

# Overview of Experimental Physics 1

## CEPE: Centre for Experimental Physics Education



Centre for  
Experimental Physics  
Education (CEPE)

Presented by:

Dr. **Muhammad Sabieh Anwar**  
Associate Professor Physics, LUMS

<http://physlab.lums.edu.pk>

# Philosophy of PHY 100

- Are lab courses hand maiden to the “theory” courses or do they have a life of their own?
- Simulations or real experiments
- Virtual or remote experiments

## The main opportunities

- Learn lots of new physics from different areas
- Extract ideas for research, fuelling “mainstream” physics research
- Avoiding excessive compartmentalization of scientific knowledge



# Components of PHY 100

- ◉ Eight classroom lectures
- ◉ Computer workshops on data processing
- ◉ Practice problems
- ◉ Pre-designed laboratory experiments
- ◉ Physics studio and exhibition

# An irresistible quote

“This Chapter is intended to introduce the reader to the peculiar fascination of collecting and examining facts, the kind of facts that are called the data of science. At first glance the man who peers for long, long hours through a telescope at the stars, who gets stiff and cold and often discouraged trying to get a few better observations than actual circumstances at the moment permit, such a man will seem a “peculiar” sort of fellow. In general, the kinds of observation that a physicist makes, measuring little marks or the spot of light on a scale controller by an electric meter, or, nowadays, the pages and pages of numbers typed out for him by a machine, all these seem abstruse and forbidding to the casual eye.”

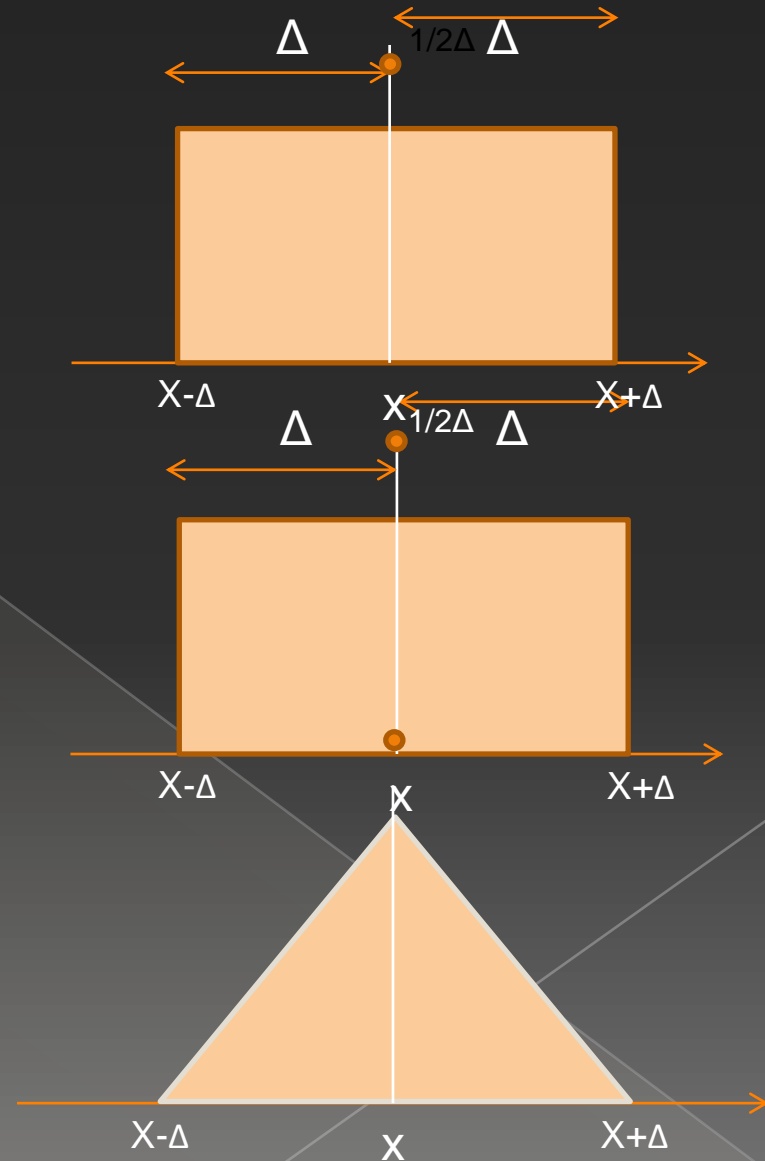
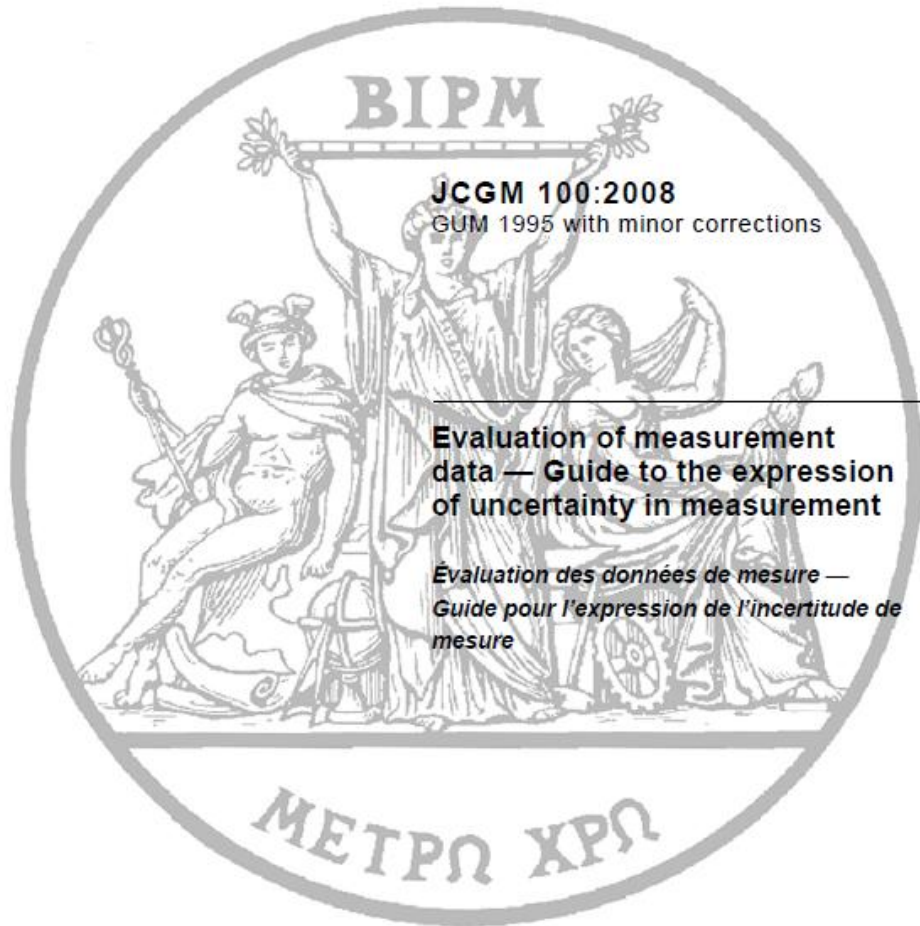
- Francis Bitter *Mathematical Aspects of Physics: An Introduction* (Anchor Books, New York 1963)

# An irresistible quote (contd.)

- “ To tell the truth, there are times when this or any kind of work seems dull, exhausting, even fruitless. When, after days of trying, you still can't find the leak in the vacuum system, or when, after you patiently have fitted an elaborate piece of apparatus together, an oscilloscope suddenly picks up a lot of meaningless “noise” from some unknown source, or when you have been working all days and all night on a series of measurements that must from some reason be completed at once, then of course the work is unattractive. The question to be answered does not concern the nature of such discouragement, but rather why any sane man would choose to be spending his time in the pursuit of experimental physics, even when everything is going just right, his apparatus performing as planned, and he can do his work seated in a comfortable chair.”

- Francis Bitter *Mathematical Aspects of Physics: An Introduction* (Anchor Books, New York 1963)

