



# MCT432 Hybrid Control Systems

lab I

Experimenting Magnetic / Optical Encoder





MEET  
OUR  
TEAM



# MEET OUR TEAM



**FARID TOLBAH**

*Professor*

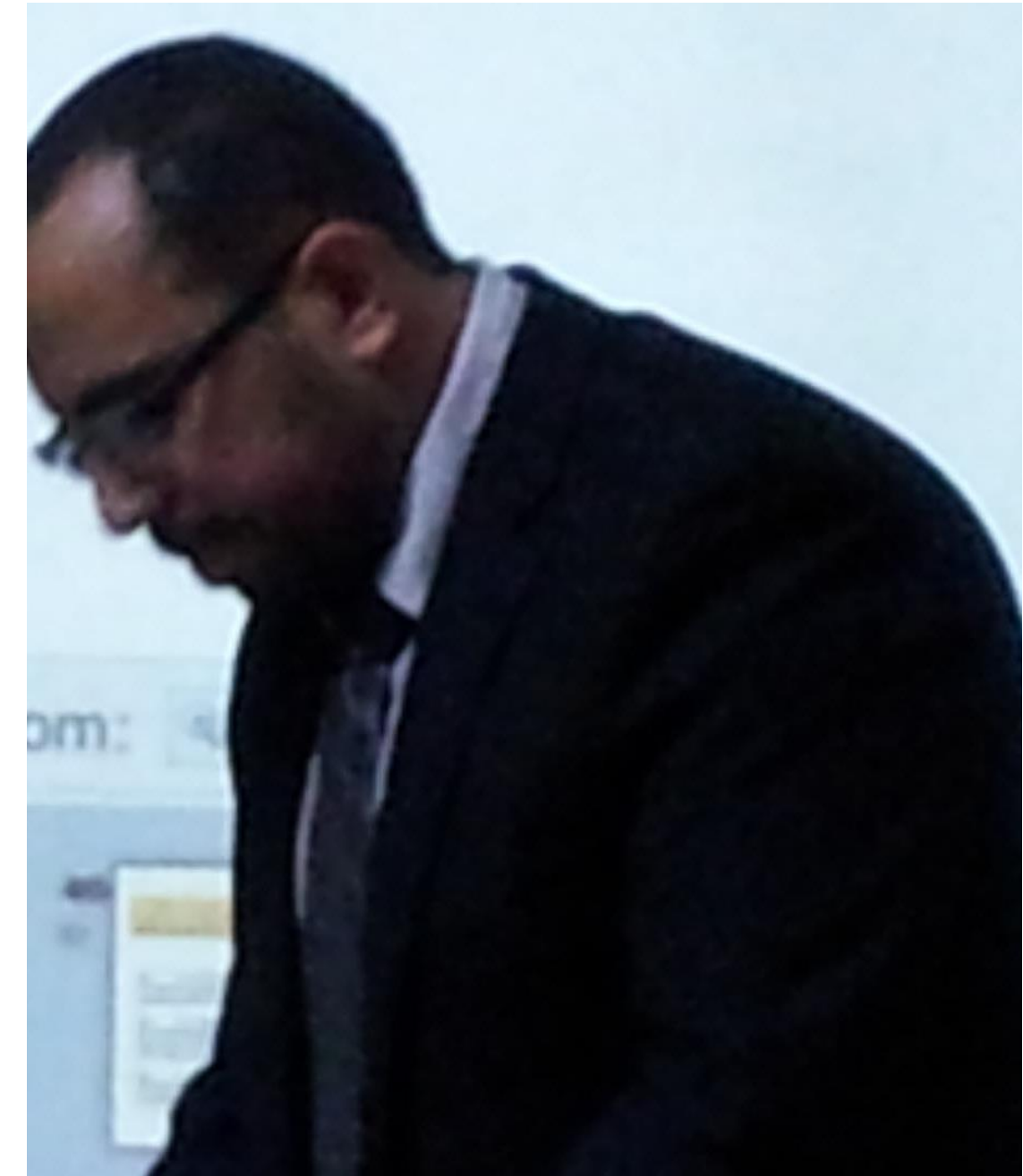
- Core curriculum.
- Lab orientation.
- Selection of tutorial exercises.



**DIAA EMAD**

*Assistant Lecturer*

- Tutorials and assignments.



**WALEED EL-BADRY**

*Assistant Lecturer*

- Design of lab experiments.

# Agenda!

1.

2.

3.

4.

Lab Agenda

# AGENDA

MONDAY

October 10, 2016

A stylized orange calendar icon with a white page showing the year 2016 in grey text.

2016

☒ Importance of Encoders

☒ Types of Encoders

☒ Reading 2-Channels Magnetic Encoder



# AGENDA

MONDAY

October 10, 2016

A stylized orange calendar icon with a white page showing the year 2016 in grey text.

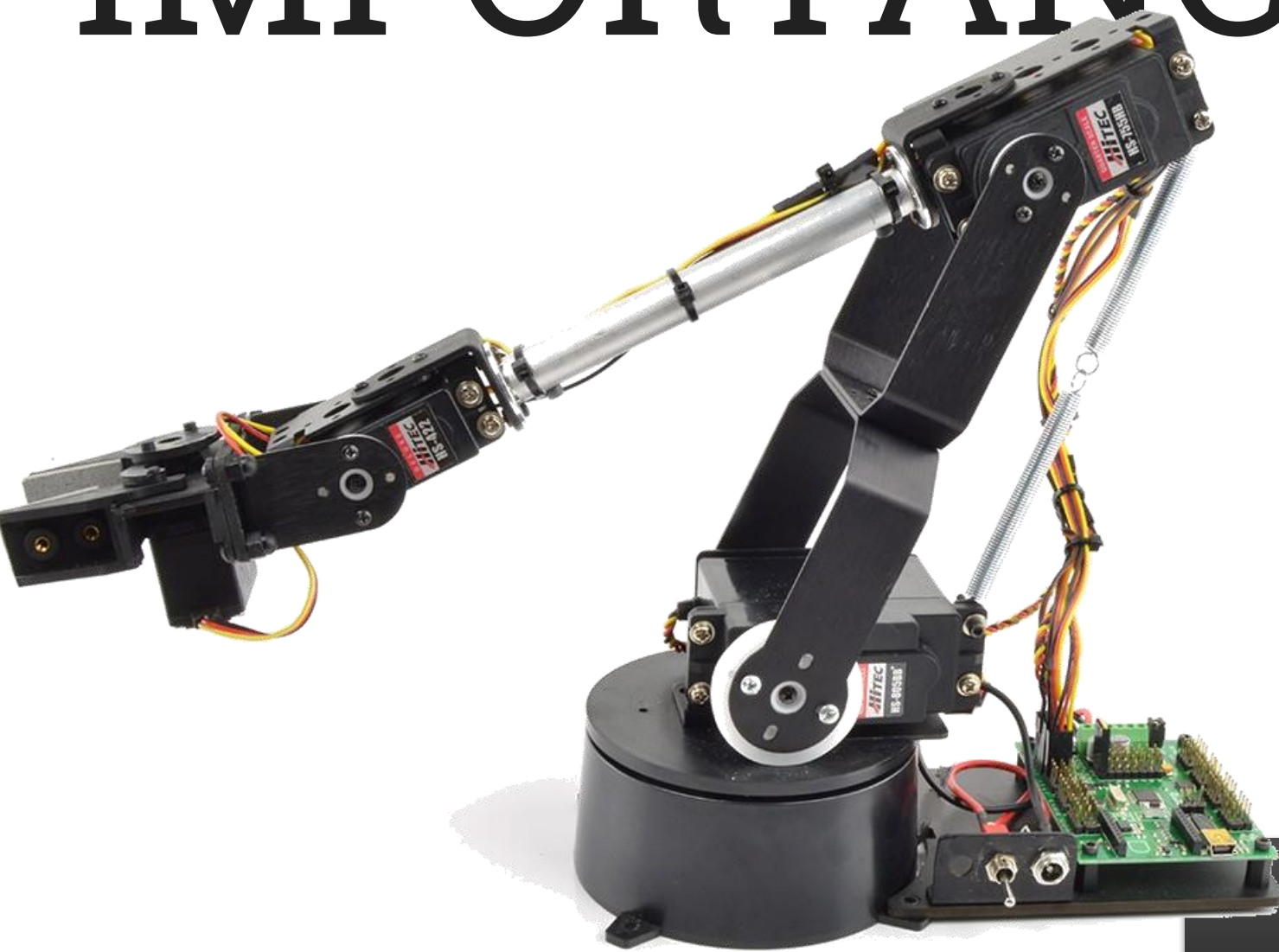
☒ Importance of Encoders

**Its rule in Mechatronics Design**

☒ Types of Encoders

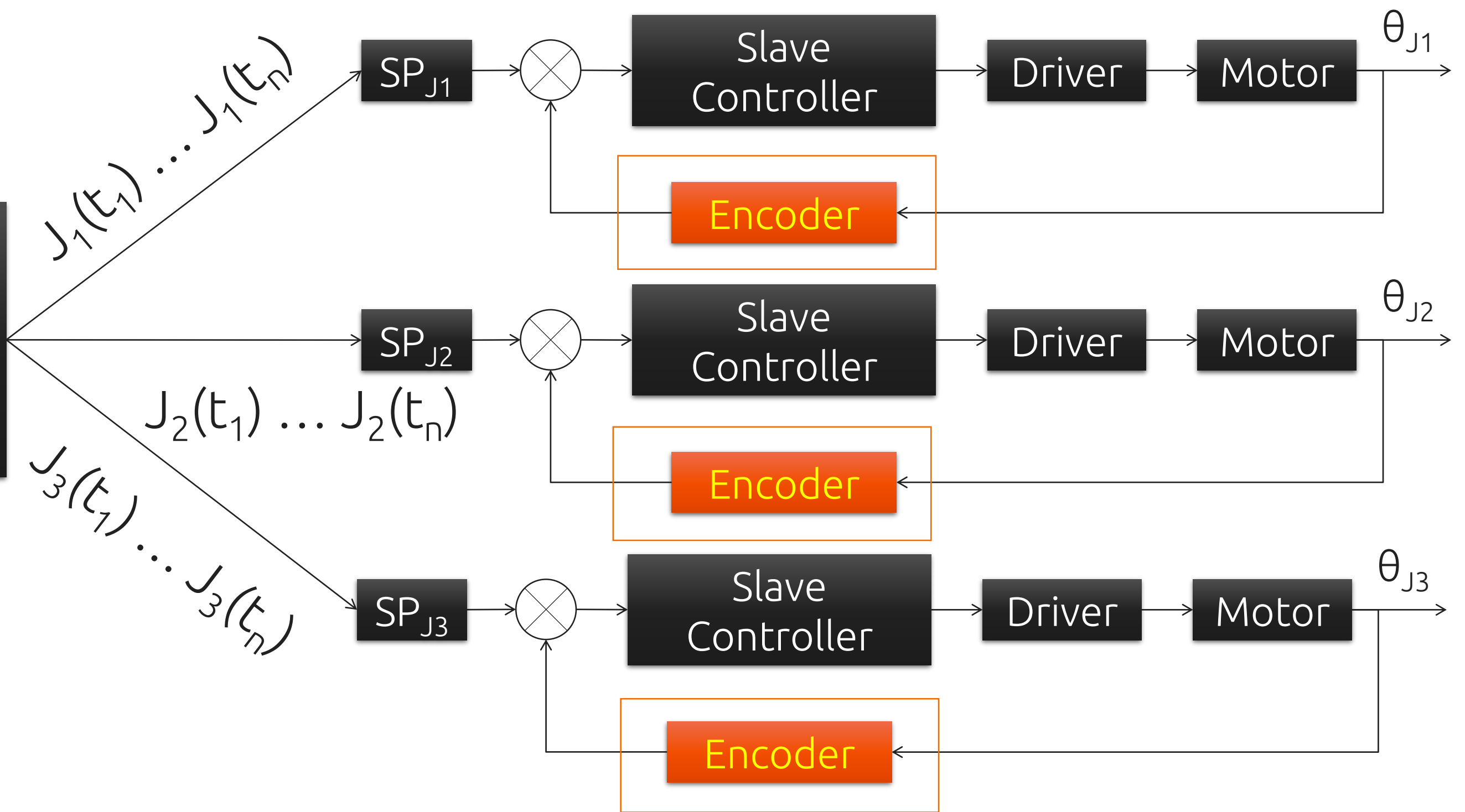
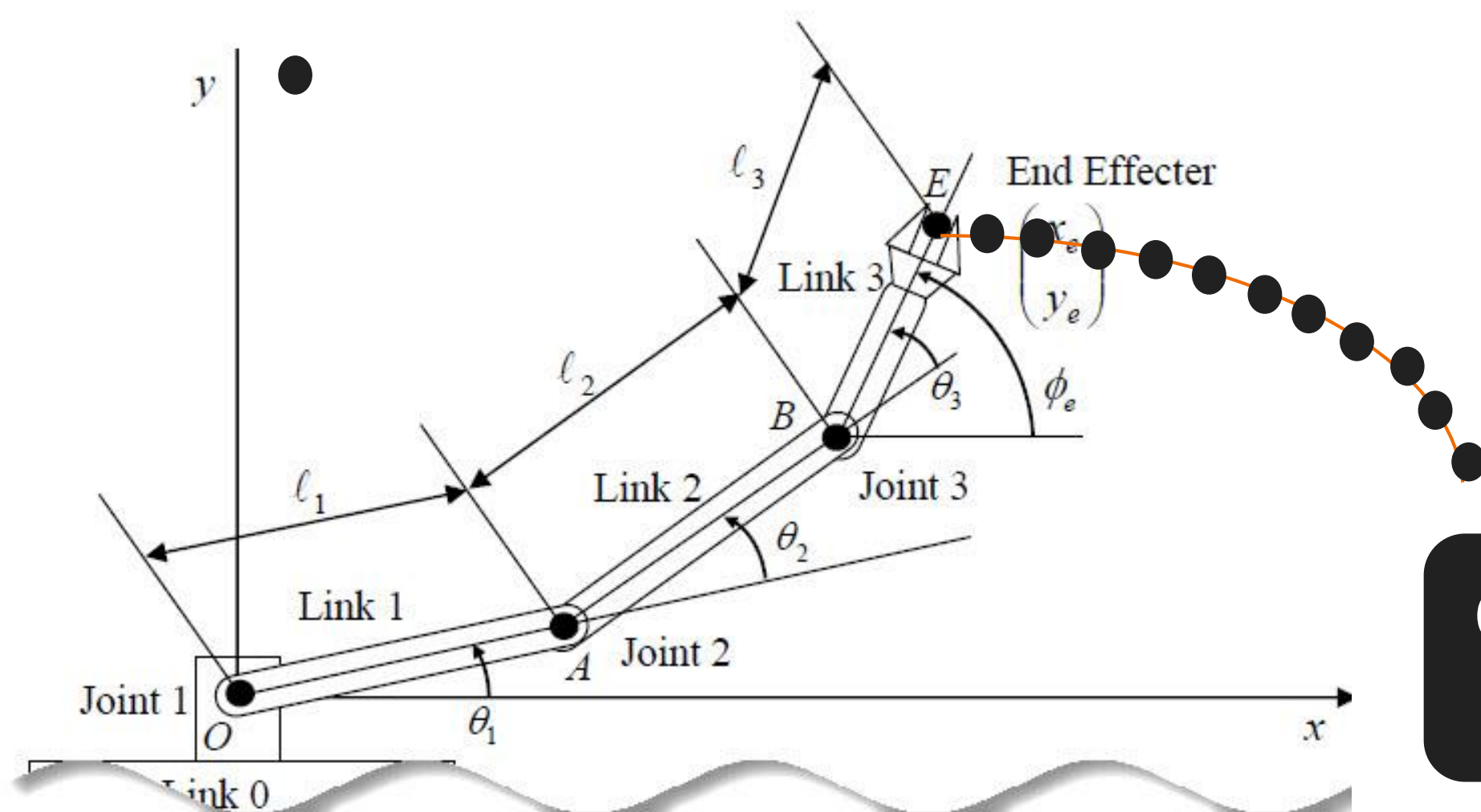
☒ Reading 2-Channels Magnetic Encoder

