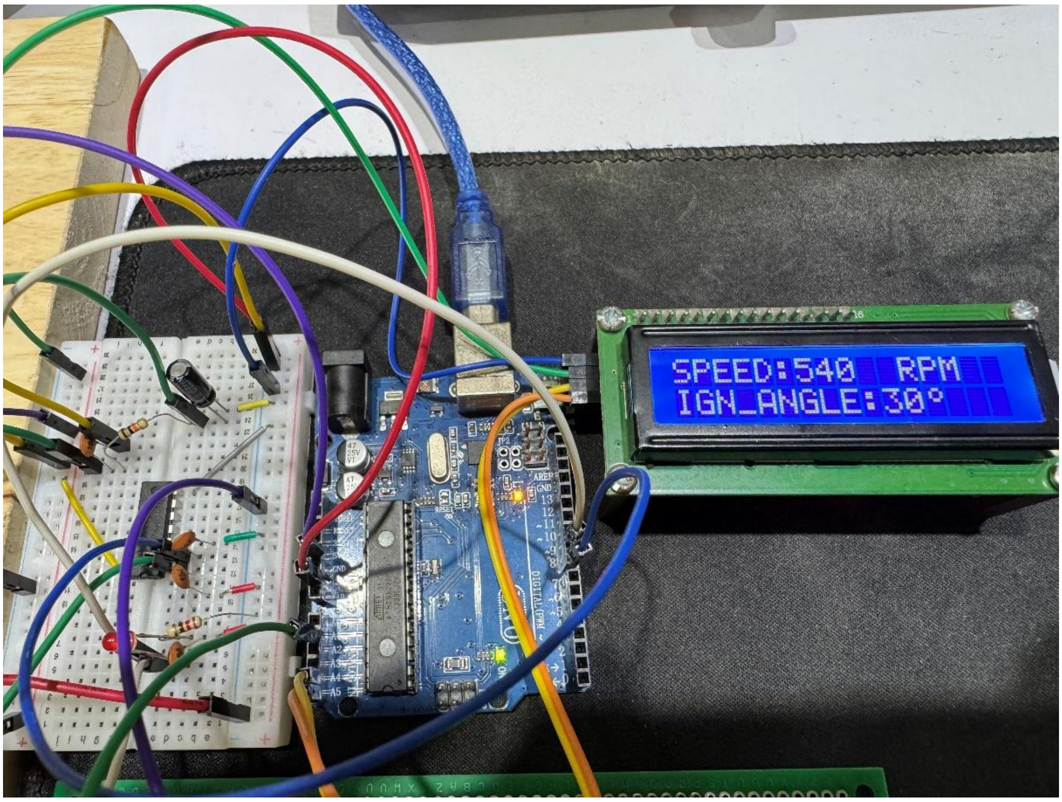


Figure 8: The value of speed on the LCD in real time

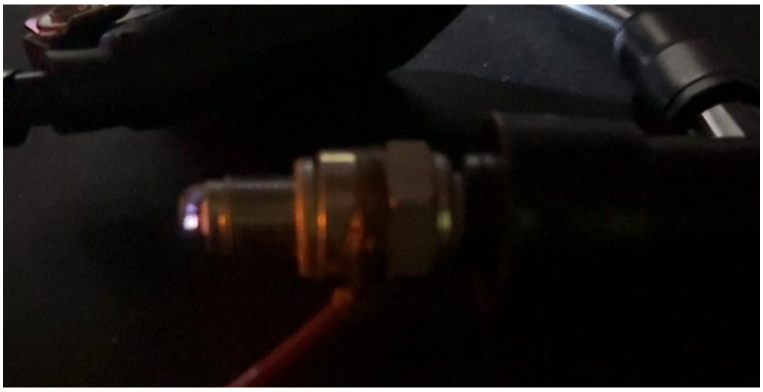


Figure 9: Compare measured speed with spark timing

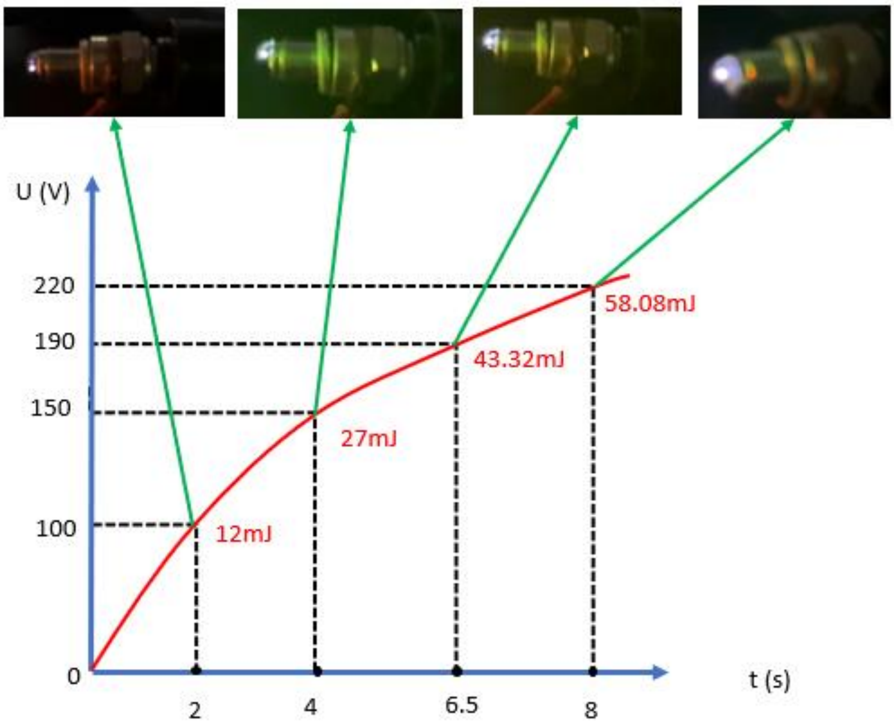


Figure 10: Spark plug ignition when system is operating

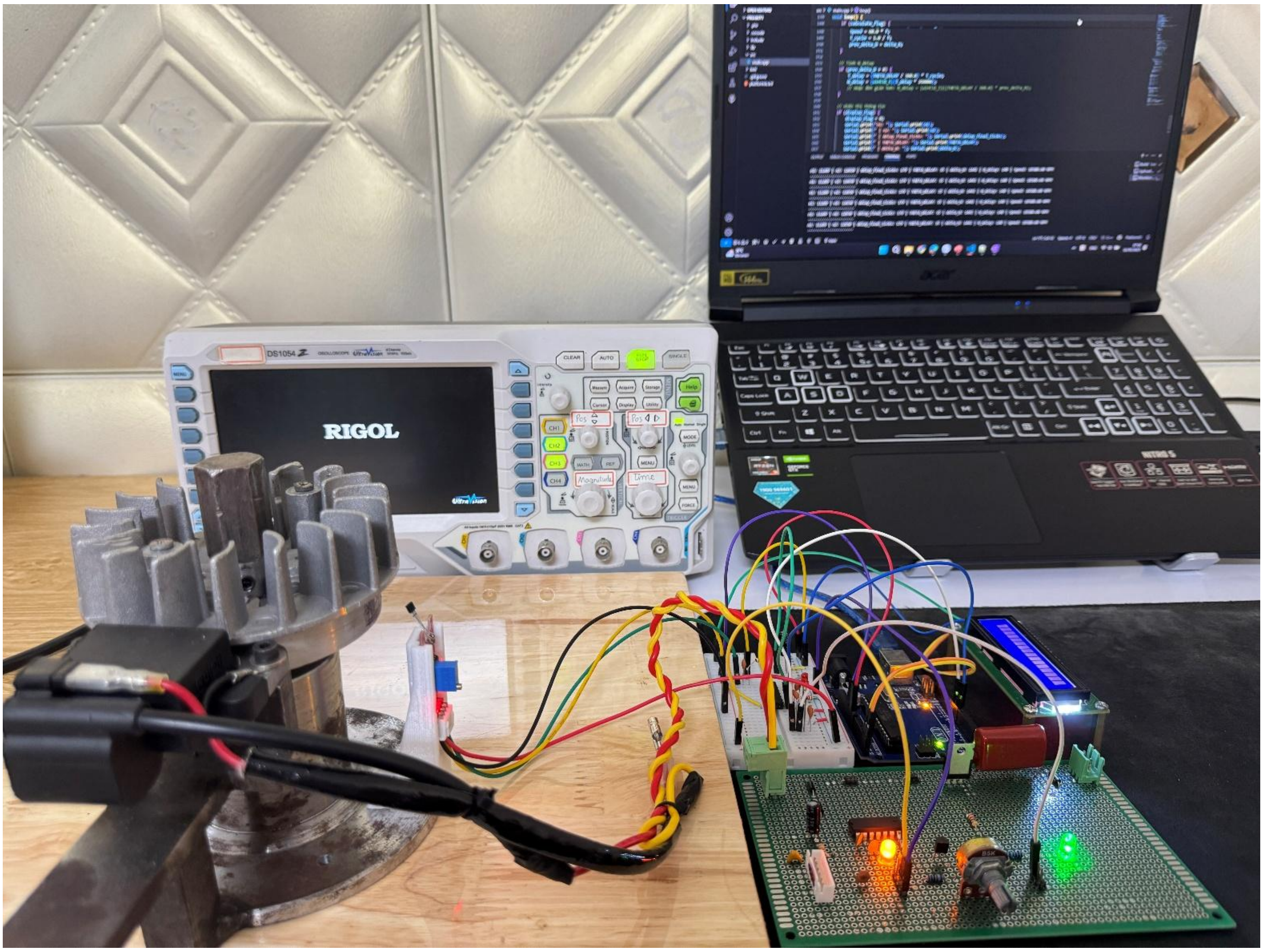


Figure 11: Realistic model of CDI ignition system using magneto - powered

4.5. Requested products:

☑ Technical report	☑ Poster	☐ Scientific paper
☐ Software	☑ Firmware	☐ Numerical model
☐ General layout drawings	☐ Detailed drawing	☐ Assembly drawings
☐ Others:		

4.6. Scope of Thesis/Capstone project:

- Design a algorithm advance ignition angle control.
- Measure flywheel speed from hall sensor signal.
- Generation a simulate speed sensor signal and ignition advance angle control signal 0−60° before TDC on the Proteus.

4.7. Tasks of each team member:

No.	Member's full name	Works assigned
1	Nguyễn Quốc Kiệt	- Design a Magneto – Powered Capacitor Discharge Ignition System. - Build algorithm control of CDI ignition system. - Simulation speed sensor signal and ignition advance angle on Proteus.

Student: Nguyễn Quốc Kiệt **- ID:** 1952802 **- Signature:**

Date (dd/mm/yyyy): 29/05/2025

ADVISOR