# Measurement and Uncertainties



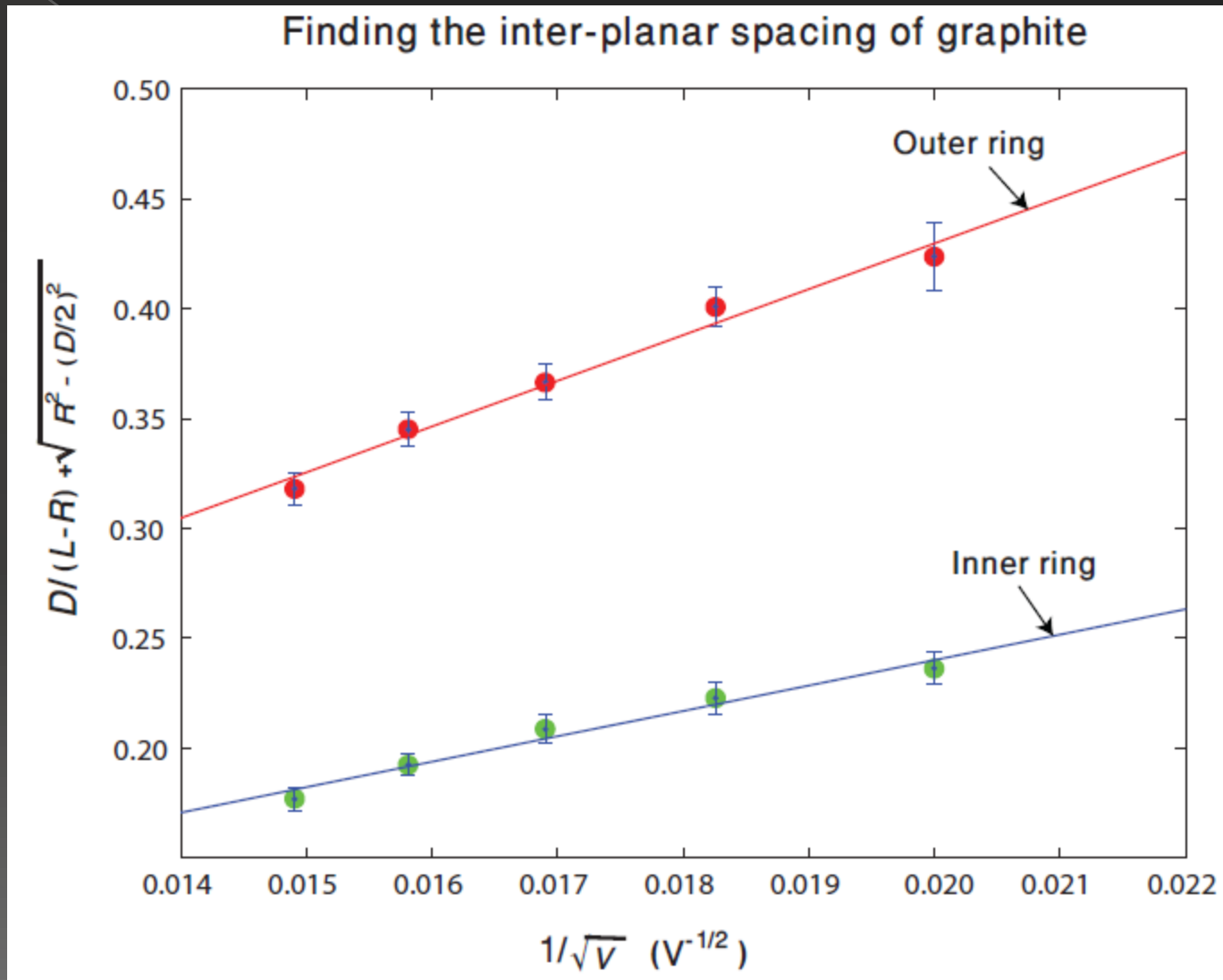


# Data Processing and Analysis

## Data Analysis

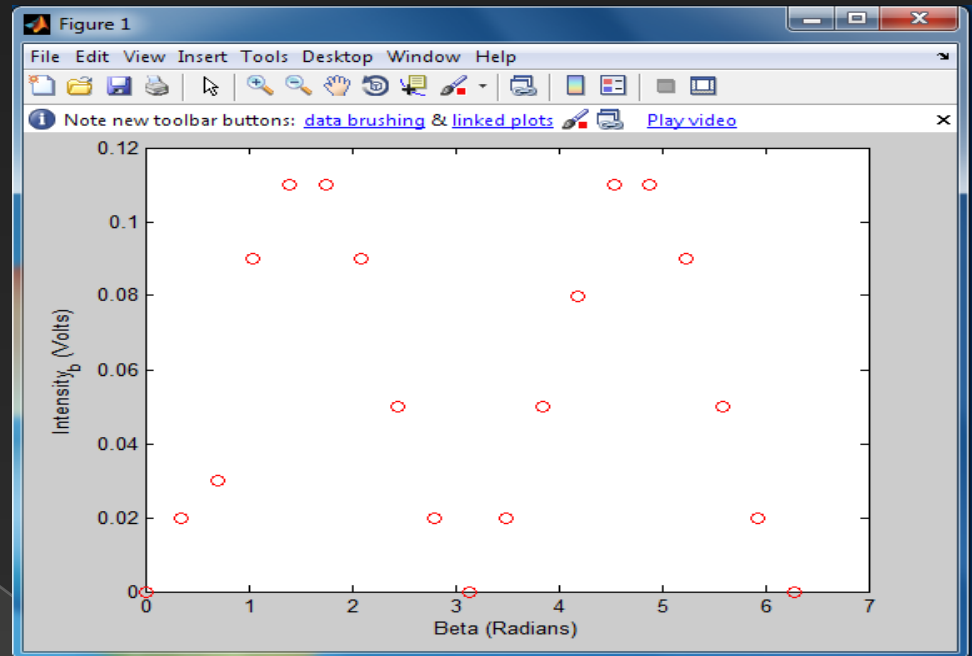
Cycle 'n'	Height (m)	$\Delta h$ (m)	N	$\Delta E$ (J)	$\Delta E_r$ (J)	Wavg (rad/s)	W (rad/sec)
1	0.565						
2	0.532				outlier		
3	0.501	0.033	11.68	0.065	0.0055	6.480	12.960
4	0.474	0.031	5.50	0.062	0.0112	6.295	12.590
5	0.450	0.027	5.21	0.052	0.0100	5.925	11.850
6	0.428	0.024	4.94	0.047	0.0095	5.555	11.110
7	0.409	0.022	4.70	0.043	0.0092	5.370	10.740
8	0.391	0.019	4.49	0.037	0.0083	4.998	9.995
9	0.376	0.018	4.29	0.035	0.0082	4.813	9.625
10	0.362	0.015	4.13	0.029	0.0071	4.628	9.256
11	0.349	0.014	3.98	0.027	0.0069	4.258	8.515
12	0.338	0.013	3.83	0.025	0.0066	4.073	8.145
13	0.327	0.011	3.71	0.022	0.0058	3.702	7.404
14	0.317	0.011	3.59	0.022	0.0060	3.703	7.405
15	0.309	0.010	3.48	0.020	0.0056	3.332	6.663
		0.008	3.39	0.016	0.0046	3.147	6.293

# Accurate Plotting of Data

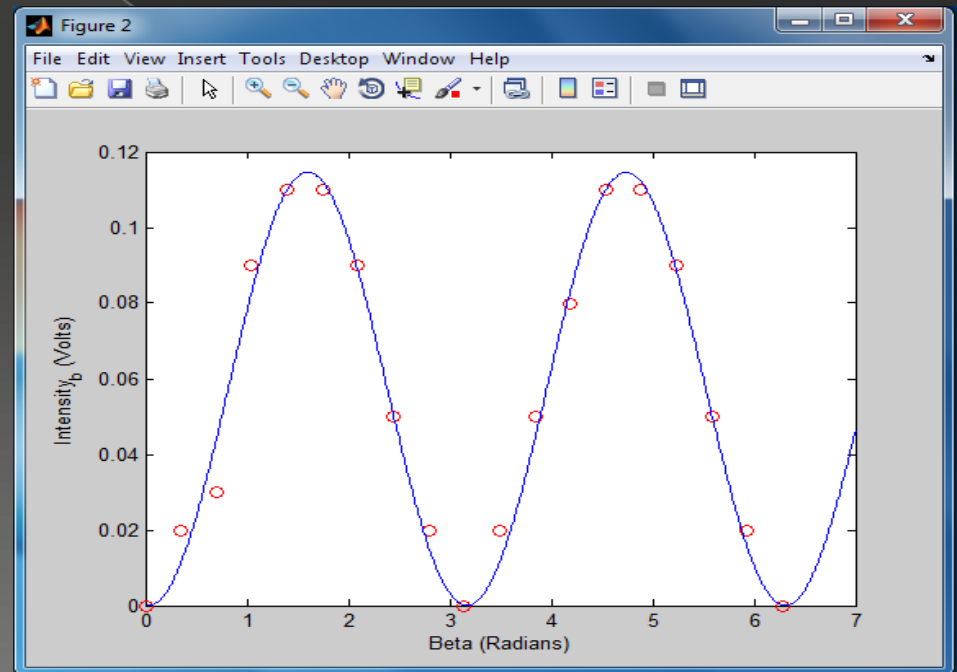




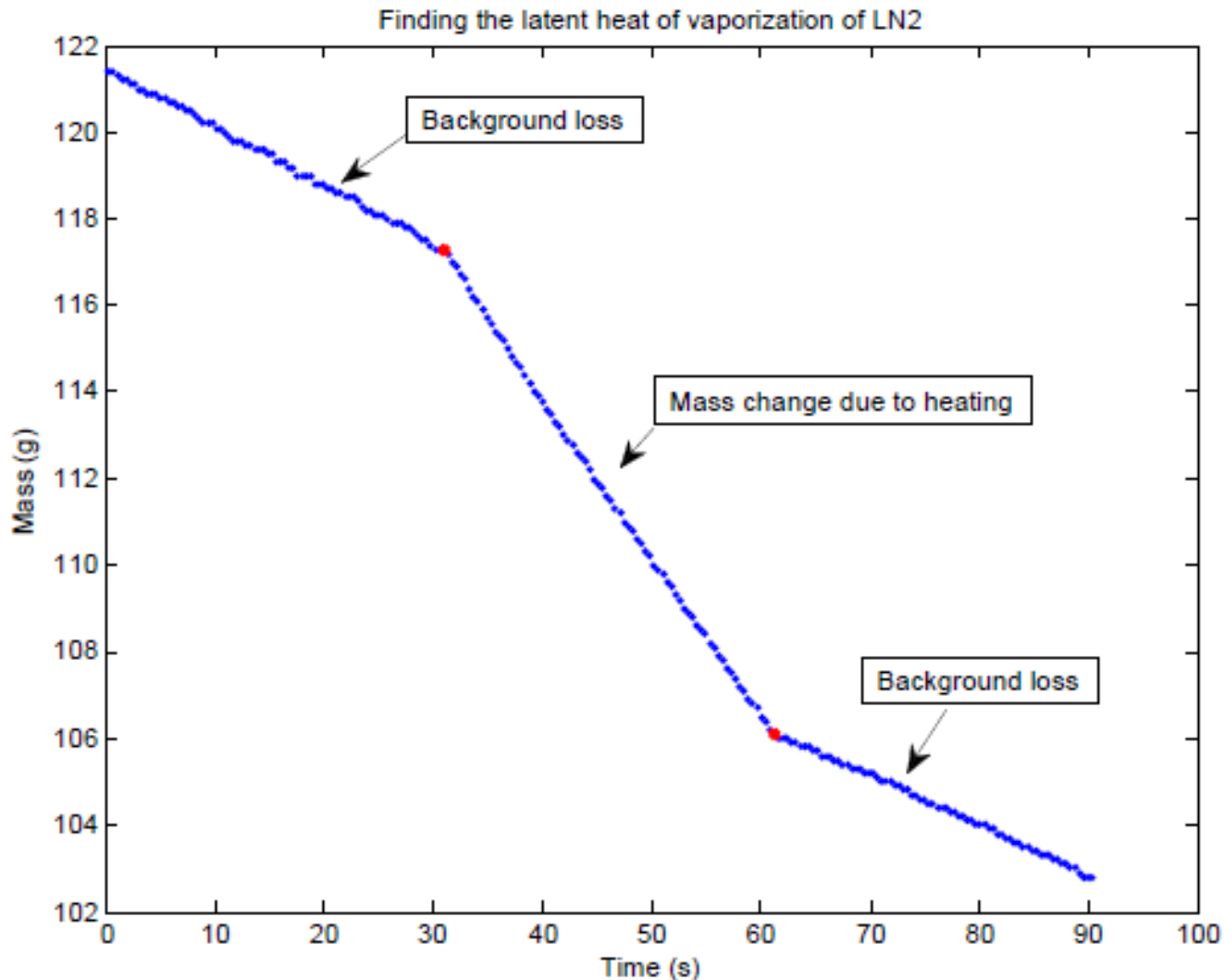
Graphing and plotting.