# IMPORTANCE OF ENCODERS



## Master Controller

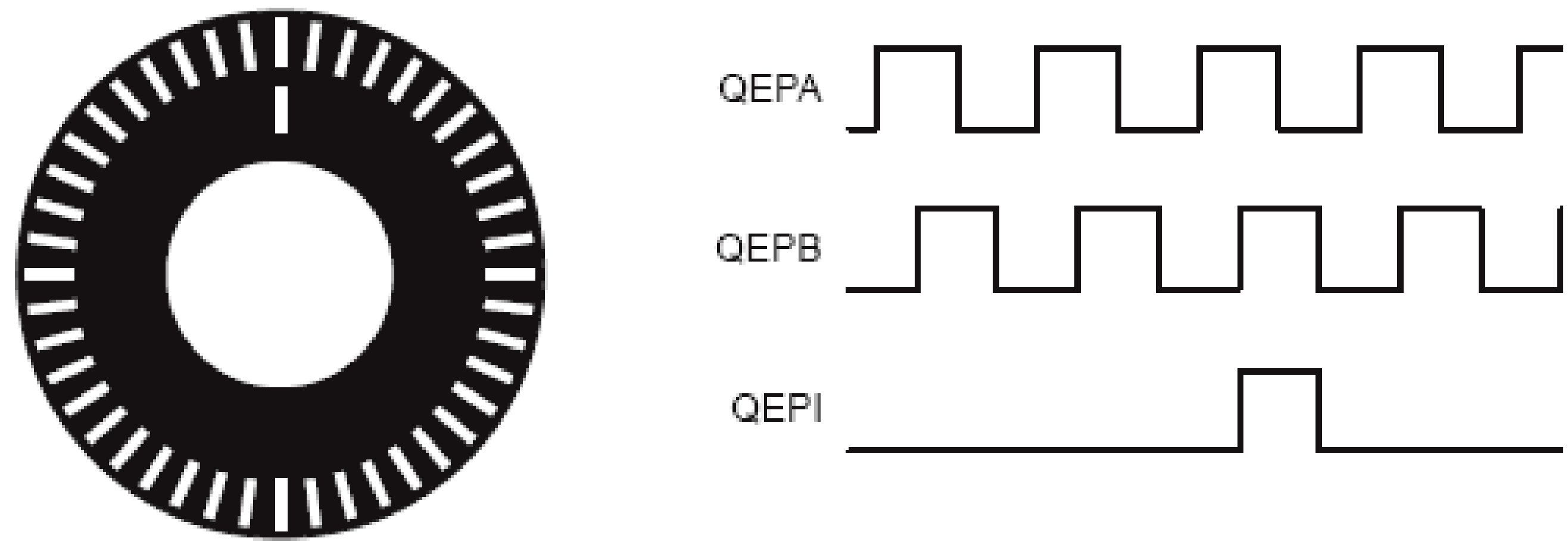
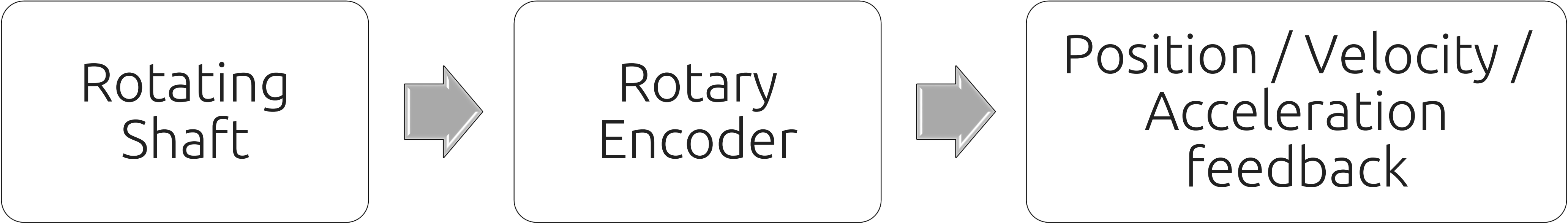
- Solving Inverse Kinematics
- **Generating** trajectory intermediate angles for each joint ( $J_i$ )



Generated trajectory points

**Why motion control for multiple axes is best to be carried in parallel?**  
**Hint (time . scalability)**

# IMPORTANCE OF ENCODERS





# AGENDA

MONDAY

October 10, 2016

A stylized orange calendar icon with a white page in the center displaying the year '2016' in a light blue font. The calendar has four tabs at the top and a dark orange shadow at the bottom.