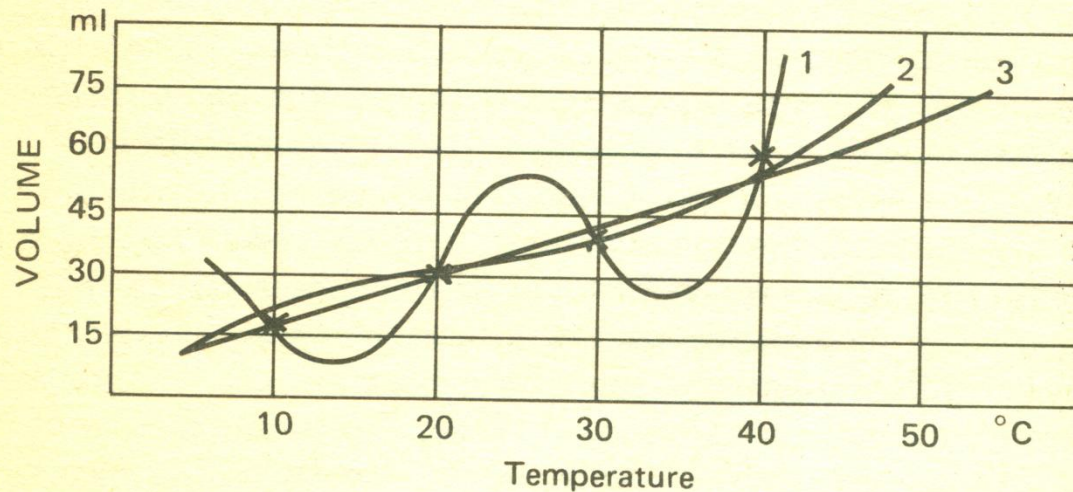
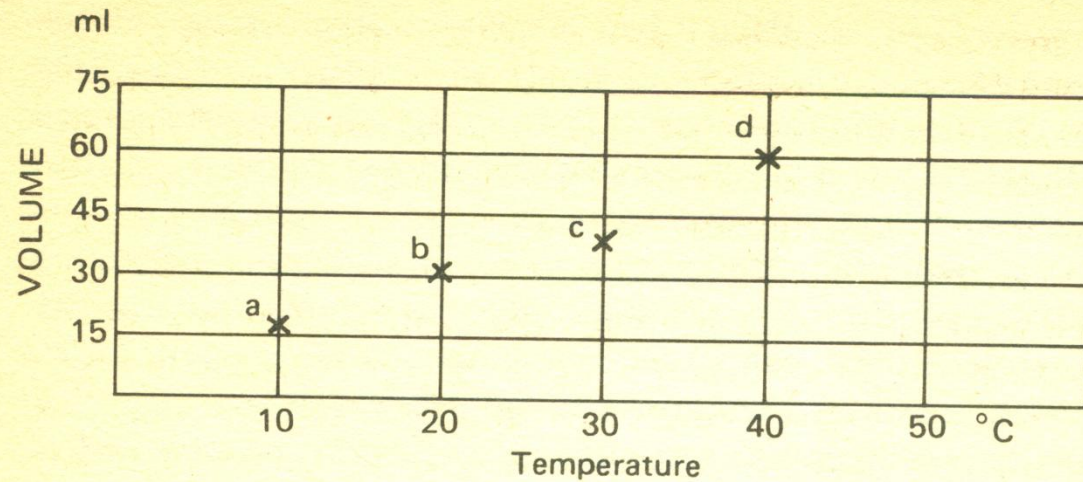
Curve fitting.



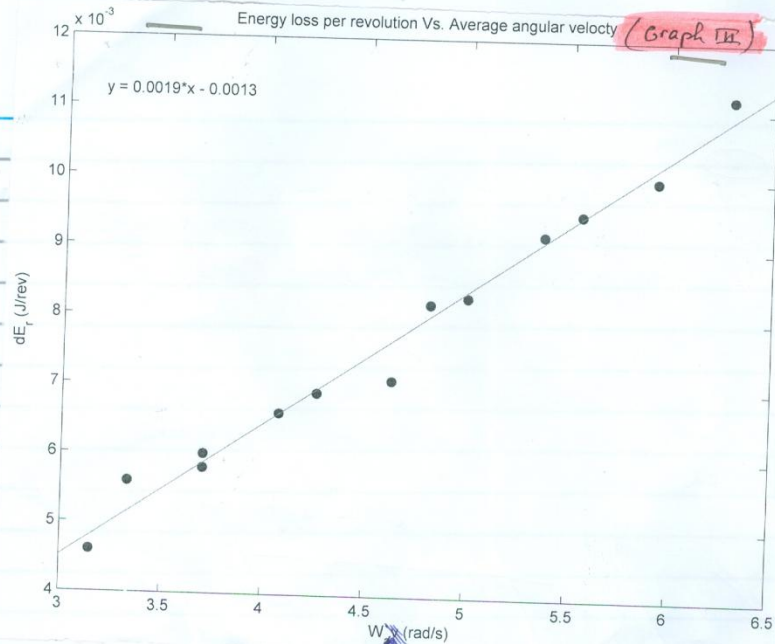
# Graphical analysis and drawing inferences



# Data, models and theory



# Laboratory diaries



## Frictional Losses :-

→ For this section we use the sonar sensor to acquire height data and make a table as shown in Table-1 "Data Analysis".

→ Formulas used in data analysis are :-

$$sh = h_2 - h_1$$

$$N = \frac{f}{\pi R_p}$$

$$\Delta E = mgh$$

$$\Delta E_r = \frac{\Delta E}{N}$$

$$W_{av} = \frac{\omega_{max} + \omega_{min}}{2}$$

$\omega_{max/min}$  = use markers in MATLAB to get values from (Graph-2)

The water W (Fig 7) was slightly acidulated.

The sound audible from M was much louder than that mentioned in Experiment 7.

The distance of  $f$  from the conductor wire (C) did not seem to affect the result.

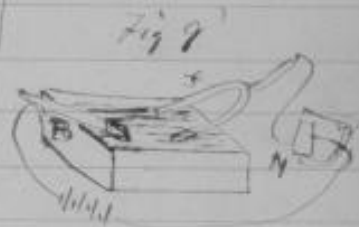
In Fig 8  $f$  was about four inches from C and yet the sound from M was as loud as in Experiment 8 (Fig 7).

When the tuning-fork,  $f$ , was only about one inch from C.

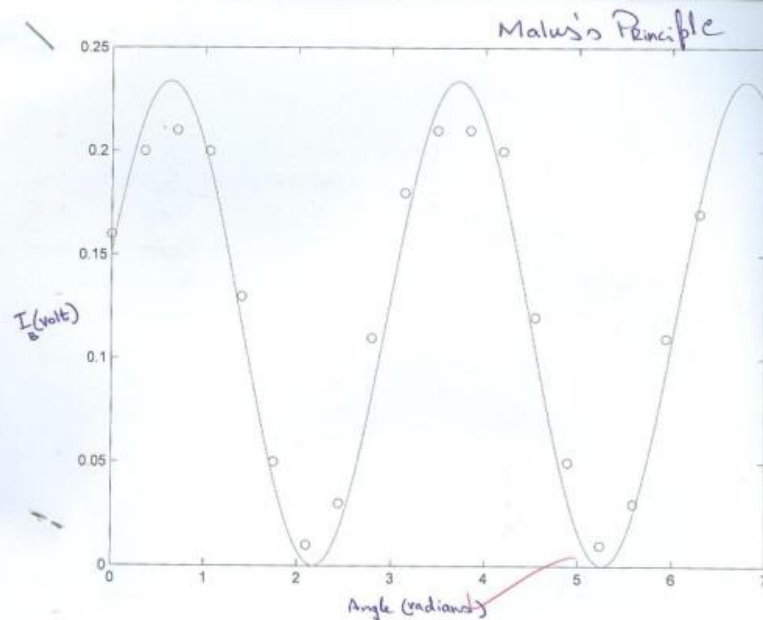
A ribbon of brass (B) was dipped into the water in place of the wire (C) (Fig 9).

Sound much louder

When the ribbon of brass B (Fig 10) was wholly immersed in the water the sound from A was very loud.