☒ Importance of Encoders

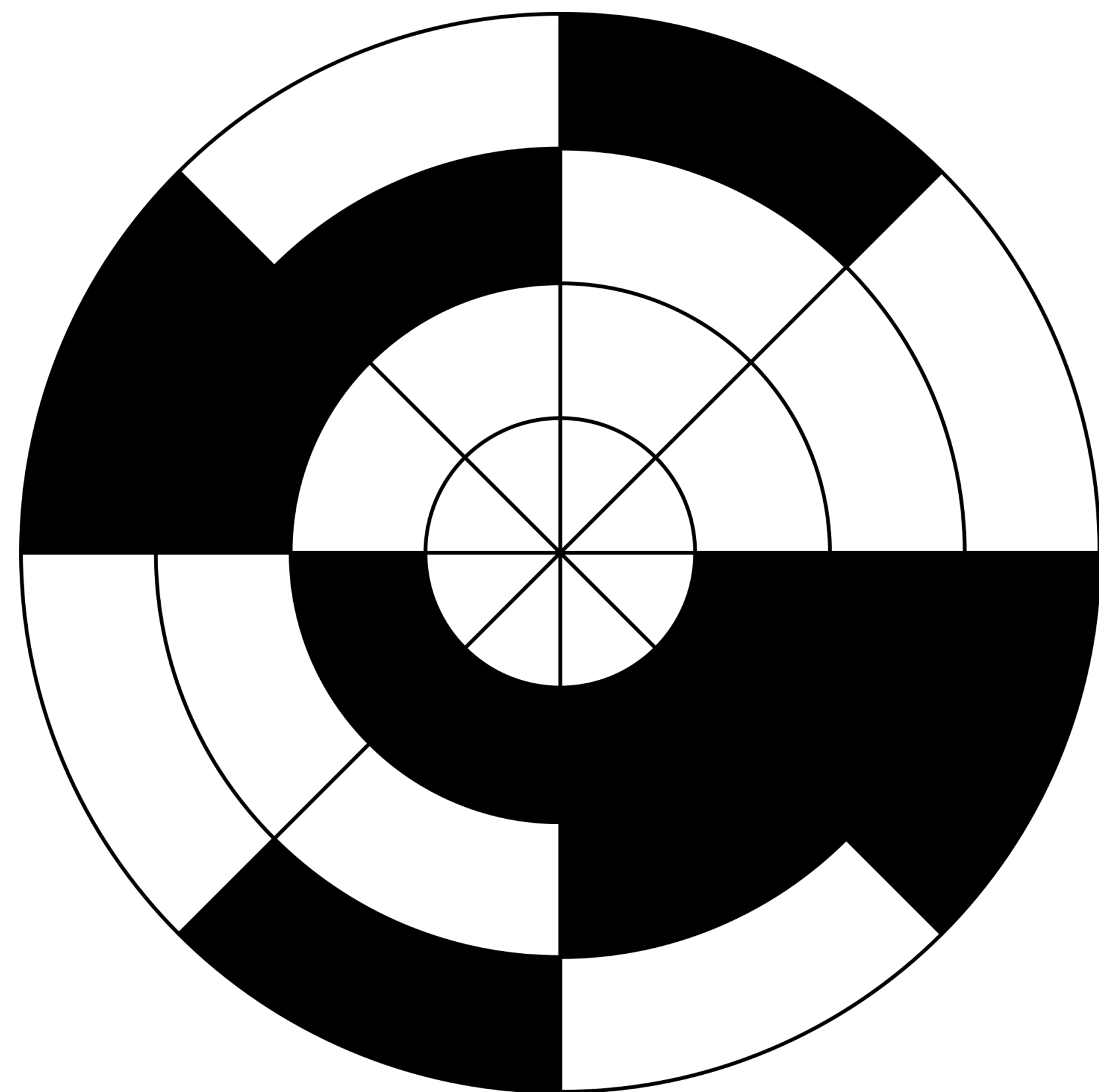
☒ Types of Encoders

**How encoder works**

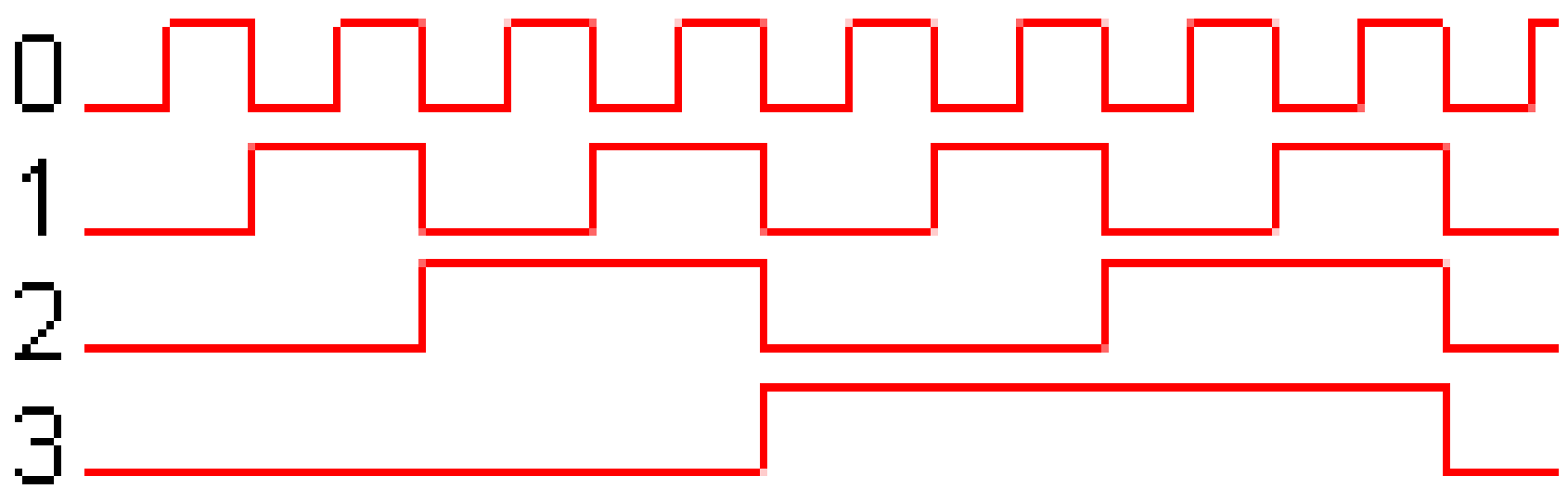
☒ Reading 2-Channels Magnetic Encoder



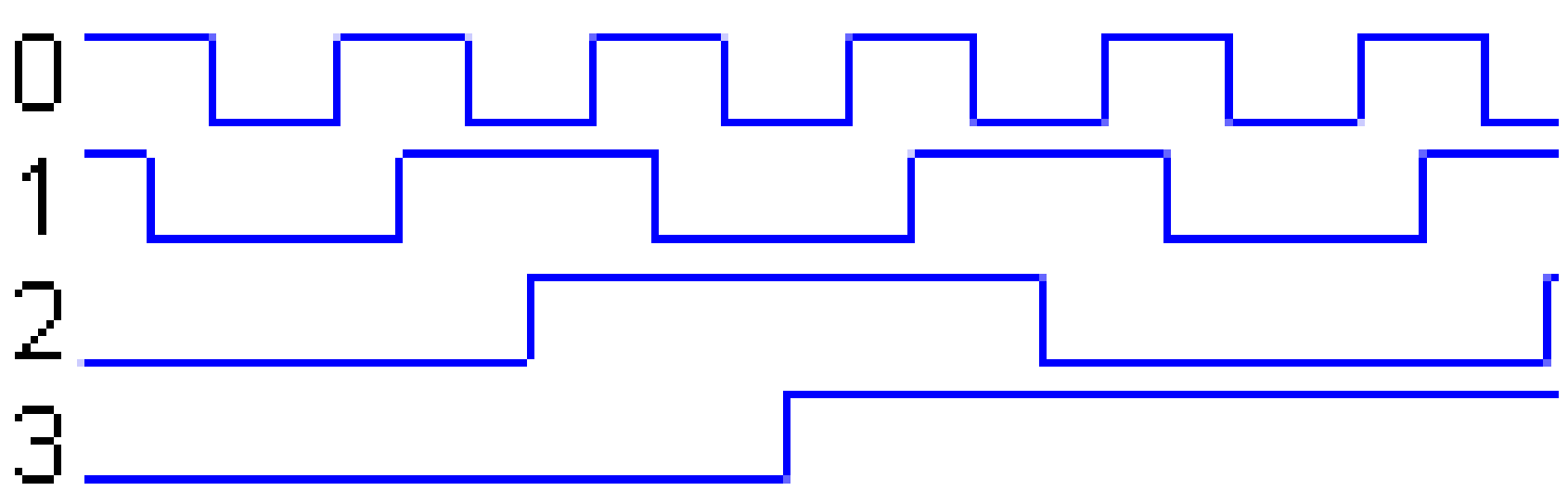
# TYPES OF ROTARY ENCODERS



Binary Code Output



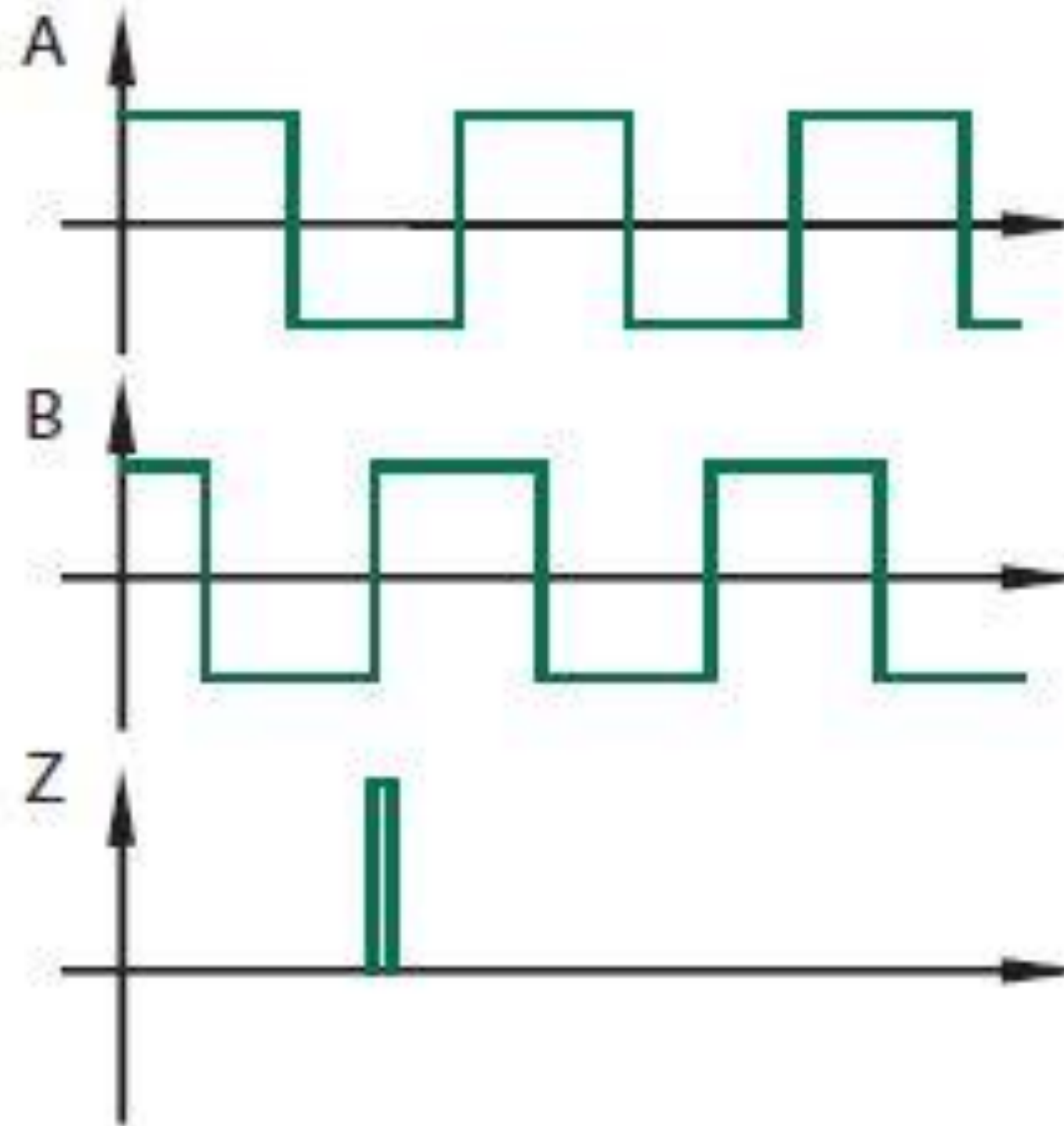
Gray Code Output



Absolute Encoder



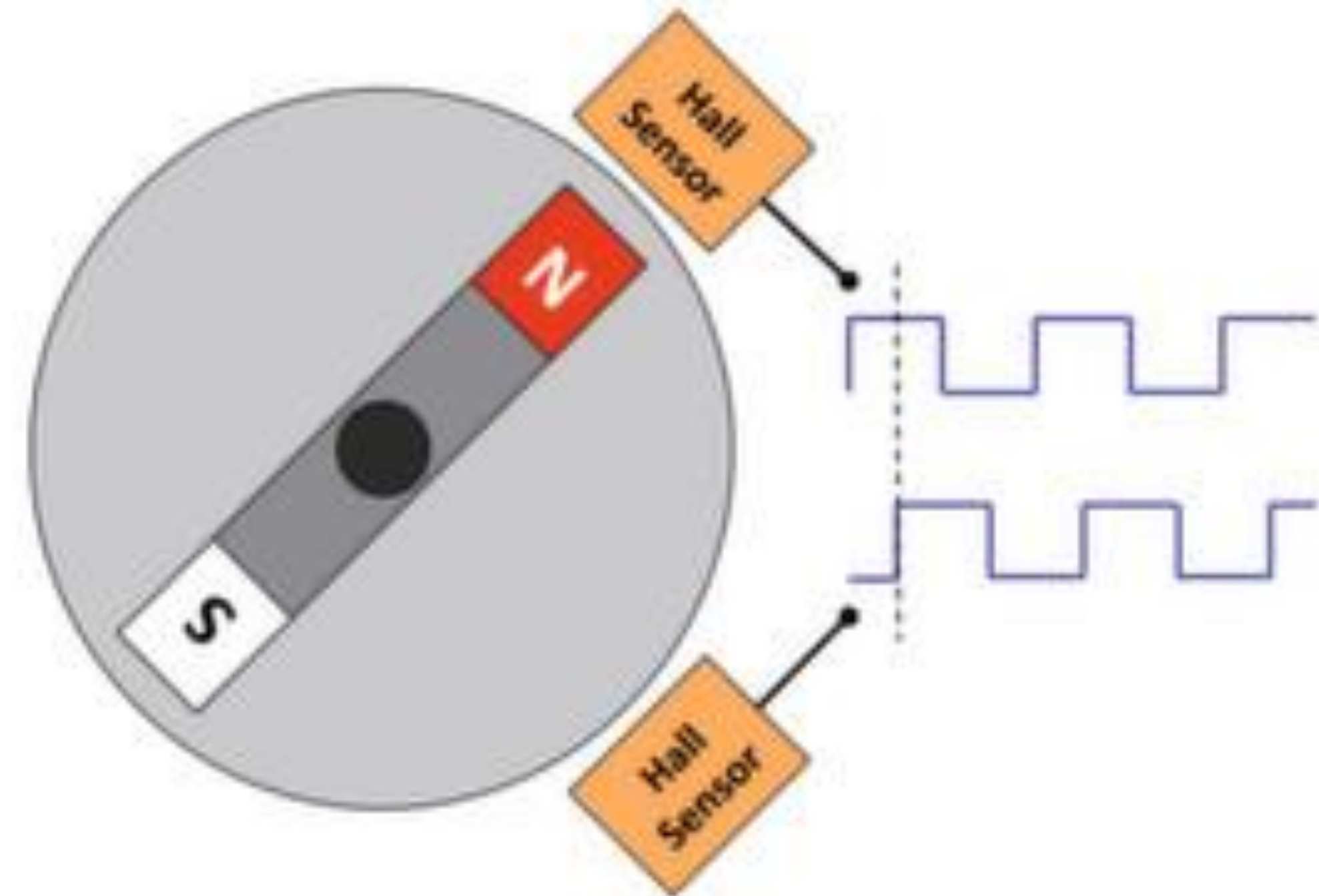
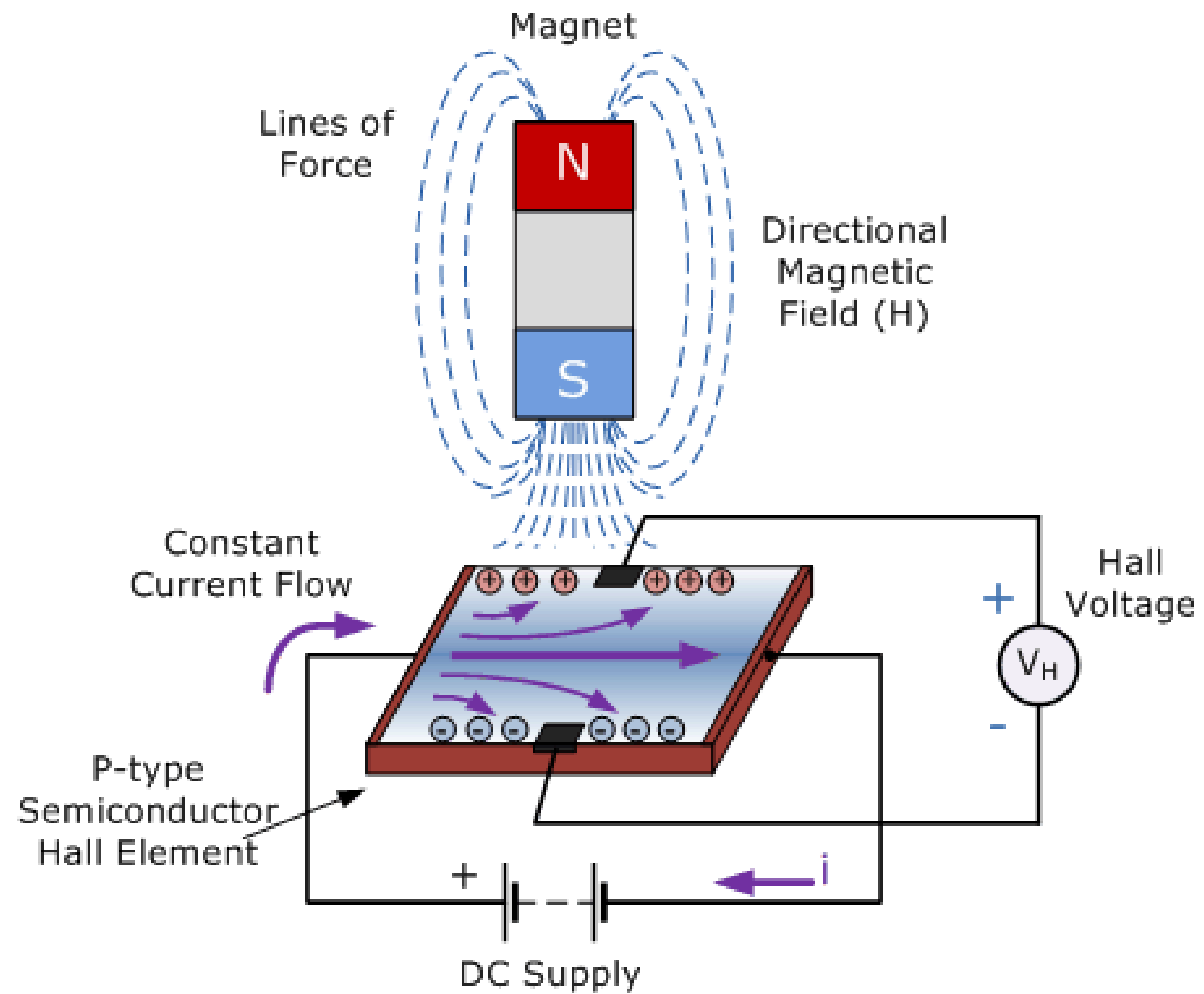
# TYPES OF ROTARY ENCODERS



Incremental Encoder



# TYPES OF ROTARY ENCODERS



Hall / Magnetic Encoder



# AGENDA

MONDAY

October 10, 2016

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☒ Importance of Encoders

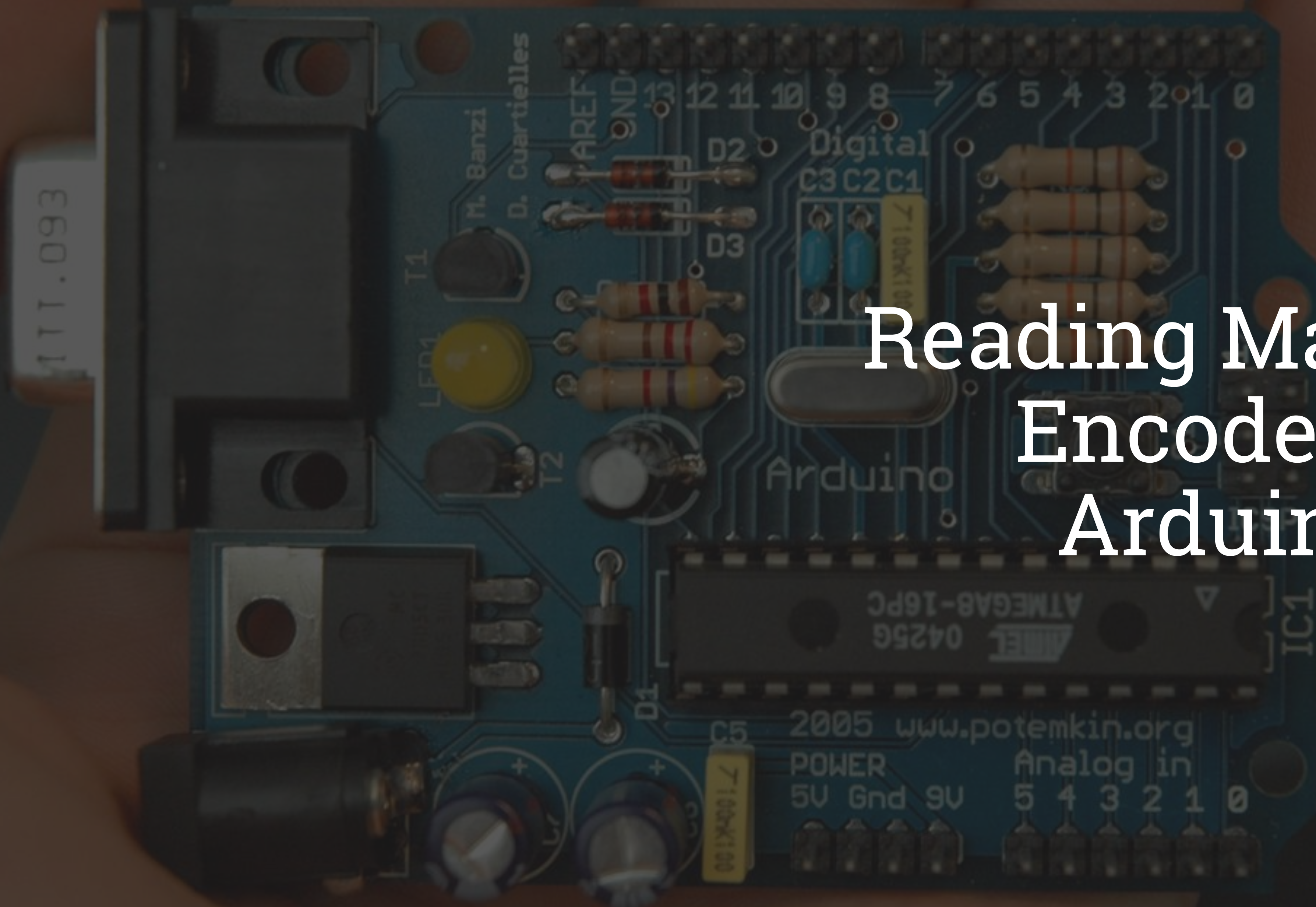
☒ Types of Encoders

☒ Reading 2-Channels Magnetic Encoder

**let's get into code**

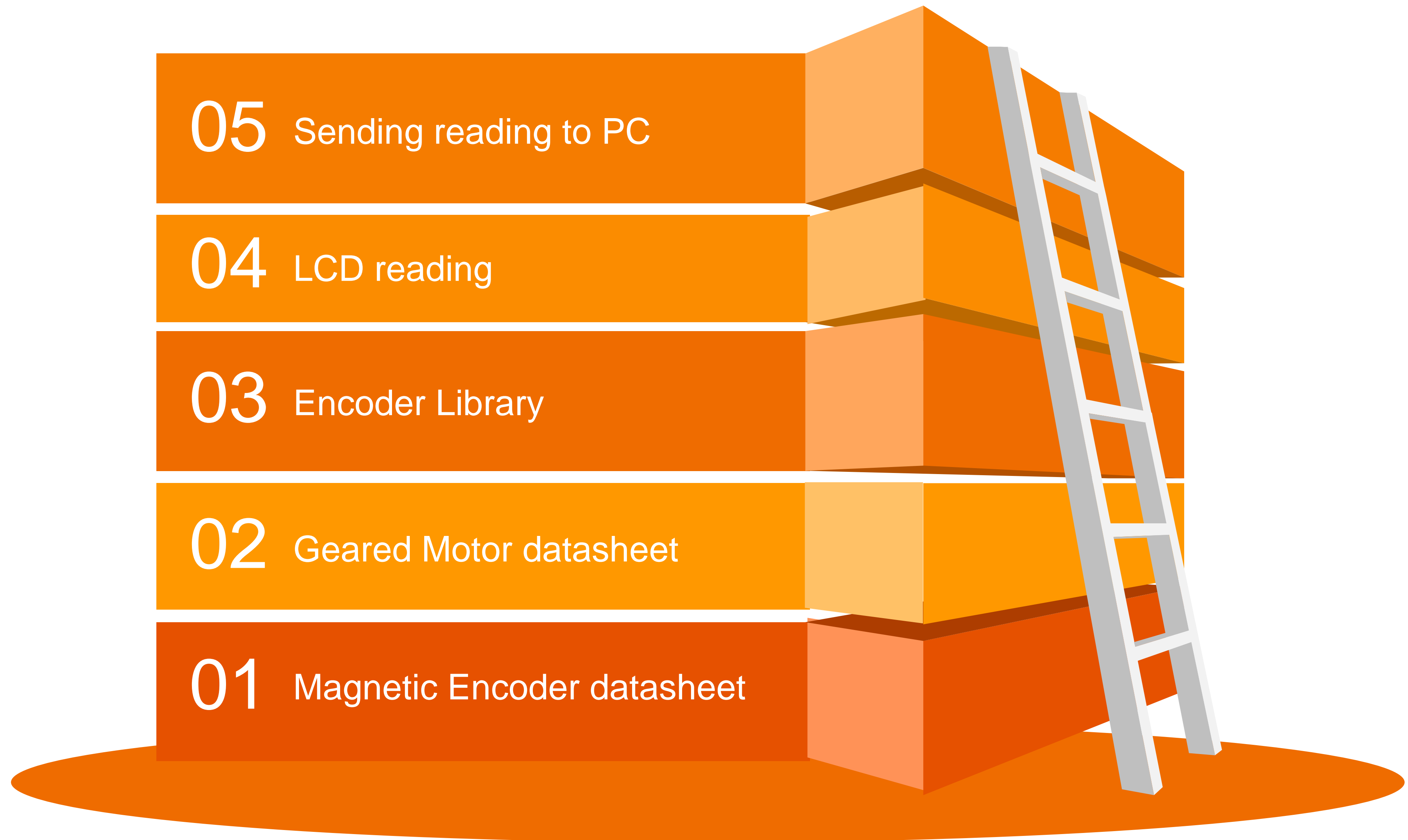


# Reading Magnetic Encoder using Arduino UNO

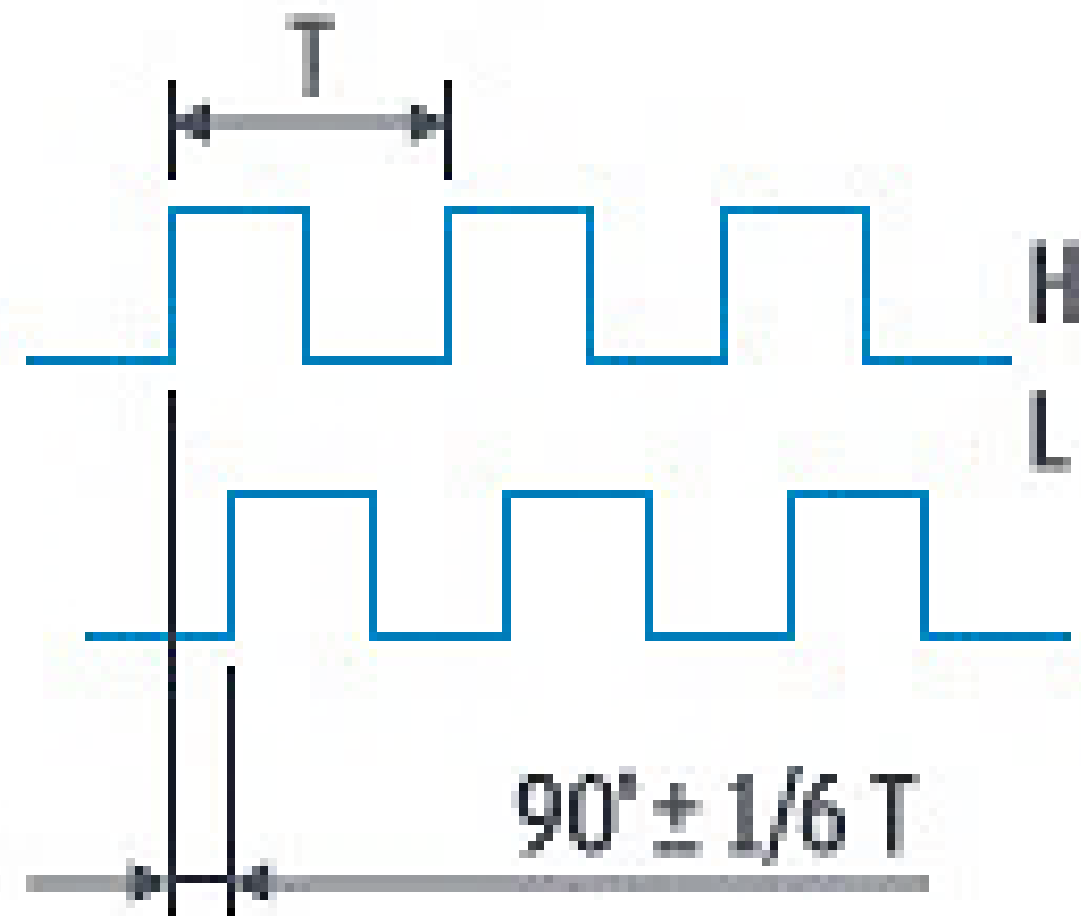




# LEARNING PLAN



# MAGNETIC ENCODER



## Two Channel Encoder Connections

1. Black : - Motor
2. Red : + Motor
3. Brown : Hall Sensor Vcc
4. Green : Hall Sensor GND
5. Blue : Hall Sensor A Vout
6. Purple : Hall Sensor B Vout