(19)

$$\alpha = 0^\circ$$

20.  $I_{\max} = 0.22V$   
 $\beta_{\max} = 220^\circ$

(21)  $I_{\min} = 0.00V$   
 $\beta_{\min} = 300^\circ$

Angular diff =  $300 - 220 = 80^\circ$

(22)

$$I_{V_2} = \frac{0.00 + 0.22}{2} = \frac{0.22 + 0.00}{2}$$

$$I_{1/2} = 0.11V$$

$$\beta_{1/2} = 260^\circ$$

$\alpha$	$\beta_{\max}^\circ$	$I_{\max} (V)$	$\beta_{\min}^\circ$	$I_{\min} (V)$	$\beta_{1/2}^\circ$	$I_{1/2} (V)$
0	220	0.22	300	0.00	260	0.11
20	250	0.22	320	0.00	280	0.11
40	254	0.20	348	0.00	302	0.10
60	100	0.21	182	0.00	142	0.10
80	120	0.22	202	0.00	162	0.11
100	<del>250</del> 138	0.22	42	0.00	82	0.11
120	340	0.21	248	0.00	282	0.11
140	164	0.21	88	0.00	128	0.10
160	202	0.20	280	0.00		0.10
180						
200						

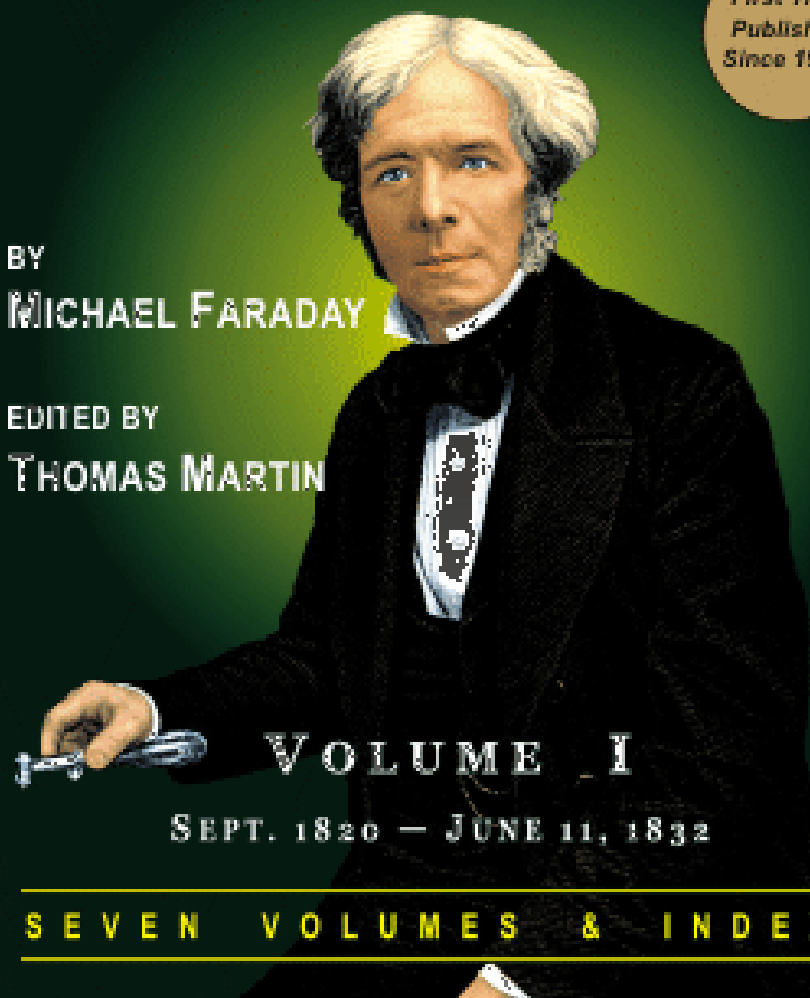
# FARADAY'S DIARY OF EXPERIMENTAL INVESTIGATION

1820 - 1862

First Time  
Published  
Since 1936!

BY  
MICHAEL FARADAY

EDITED BY  
THOMAS MARTIN



VOLUME I

SEPT. 1820 - JUNE 11, 1832

SEVEN VOLUMES & INDEX

21 JUNE 1836.

3110. Experimented on effect of hot current of air rising from the chimney of a charcoal furnace. Using ends of brass rods of about this size<sup>†</sup>. When these were connected with the Electrical machine and rendered *Positive*, I could easily obtain the glow on any of them by quick working, it sinking into brushes as the supply of Electricity was less.

3111. On placing the points over the current of hot air from the furnace, I could obtain the glow also, but there was an evident increased tendency to break into long ramifying brushes.

3112. Using air above 300° but not hot enough to char writing paper and placing two ends above thus\*; when the hot air was turned away, the end of P had glow and end of N dark—but when hot air ascended, fine brushes and ramifications passed between the ends. Was the same if A was made neg. by machine and B positive by contact with the earth.

3113. Hot air decidedly tends to make glow break into brushes. It may be from expansion only, but I think the heat goes for something.

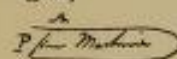
3114†. Have had an apparatus made for passage of sparks, brushes, glow, etc. between wire ends in differt. gases. A, Glass globe inches in diameter. B and C, brass rods sliding in stuffing boxes, air tight, with rounded ends inside, about this size<sup>†</sup>: D, a cap and stop cock to exhaust. The glass of the Globe was thin but good and it bore exhaustion well and was very tight.

3115. By connecting B with the Pos. conductor of Machine and C with the ground, I could obtain the sparks, brushes and glow very well on the ends within, in common air at common pressures.

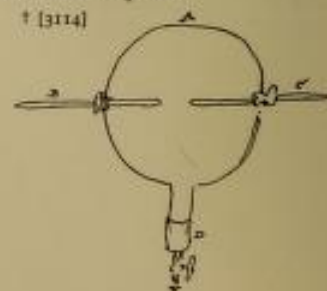
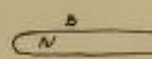
3116. Reduced pressure of air within to 20 inches mercury and ends being about 3 inches apart, found the brushes and the glow to come on sooner than when pressure one atmosphere, i.e. less electricity from the machine produced them, but still glow re-

<sup>†</sup> The diagram is reduced to  $\frac{2}{3}$  scale.

\* [3112]

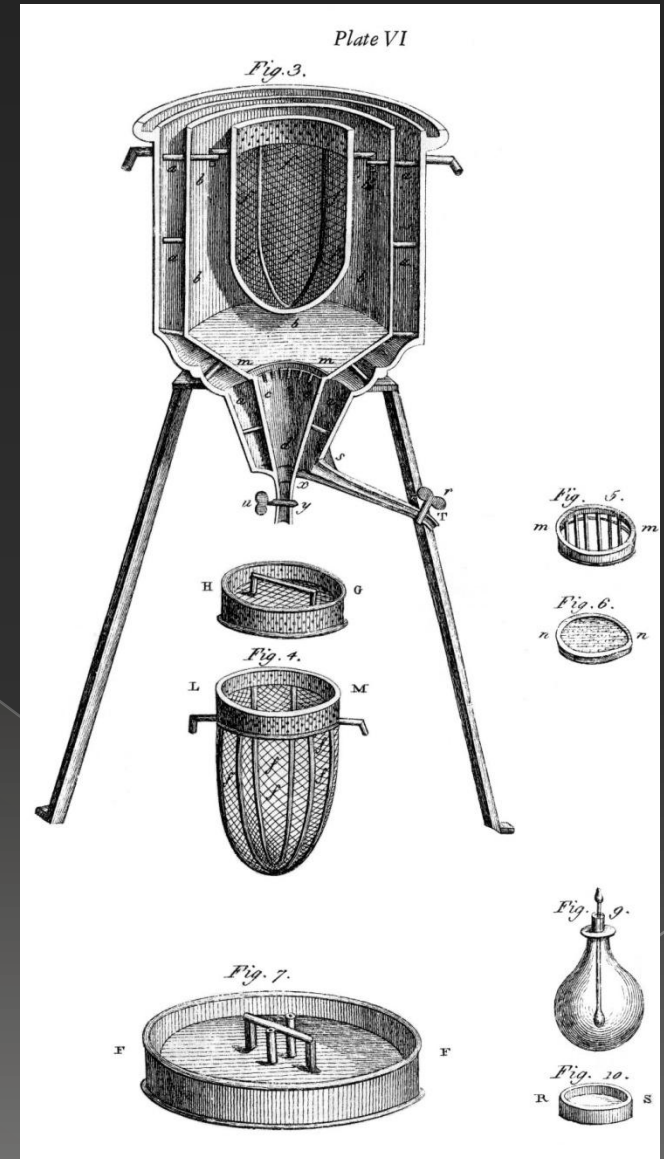
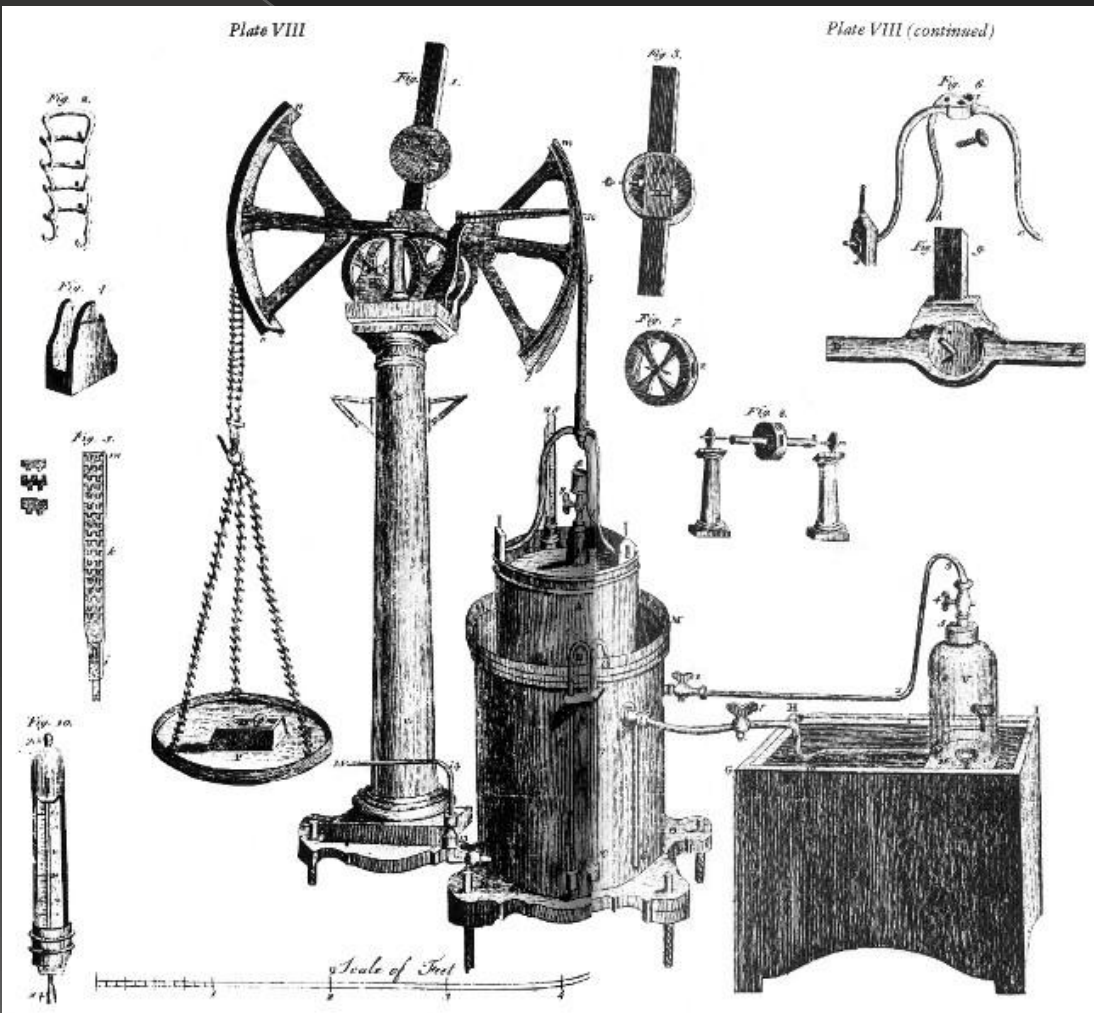