## Magnetic Encoder

- 3.3 V – 20 V
- 2-Channels
- 6 poles

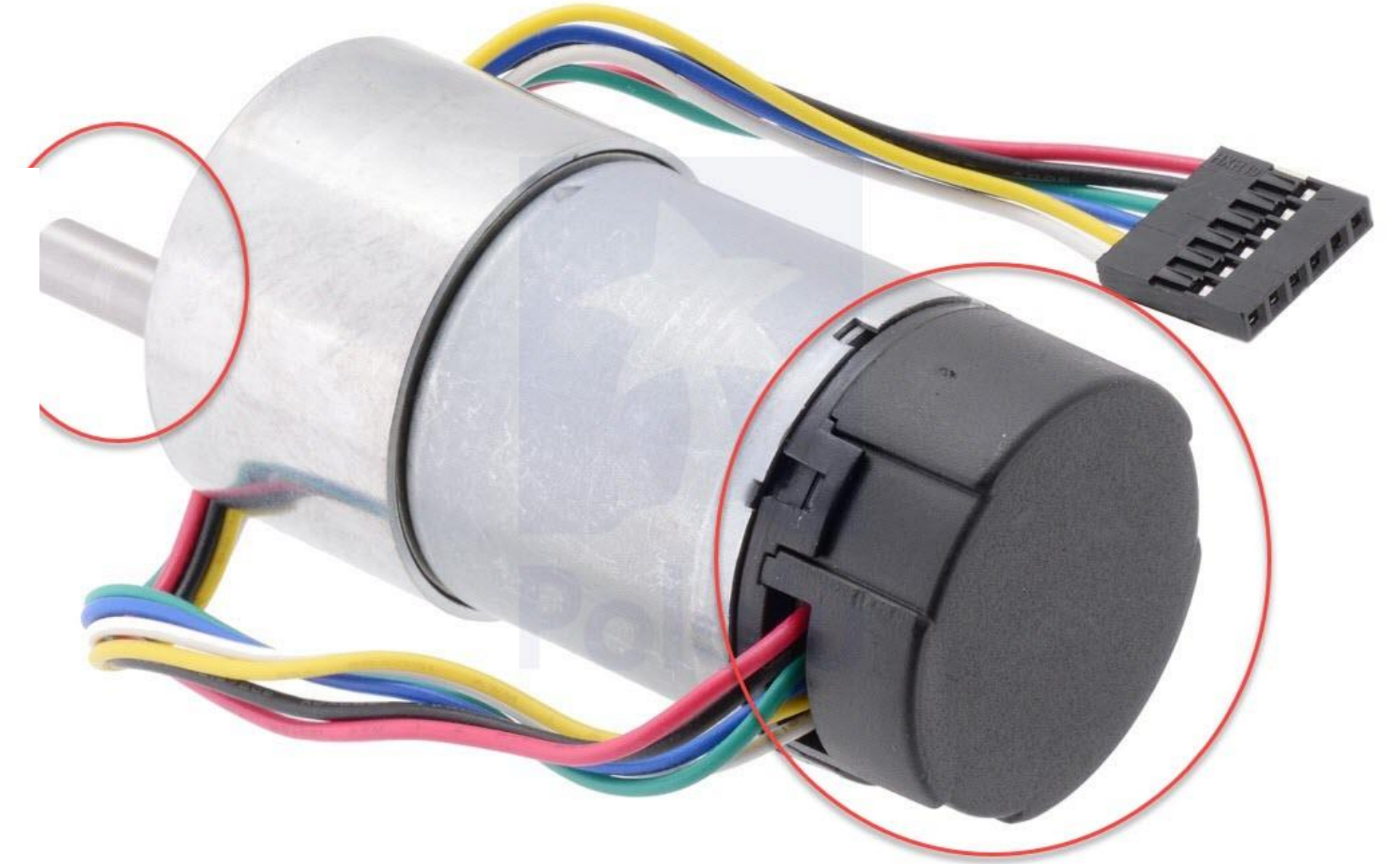
What's the number of pulses per revolution / channel?

Can we increase the encoder resolution? XOR?



# GEARED DC MOTOR

3. Mechanical characteristic	
3.1 Reduction ratio	1/19.225



## Advantages of Gear Reduction

- Boosting torque.
- Enhancing encoder resolution

*Resolution ?*

$$\text{Encoder (PPR)} = 6 (\text{poles}) \times 2 (\text{channels}) \times 19 \text{ Reduction Ratio}$$

*Encoder (PPR)  $\cong$  231*

*Error theoretical and practical?*

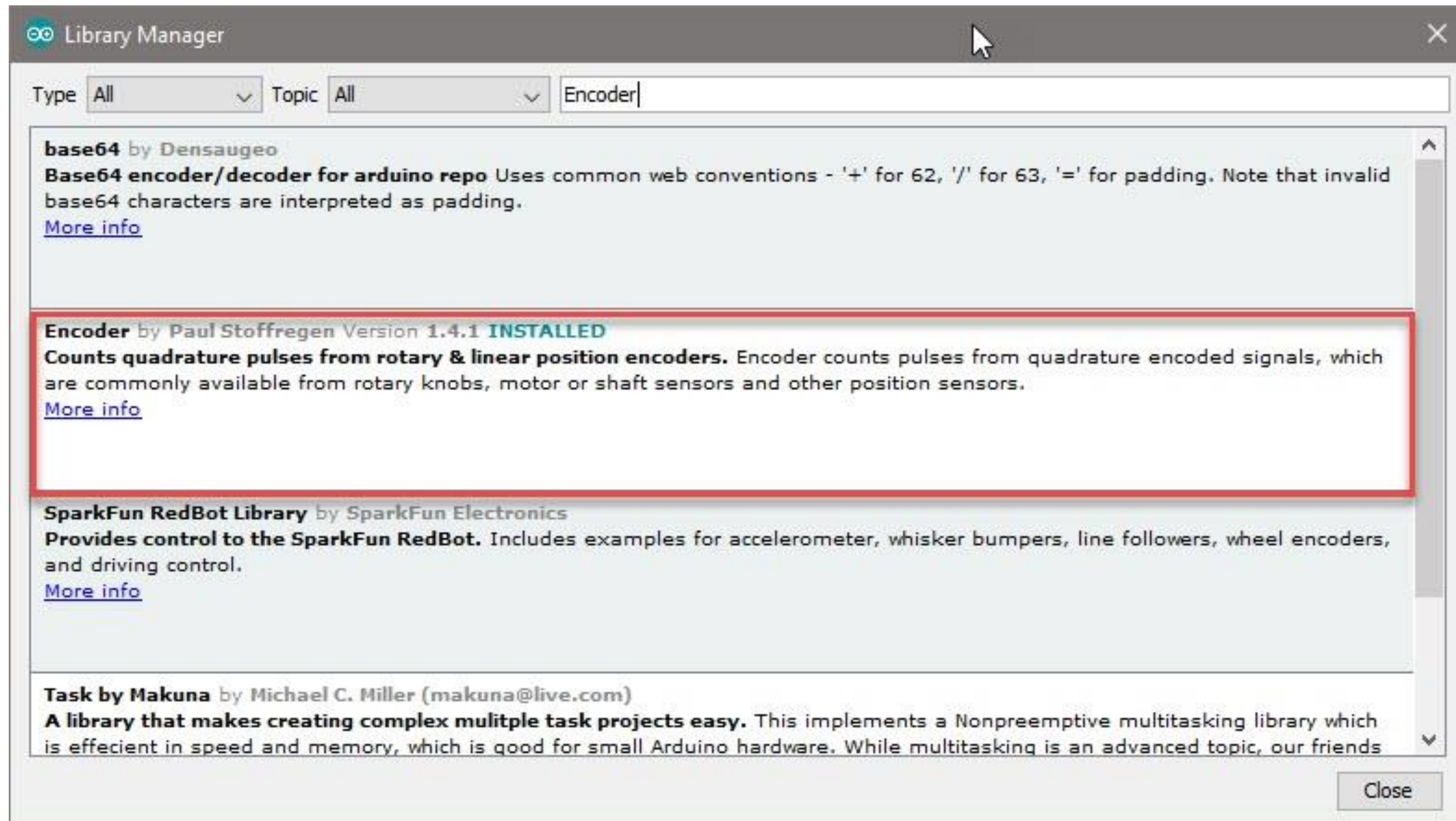




# ARDUINO ENCODER LIBRARY



# ARDUINO ENCODER LIBRARY





# ARDUINO ENCODER COMMANDS

```
#include <Encoder.h>
```

Encoder library

```
const int encaPin=2;  
const int encbPin=3;
```

encoder channels on  
interrupt pins. **why?**

Create encoder object

```
Encoder myEnc(encbPin, encaPin); // for high performance  
void setup()
```



# ARDUINO ENCODER COMMANDS

```
void loop()
```

```
{
```

```
int newPosition = myEnc.read(); // Reading encoder position
```

```
myEnc.write(0);
```