† [3114]





# Sketches and schematics



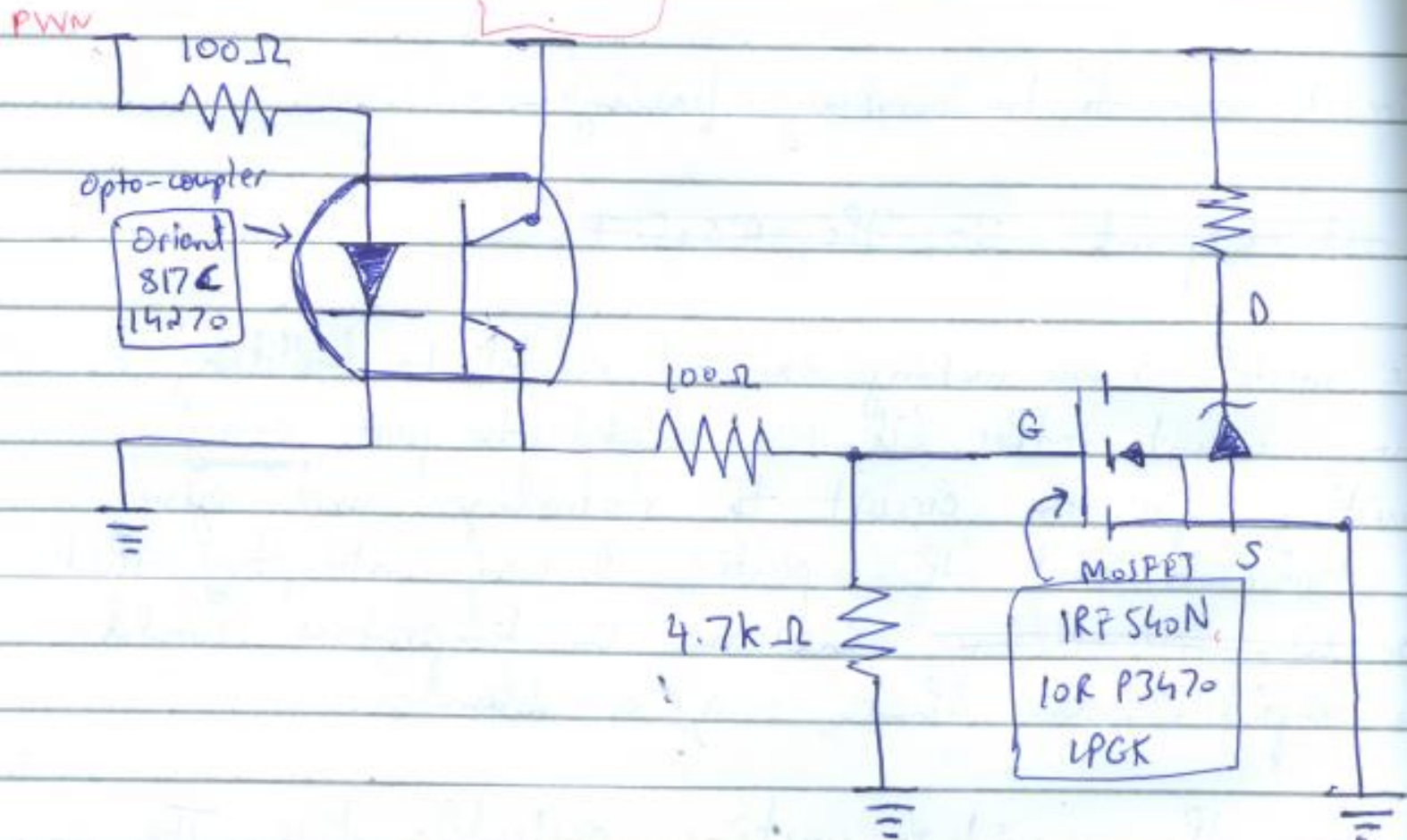
→  $K_p$ ,  $K_i$  for different values we have to see the effects on the PID.

## Control Circuit (New)

Arduino PWM

(0-5V) depending upon duty cycle

10-12V



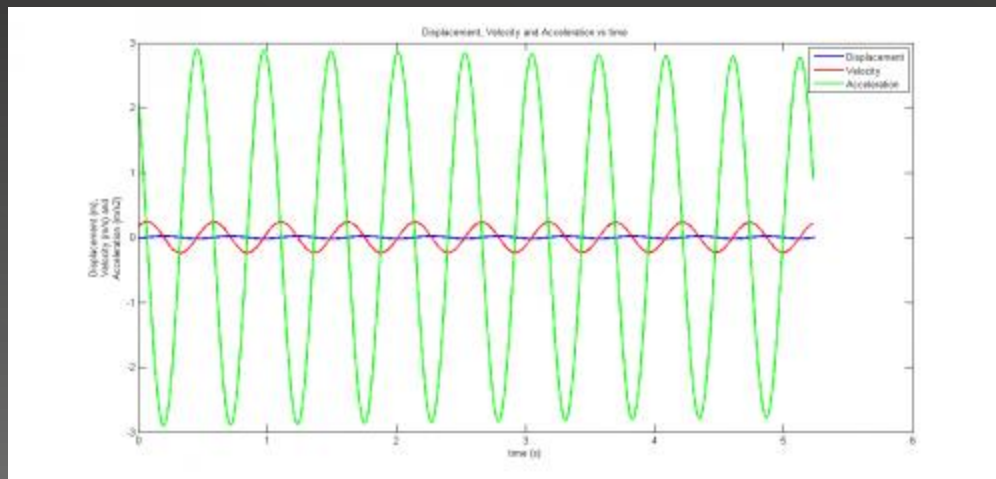
# Components of PHY 100

Physics using video analysis, high speed cameras and webcams



High-Speed Video of a coin revolving and precessing about different axes. Shot at 240 frames per second.

## Smartphone physics



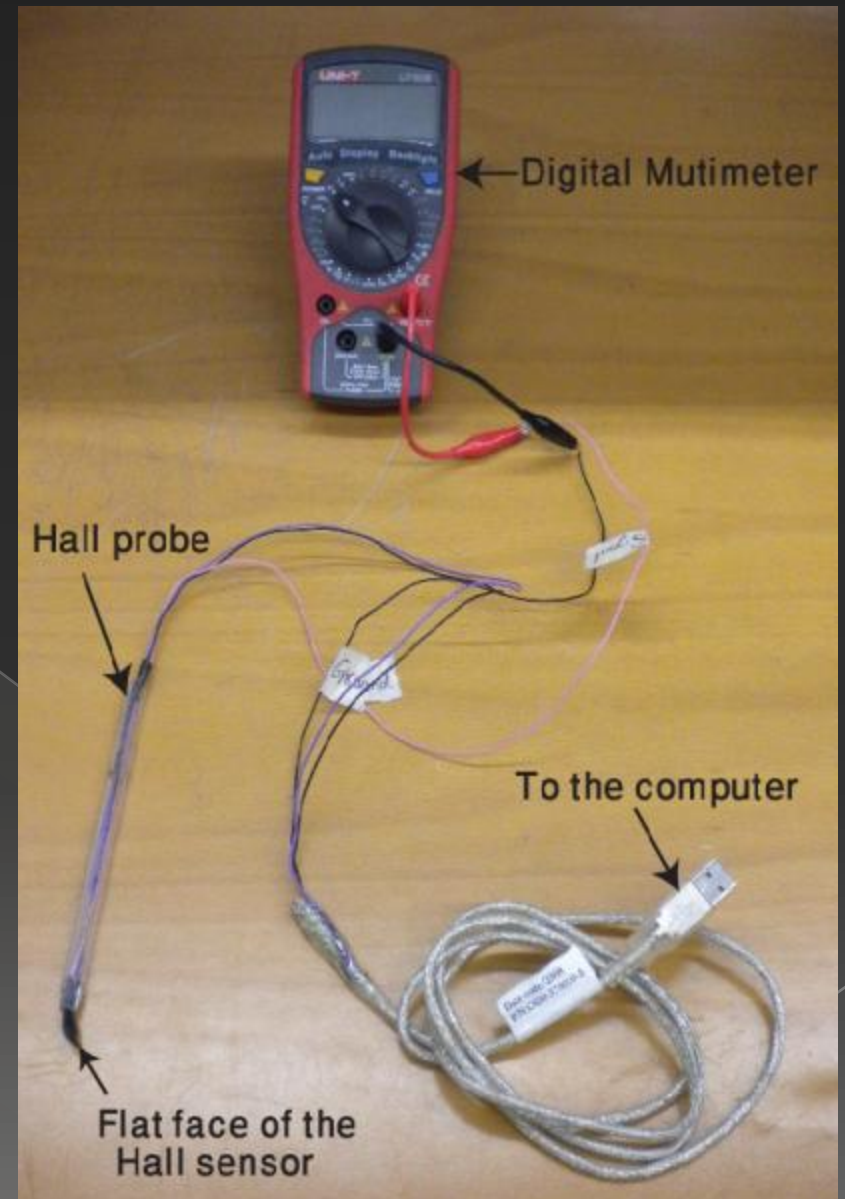


# Lasers and optics

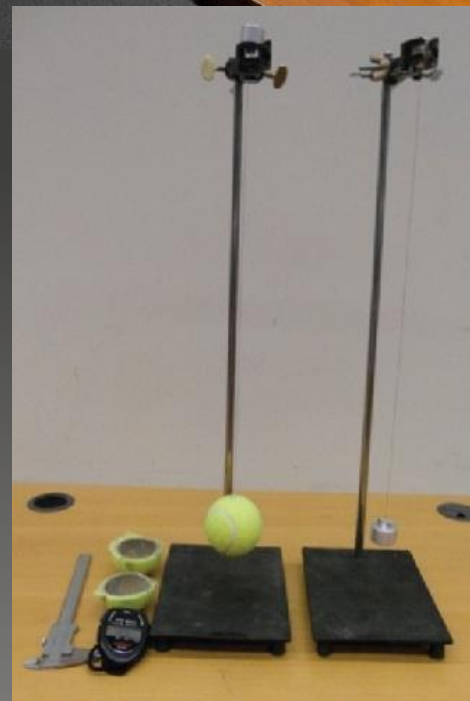
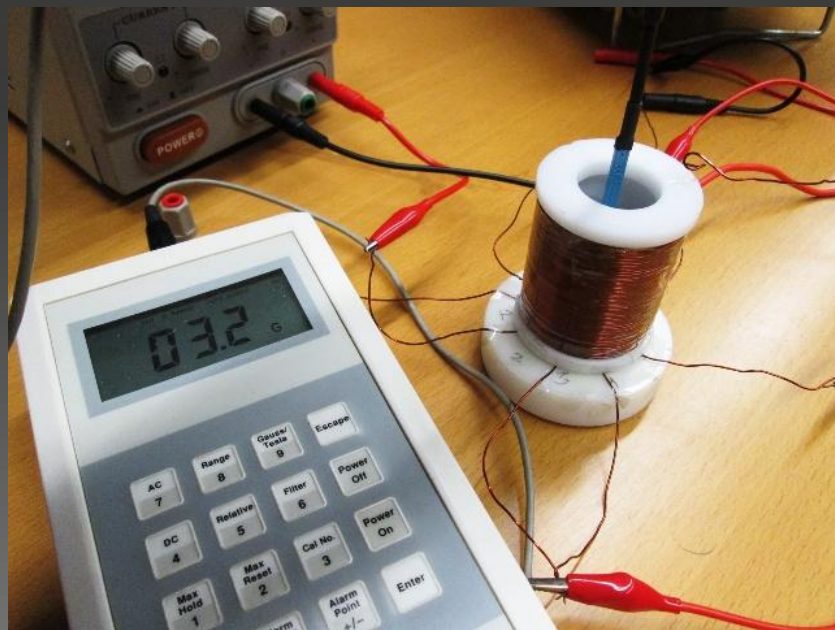


# Sensors and transducers



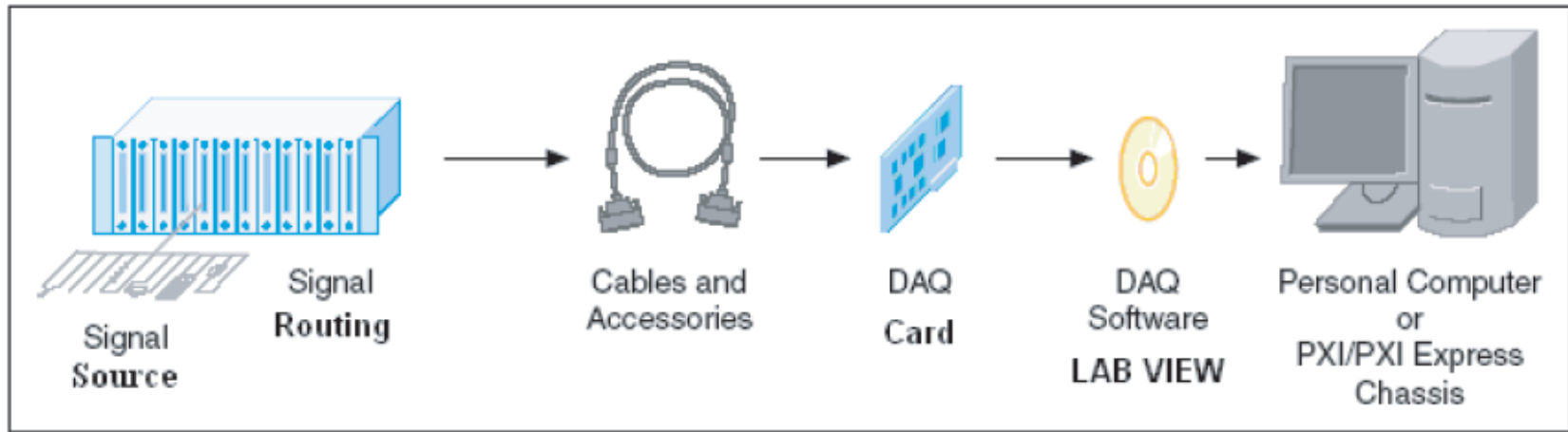




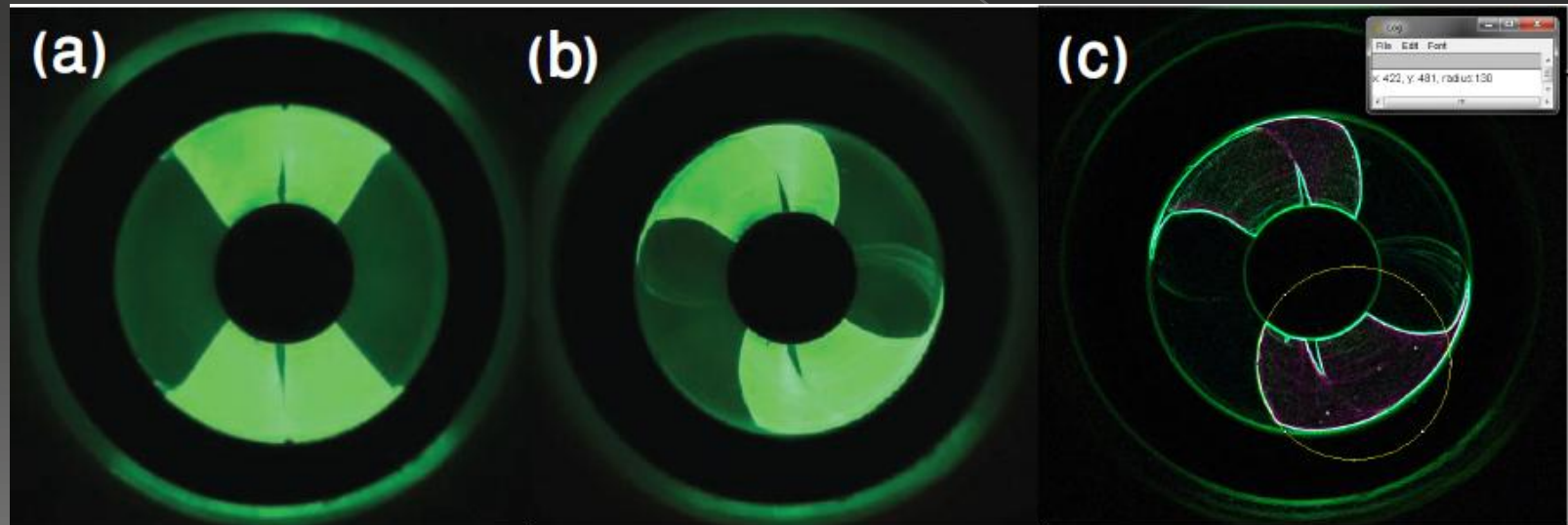




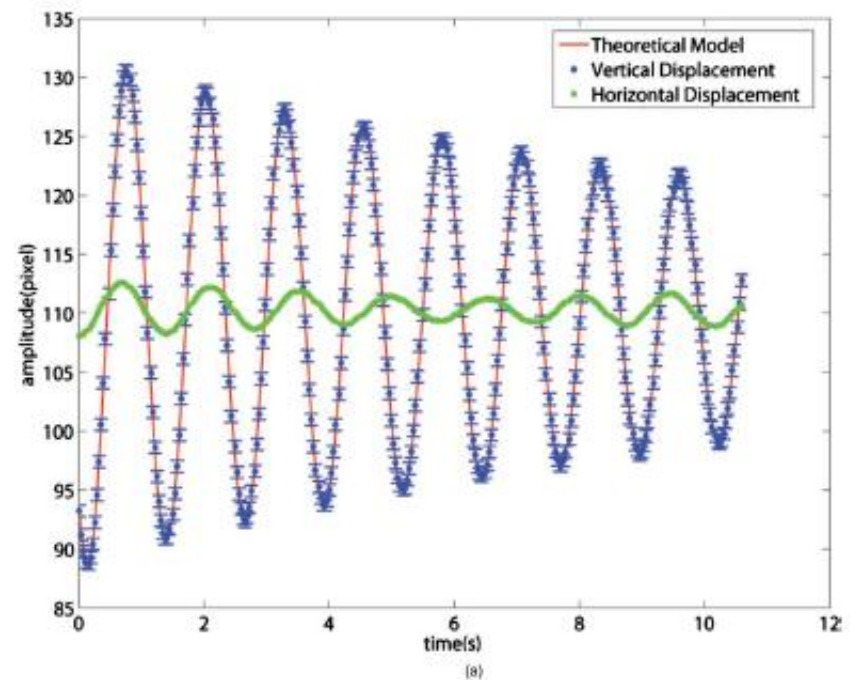
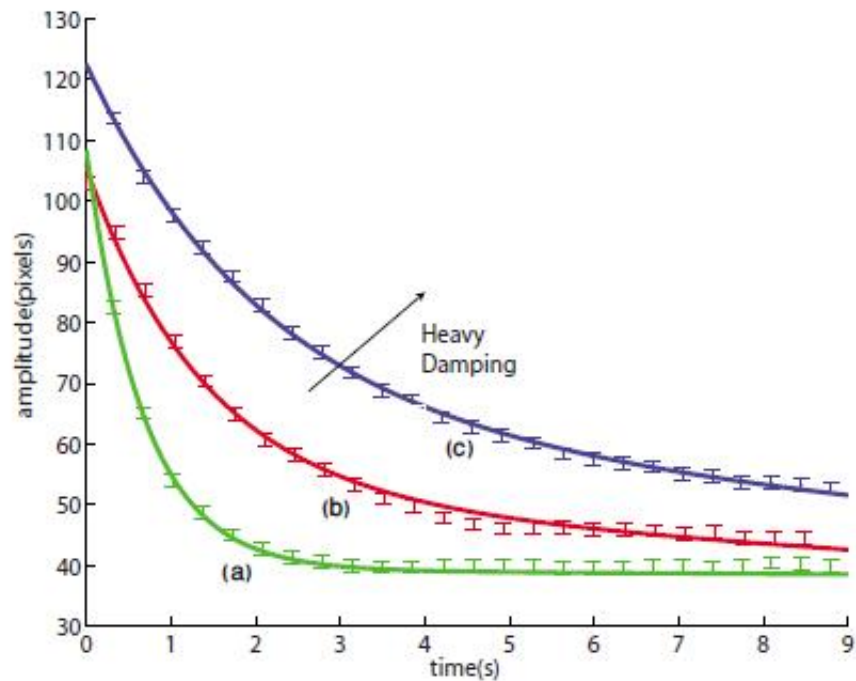
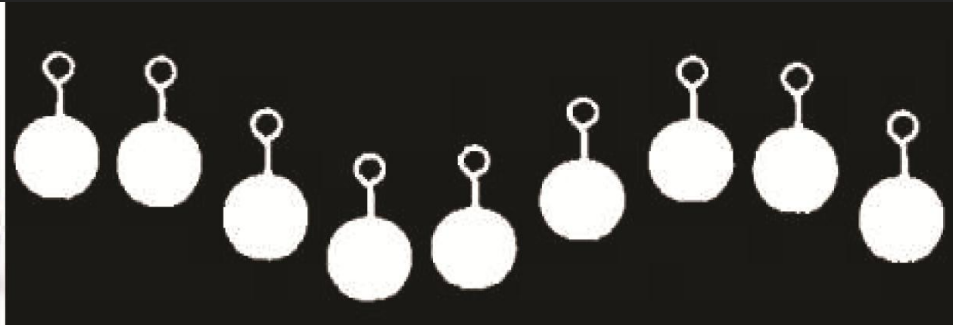
# Computer interfacing and automation