Reset counter after each  
revolution

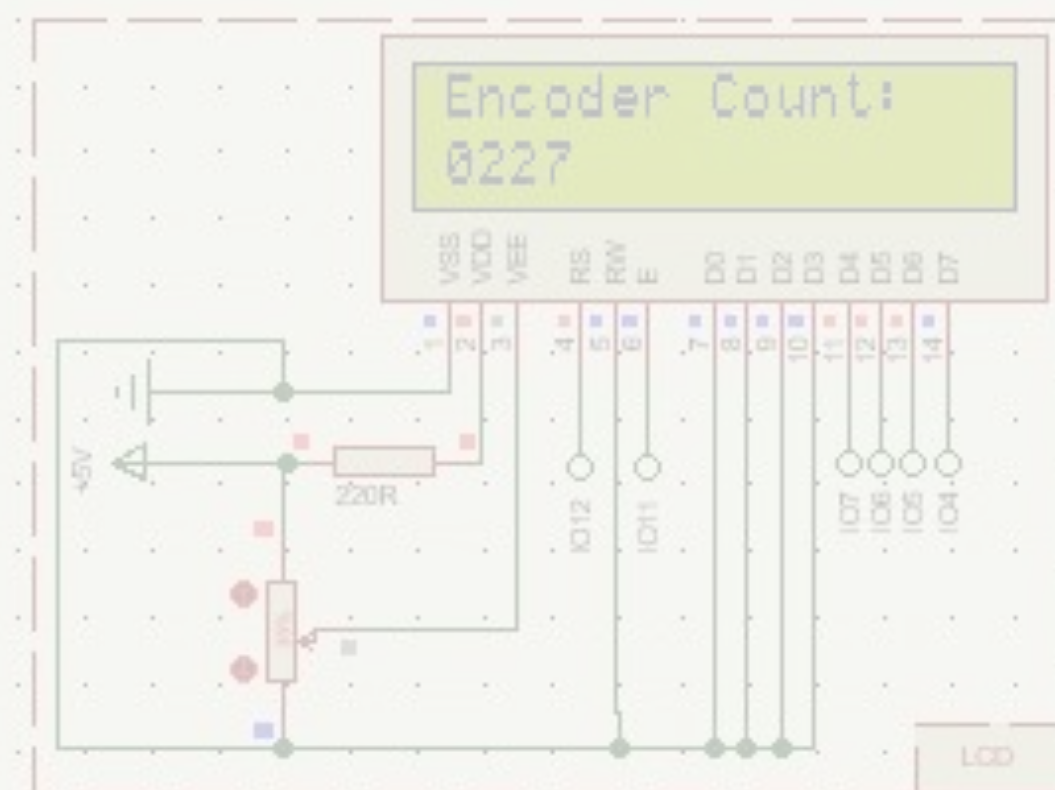
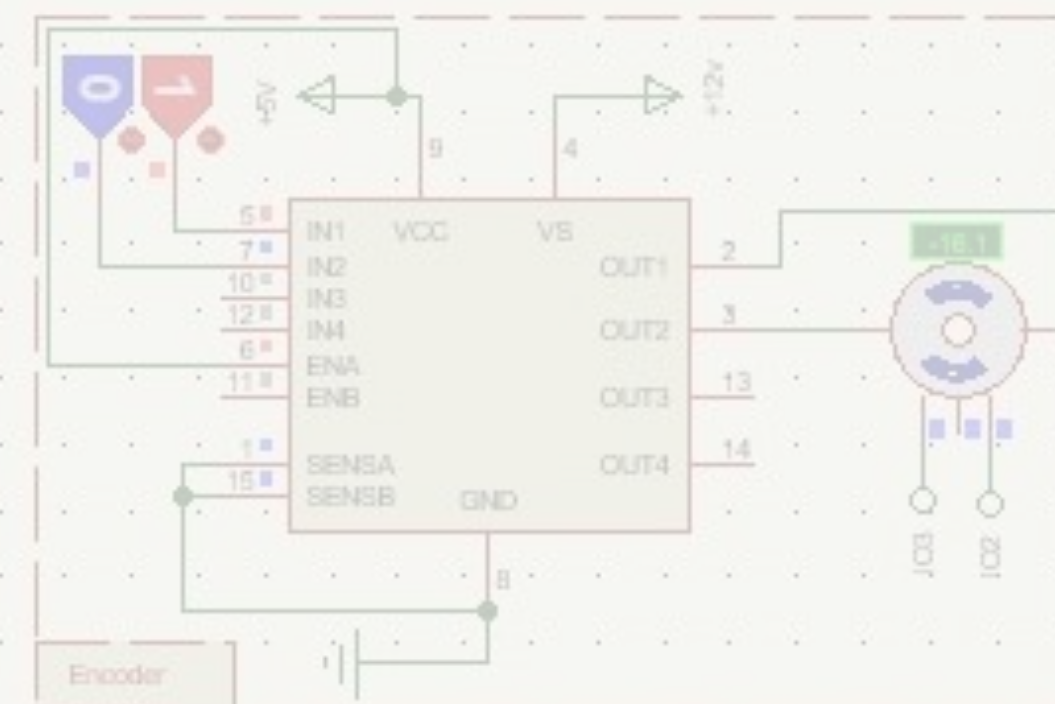
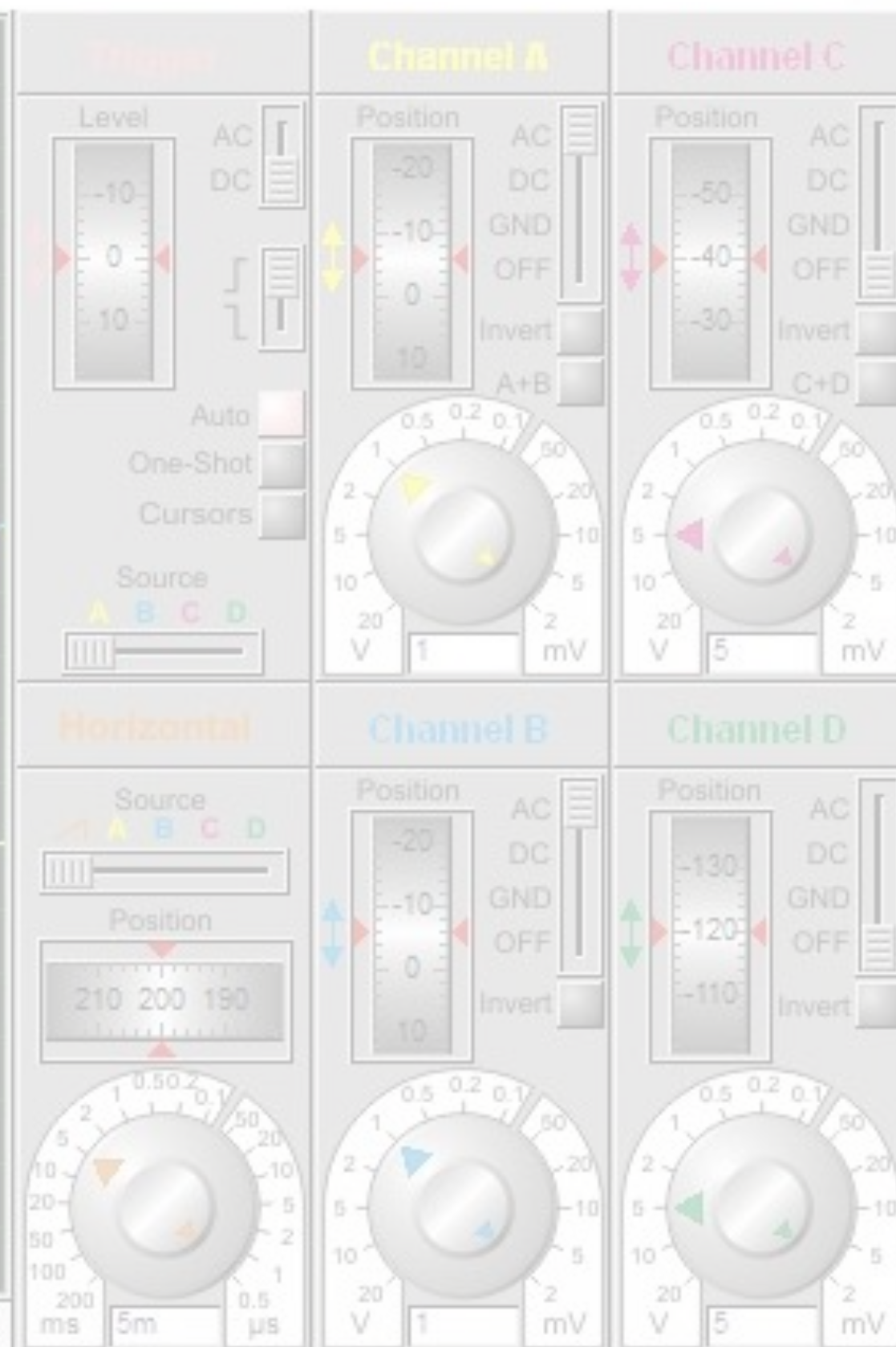
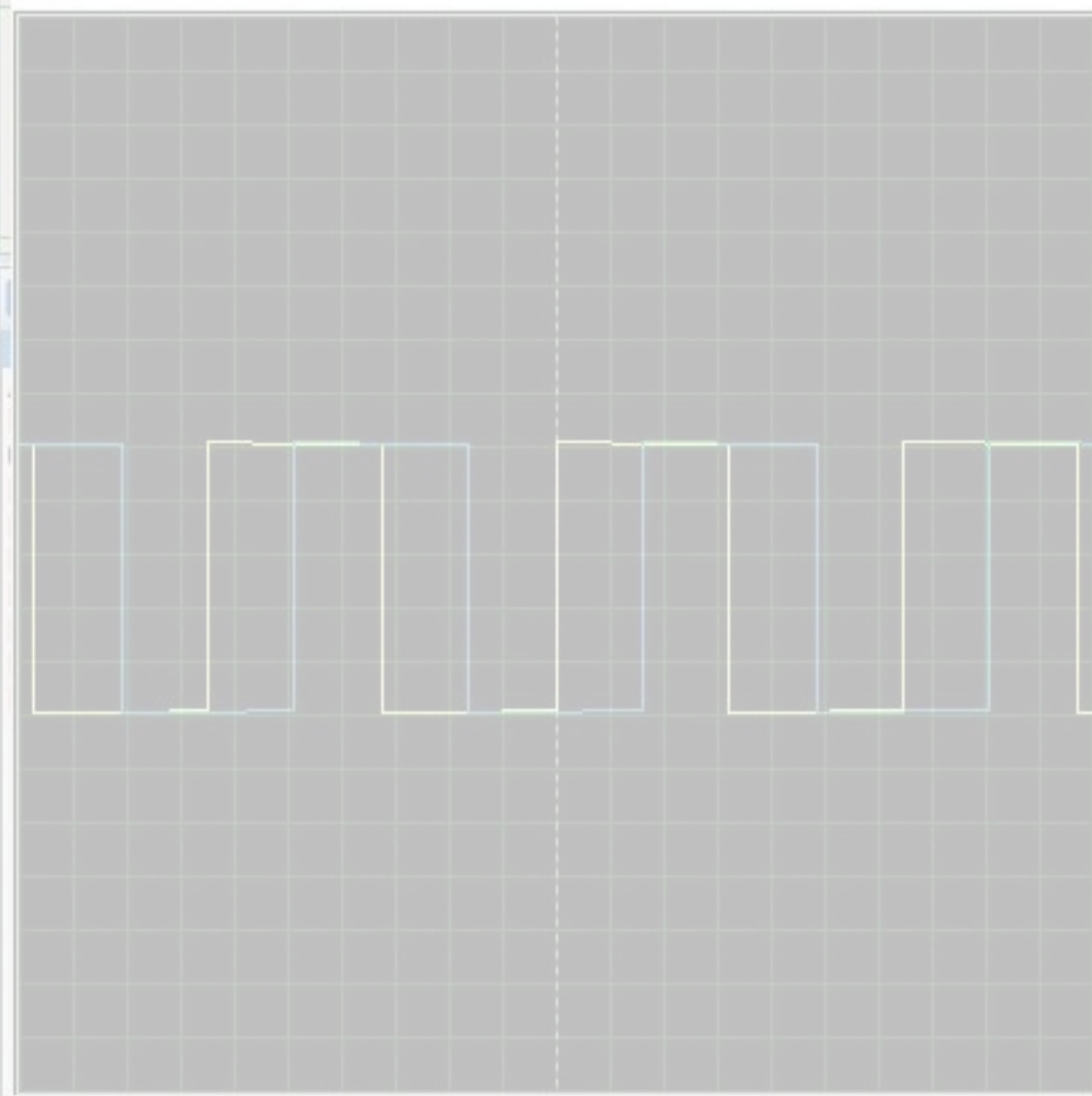
Read encoder count  
(counter running in background)  
(ISR)

```
}
```





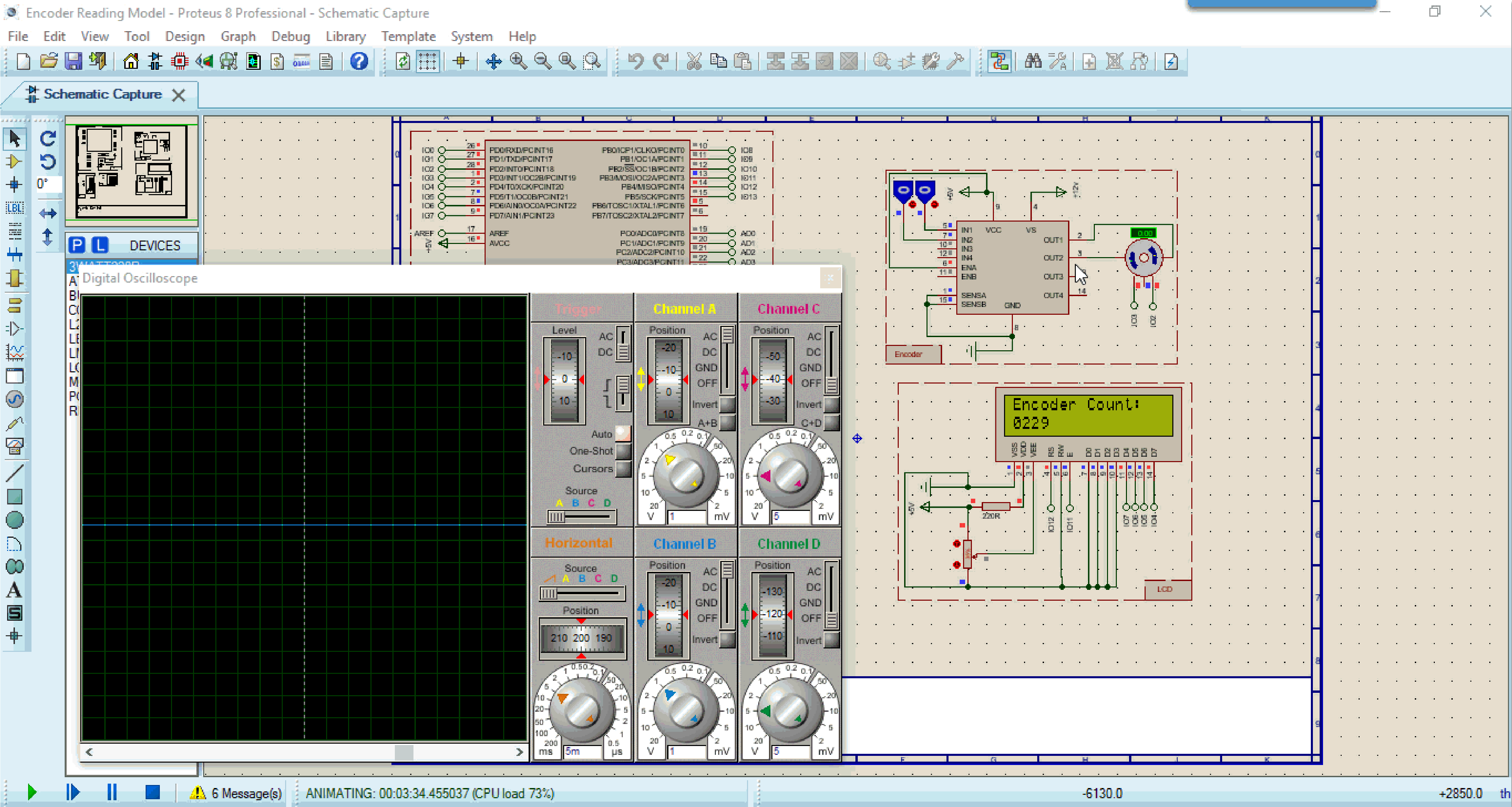
# SEE IT IN ACTION



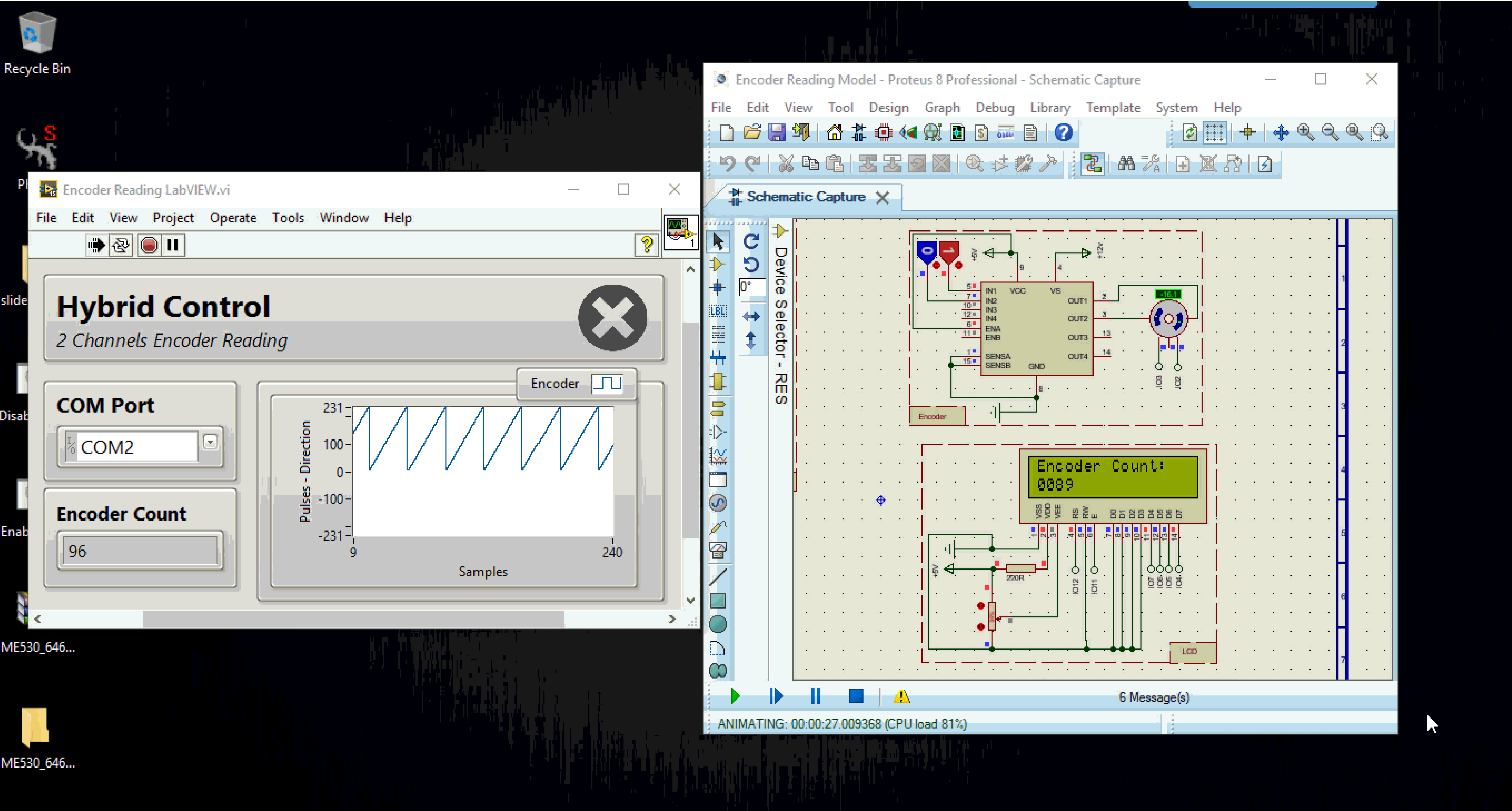
Hybrid Control  
Reading Optical Encoder



# ENCODER READING EMBEDDED



# Data Streaming to Another Device (PC)

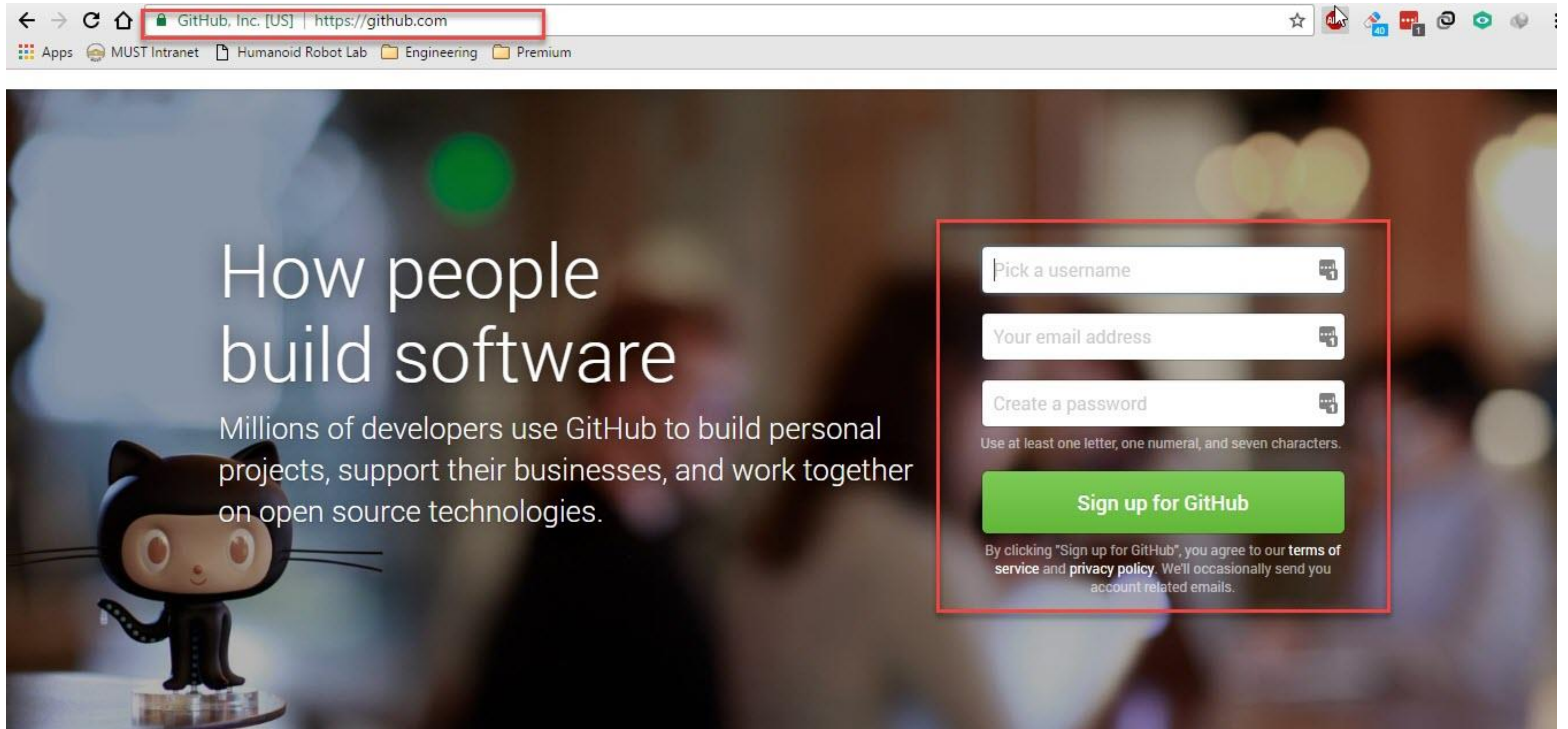




Getting Lab Files

**github**  
**SOCIAL CODING**

# Create GitHub account



The image is a screenshot of a web browser displaying the GitHub sign-up page. The browser's address bar shows the URL 'https://github.com' and the page title 'GitHub, Inc. [US]'. Below the address bar, there are several tabs: 'Apps', 'MUST Intranet', 'Humanoid Robot Lab', 'Engineering', and 'Premium'. The main content area features a large heading 'How people build software' and a subheading 'Millions of developers use GitHub to build personal projects, support their businesses, and work together on open source technologies.' To the left of the text is a small image of the GitHub mascot, Octocat. On the right side, there is a sign-up form with three input fields: 'Pick a username', 'Your email address', and 'Create a password'. Below these fields is a green button labeled 'Sign up for GitHub'. At the bottom of the form, there is a disclaimer: 'By clicking "Sign up for GitHub", you agree to our terms of service and privacy policy. We'll occasionally send you account related emails.'

← → ↻ 🏠 GitHub, Inc. [US] | https://github.com ☆ 40 1

Apps MUST Intranet Humanoid Robot Lab Engineering Premium

## How people build software

Millions of developers use GitHub to build personal projects, support their businesses, and work together on open source technologies.

Pick a username

Your email address

Create a password

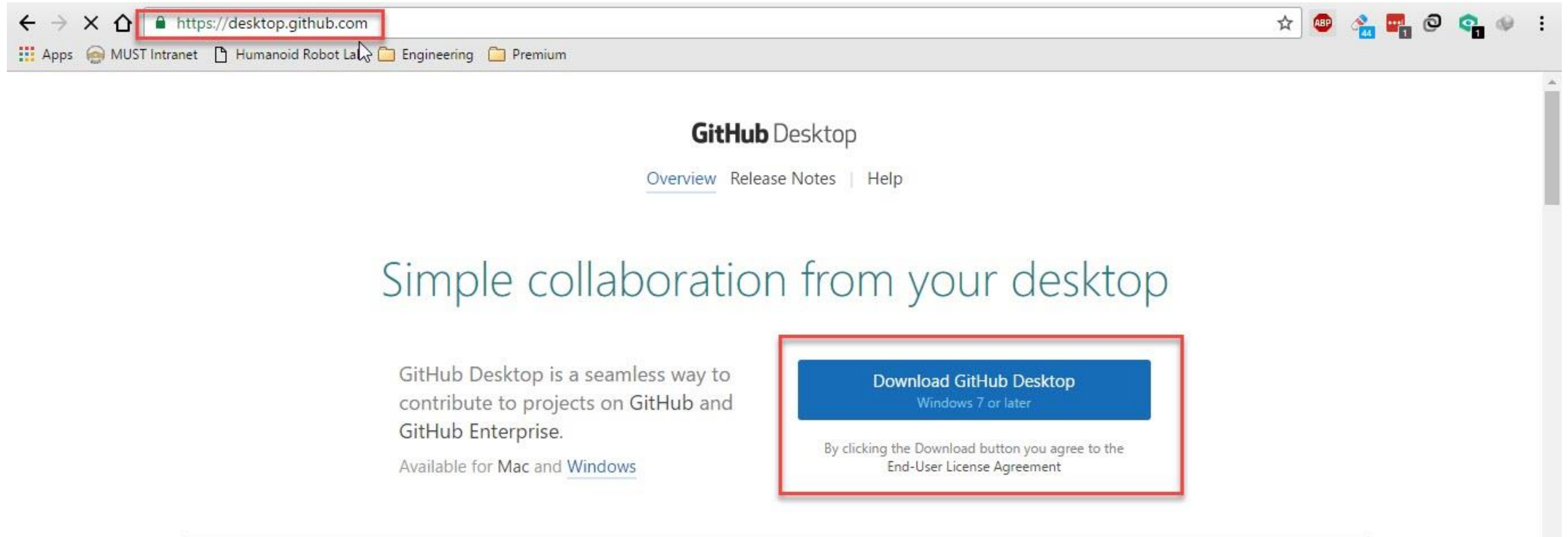
Use at least one letter, one numeral, and seven characters.