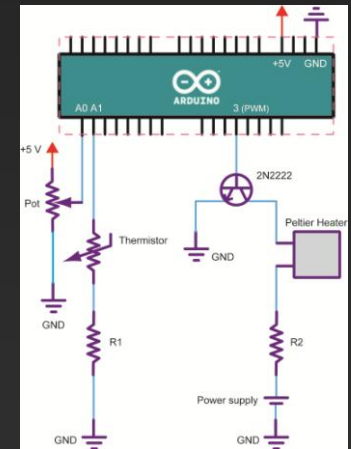
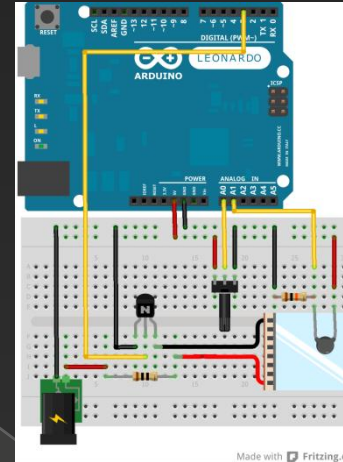
## Image processing



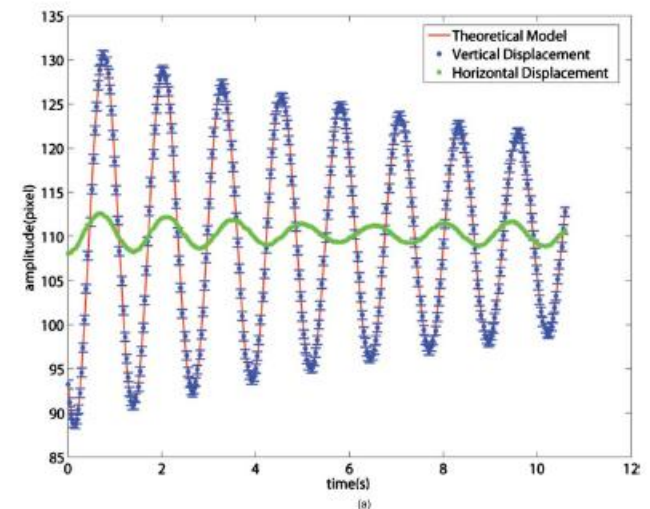
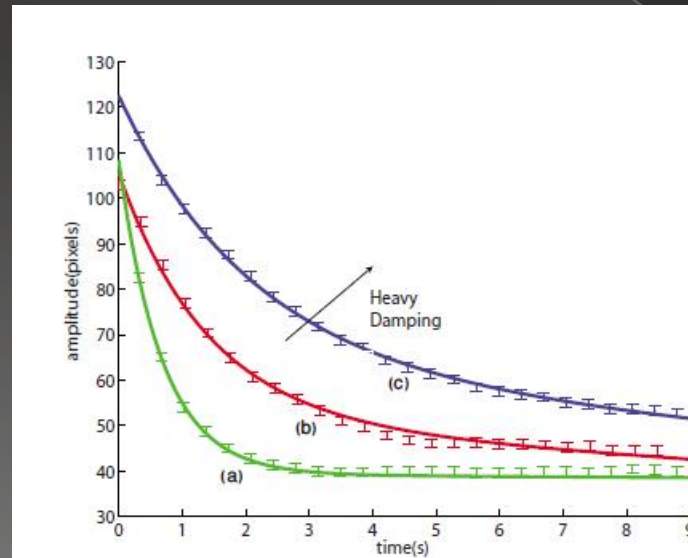
# Video processing



# Emerging world of Arduinos



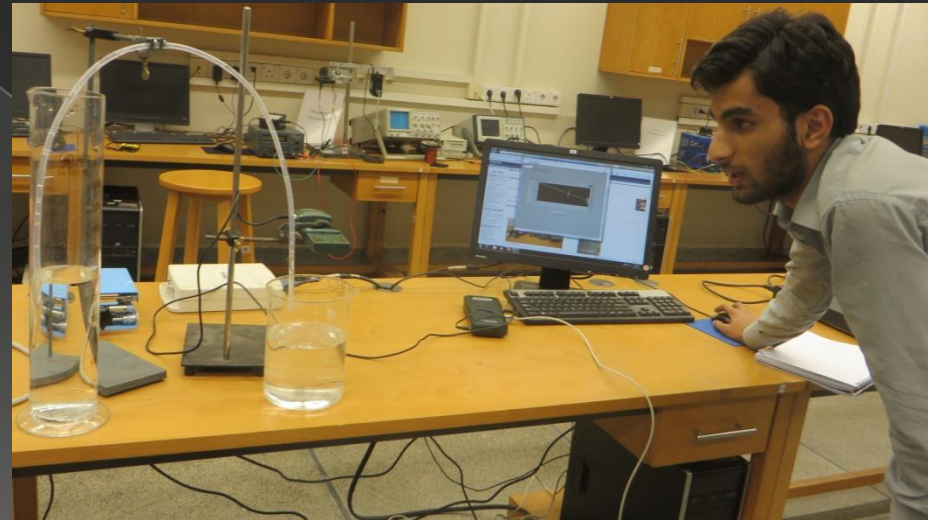
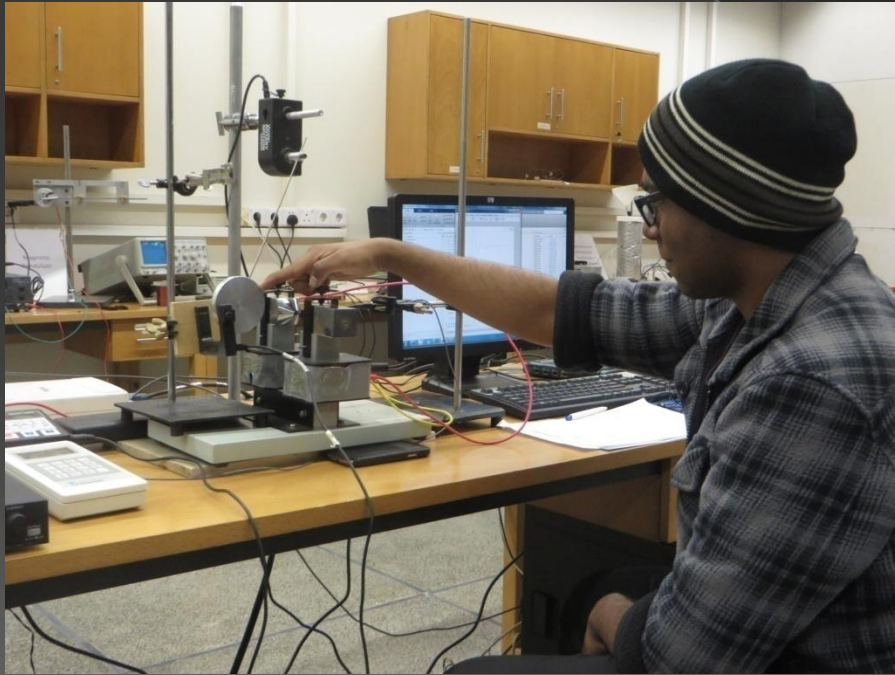
## Presenting Data