**Sign up for GitHub**

By clicking "Sign up for GitHub", you agree to our **terms of service** and **privacy policy**. We'll occasionally send you account related emails.



# DOWNLOAD GITHUB DESKTOP



# GO TO

## <https://github.com/wbadry/MCT432-Hybrid-Control>

The screenshot shows the GitHub repository page for `wbadry / MCT432-Hybrid-Control`. The page is annotated with three red circles and numbers:

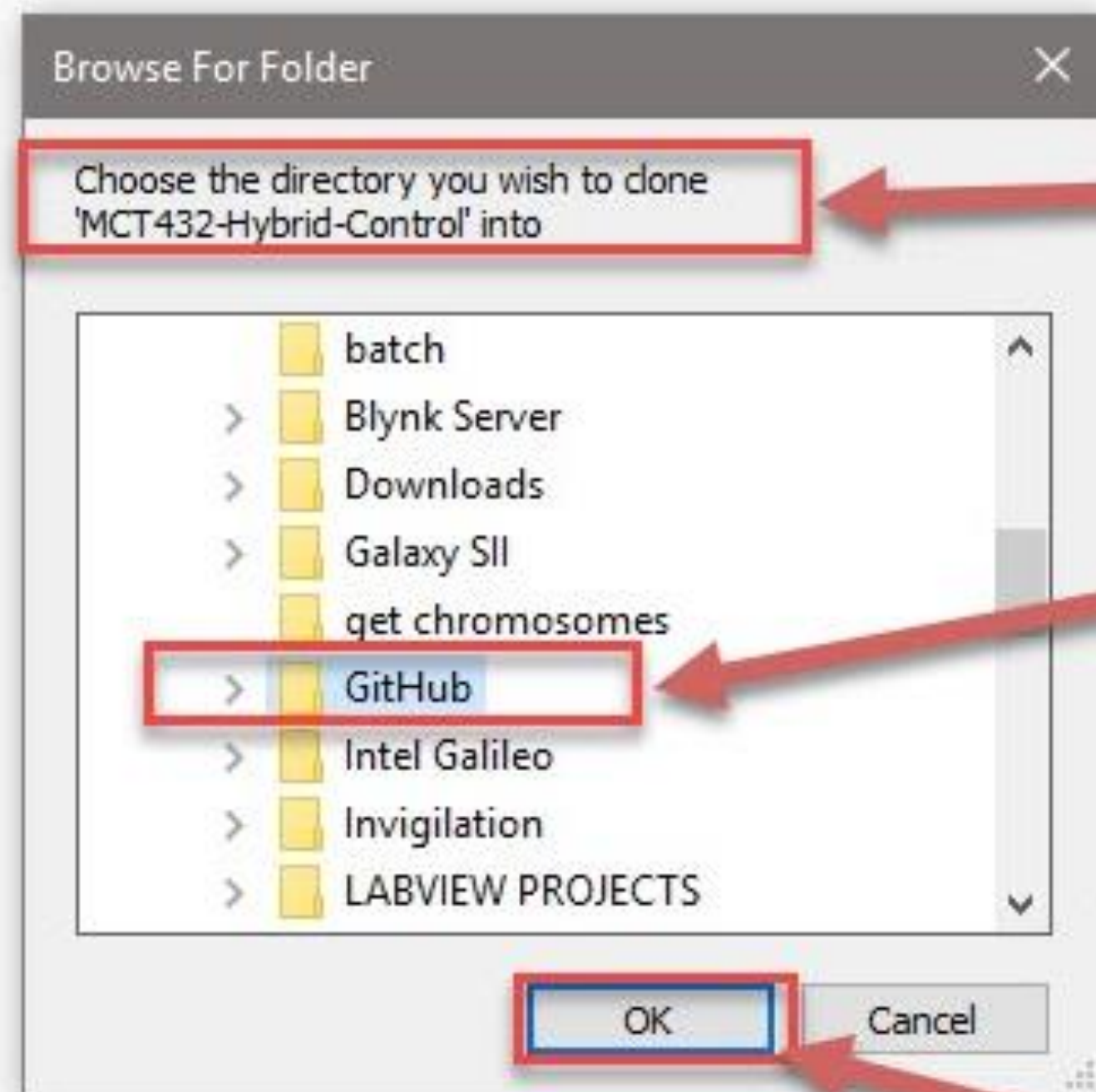
- 1**: Points to the browser's address bar, which contains the URL `https://github.com/wbadry/MCT432-Hybrid-Control`.
- 2**: Points to the **Clone or download** button in the repository header.
- 3**: Points to the **Open in Desktop** button in the dropdown menu that appears after clicking the **Clone or download** button.

The repository page displays the following information:

- Repository name: `wbadry / MCT432-Hybrid-Control` (Private)
- Unwatch: 1, Star: 0, Fork: 0
- Code, Issues (0), Pull requests (0), Projects (0), Wiki, Pulse, Graphs, Settings
- Repository description: `Repository for lab presentations and exercises — Edit`
- 2 commits, 1 branch, 0 releases, 1 contributor
- Branch: master, New pull request
- Create new file, Upload files, Find file, Clone or download
- Clone with HTTPS (selected), Use SSH
- Use Git or checkout with SVN using the web URL.
- URL: `https://github.com/wbadry/MCT432-Hybrid-Co`
- Open in Desktop (selected), Open in Visual Studio, Download ZIP
- Commit history: wbadry committed on GitHub Update README.md
- Files: README.md (Update README.md)
- Repository title: `MCT432-Hybrid-Control`
- Repository description: `Repository for lab presentations and exercises`



# SAVE IT ON YOUR LOCAL FOLDER



Cloned repository

Local folder

Repository selected

Click "OK"

# SYNC TO GET NEW FILES

The screenshot shows the GitHub web interface for the repository 'MCT432-Hybrid-Control'. The repository is selected in the left sidebar. The main content area shows the 'master' branch with a commit history. The 'Sync' button is highlighted with a red box and a red arrow. A red text box with a white border contains the text 'Click to update when new contents are available'.

Filter repositories

- blynk-server
- CircularProgressBar
- LabVIEW-Courseware
- MATLAB-Control
- MCT-371-Automatic-Control
- MCT432-Hybrid-Control**
- MTE504-Mechatronics-II
- Project-NAO-Control
- SimpleTimer

master

Compare

Update README.md  
4 hours ago by Waleed El-Badry

Initial commit  
4 hours ago by Waleed El-Badry

Update README.md  
Waleed El-Badry 630a6ac

GitHub Revert Collapse all

▼ README.md

...	...	@@ -1,2 +1,5 @@
1	1	# MCT432-Hybrid-Control
2	2	Repository for lab presentations and exercises
	3	+
	4	+ # 10-October-2016
	5	+ Lab 1 was added with Proteus, LabVIEW and Arduino files for reading 2 channels encoder.

Click to update when new contents are available



# COURSE INTERACTIVITY

The screenshot shows a web browser window displaying the GitHub repository page for 'wbadry / MCT432-Hybrid-Control'. The browser's address bar shows the URL 'https://github.com/wbadry/MCT432-Hybrid-Control/issues'. The repository name 'wbadry / MCT432-Hybrid-Control' is highlighted with a red box, and the 'Private' label is visible next to it. The 'Issues' tab is selected, and the 'New issue' button is highlighted with a red box. The main content area displays a message: 'For inquiries about course issue or inquiry, open new issue' in red text with a shadow effect, followed by a 'Welcome to Issues!' heading and a paragraph explaining the purpose of issues. The browser's taskbar at the bottom shows the file '2000px-GitHub.svg.png' and a 'Show all' button.

GitHub, Inc. [US] | <https://github.com/wbadry/MCT432-Hybrid-Control/issues>

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This repository Search Pull requests Issues Gist

wbadry / MCT432-Hybrid-Control Private

Unwatch 1 Star 0 Fork 0

Code Issues 0 Pull requests 0 Projects 0 Wiki Pulse Graphs Settings

Filters is:issue is:open Labels Milestones New issue

**For inquiries about course issue or inquiry,  
open new issue**

**Welcome to Issues!**

Issues are used to track todos, bugs, feature requests, and more. As issues are created, they'll appear here in a searchable and filterable list. To get started, you should [create an issue](#).

2000px-GitHub.svg.png Show all

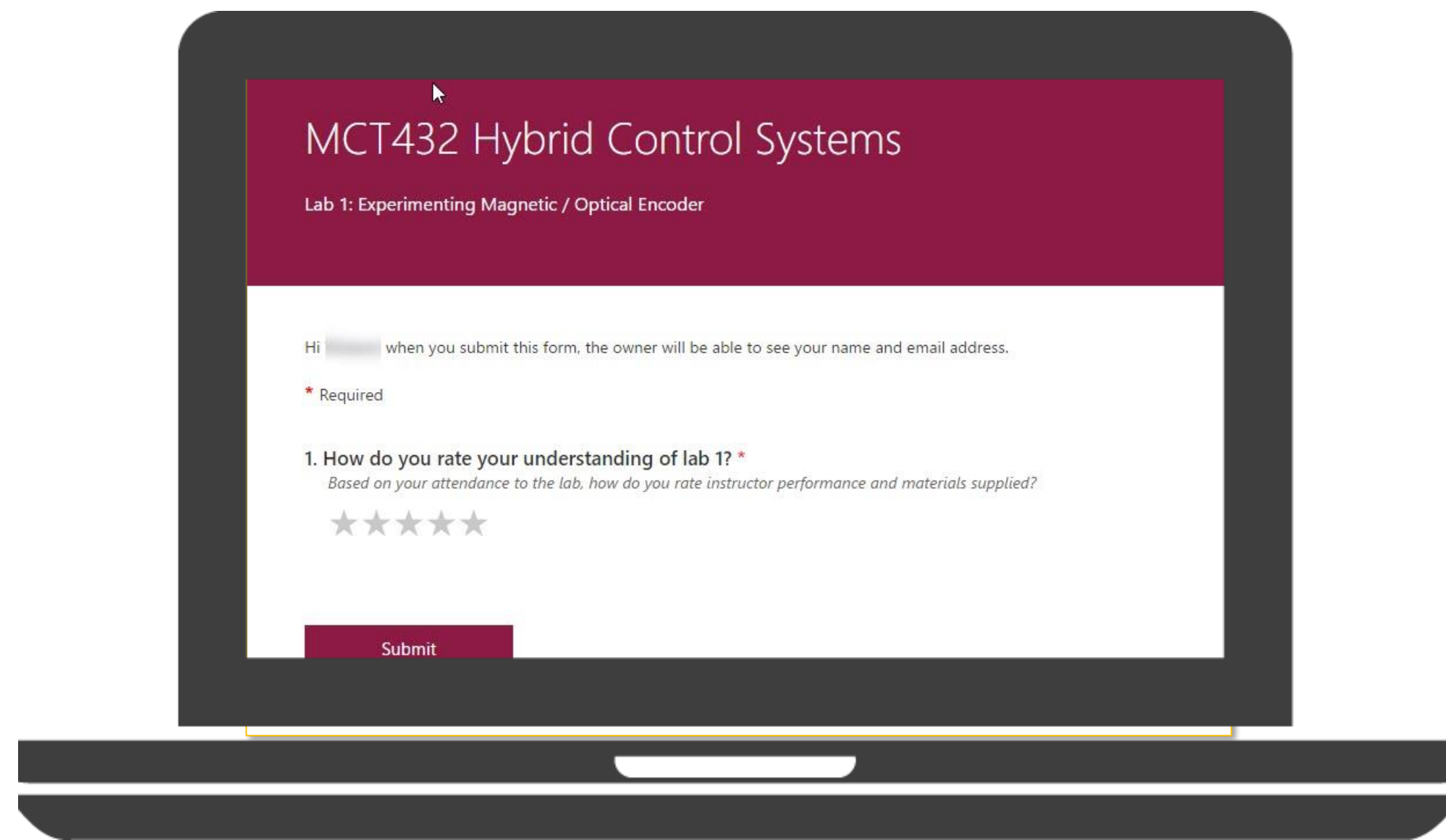


A person's hands are holding a white rectangular sign. The sign has the text "YOUR FEEDBACK MATTERS!" written in a bold, dark red, sans-serif font. The background is a blurred bokeh of various colors, including red, orange, green, and blue.

**YOUR  
FEEDBACK  
MATTERS!**



# YOUR OPINION MATTERS



LINK to rate lab 1

<https://goo.gl/H5n8BY>

THANK YOU