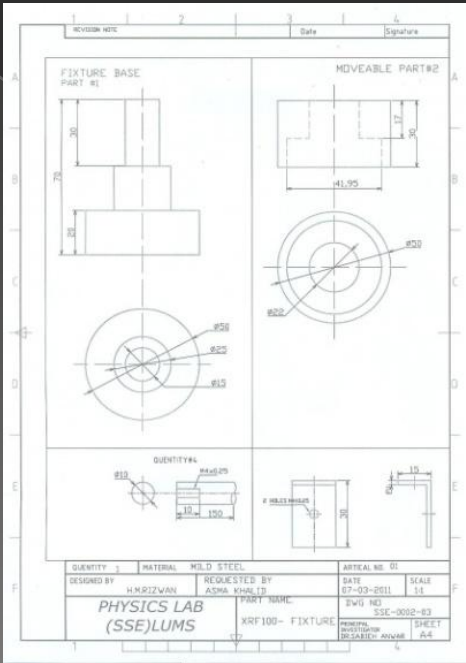




# Physics studio

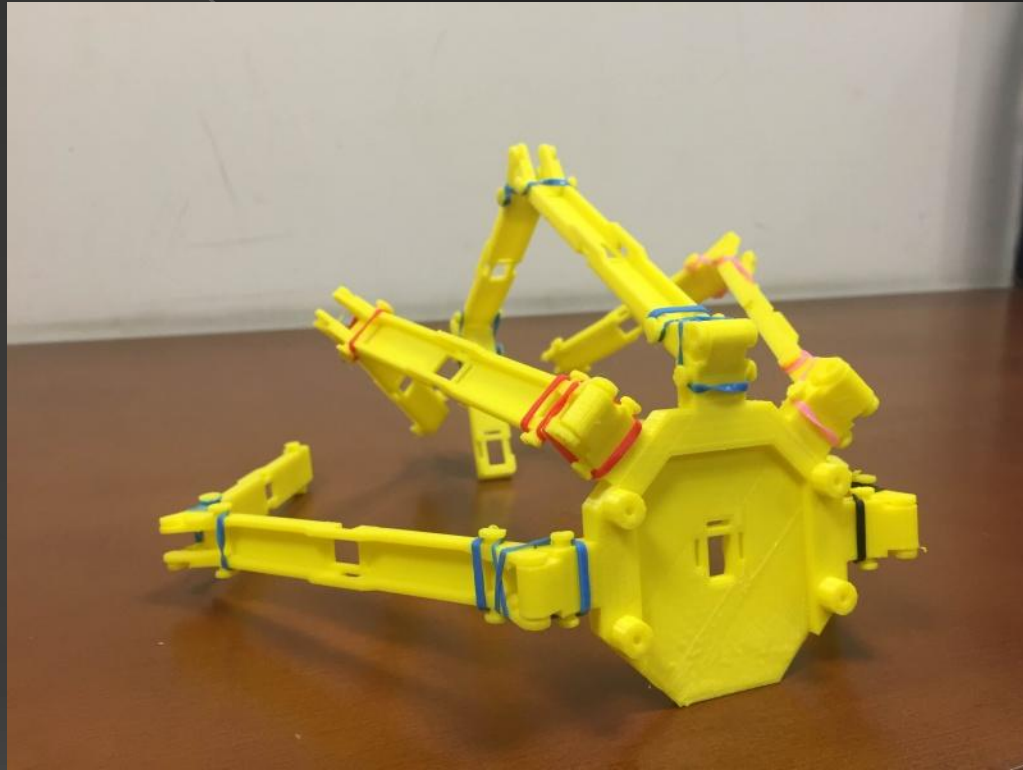
An optional track for students where they design new experiments from scratch





This diagram shows an exploded view of a mechanical assembly. The components include a yellow rectangular block at the top, a green horizontal bar, a yellow rectangular plate with several black pins, a black horizontal bar, a green rectangular block, a black circular plate with a pink pin, a green cylindrical component, a red cylindrical component, and several white cylindrical components. A 3D coordinate system with red, green, and blue axes is visible in the bottom left corner.

# 3D Printing





# Website

## <http://physlab.lums.edu.pk>

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### Experiments in Lab-I

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- Welcome to Physlab
- National Lab Immersion Program
- Older Physlab News
- Physlab Staff
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- Internship
- Classroom Demonstrations
- Facilities & Equipment
- Spreading Physics Education
- Mechanical Workshop
- Forms
- Image gallery

#### Research and Teaching Pages

- Teaching
- Research and Development
- Dr. Sabieh Anwar Personal Page
- Scientific Publications
- Theses and Reports

(Redirected from List of Experiments)




### Experimental physics Lab-I (PHY-200)--Fall 2014

- Instructors:** Amrozia Shaheen Office hours: Monday to Thursday, (01:00 pm to 5:00 pm) Afshan Jamshaid Office hours: Monday to Thursday, (01:00 pm to 5:00 pm) Junaid Alam Office hours: Monday to Thursday, (01:00 pm to 5:00 pm)
- Teaching Instructors:** Aneeq ur Rehman, Muhammad Asif, Muhammad Abdul Haseeb, Mahnoor Arshad
- Lab Schedule** Click here to find the schedule

### Experimental Preparation

In addition to the practical sessions conducting by the SSE Physlab, we also train the students for the experimental course in the form of lectures, computer based studies, interactive discussions and demonstrator-led demonstrations. For example, prior to the Lab I course, there is a set of lectures and activities that expose the students to the concepts of:

- Lab Safety
- Uncertainties and Measurements in experimental physics **Must Read**



https://physlab.lums.edu.pk/index.php/Internship\_Programme tainties and measurements

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## Research and Teaching Pages

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## Laboratory Courses

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## Rotational Dynamics, Moment of Inertia, Torque and Rotational Friction (1.2)

[Click here to go to list of experiments](#)

**Students Manual**

The experiment investigates the principle of conservation of angular momentum. The experiment will also involve several measurements of angular momentum and moment of inertia and make comparisons with theoretical predictions. Students will also learn the art of extracting useful information from experimental data.

**Lab View Code**



Mechanics code

**Sample Results**

Sample data for measurement of friction

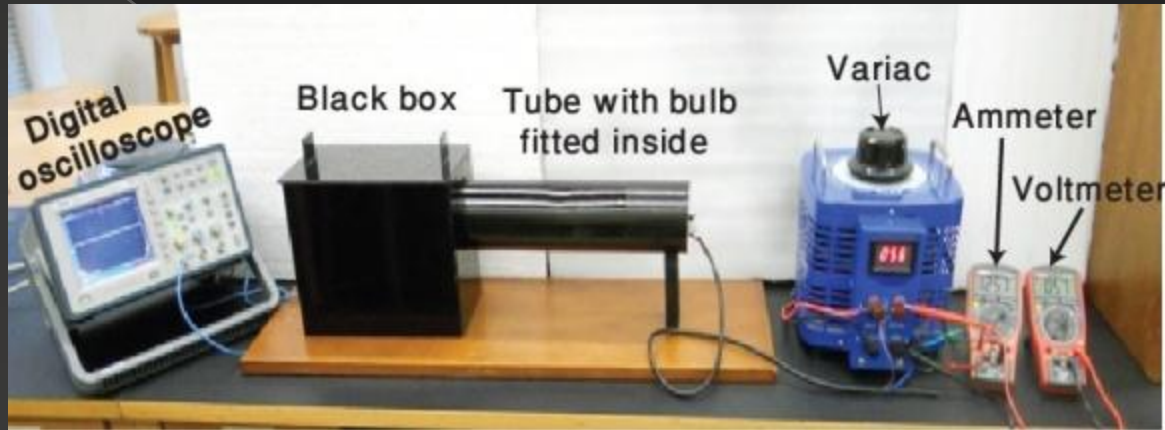
Angular velocity with respect to time

**Pictorial procedure (1.2)**



- Students manual
- Sample Results
- Labview Code
- Matlab Code

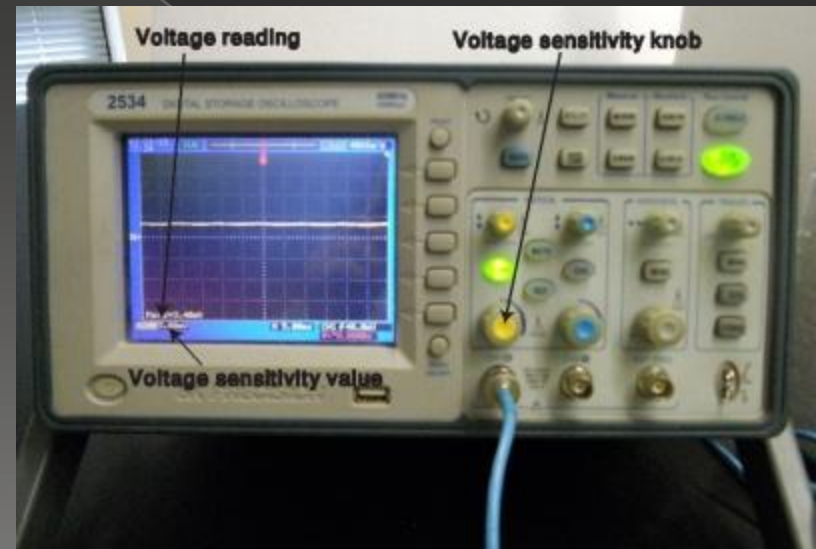
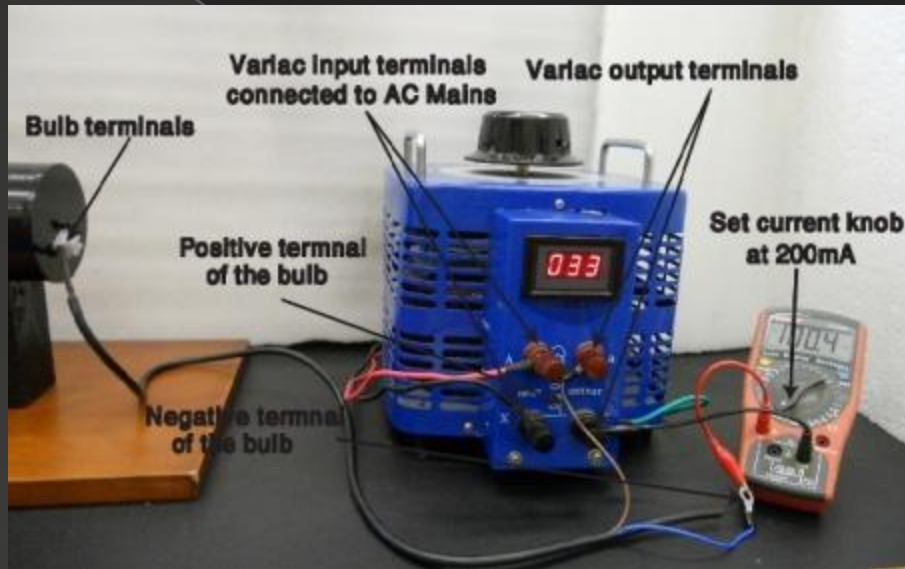
# Pictorial Procedures





# Pictorial Procedures

Contd. From previous page



# Lab Assessment

## Grading criteria:

Sr. No	Objectives	Good	Average	Poor
1	Understanding of theory of the experiment			
2	Error propagation			
3	Significant figures			
4	Units written properly			
5	Axes labeling			
6	Curve fitting			
7	Interpretation of results			
8	Plotting and presentation of results			
9	Lab notebook			
10	Student's attitude			
11	Extra points			

## Overall impression:

Grade	Comment
A+	Exceptional
A-	Very Good
A	Good
B	Average
B-	Below average
C	Satisfactory

# Lab Schedule

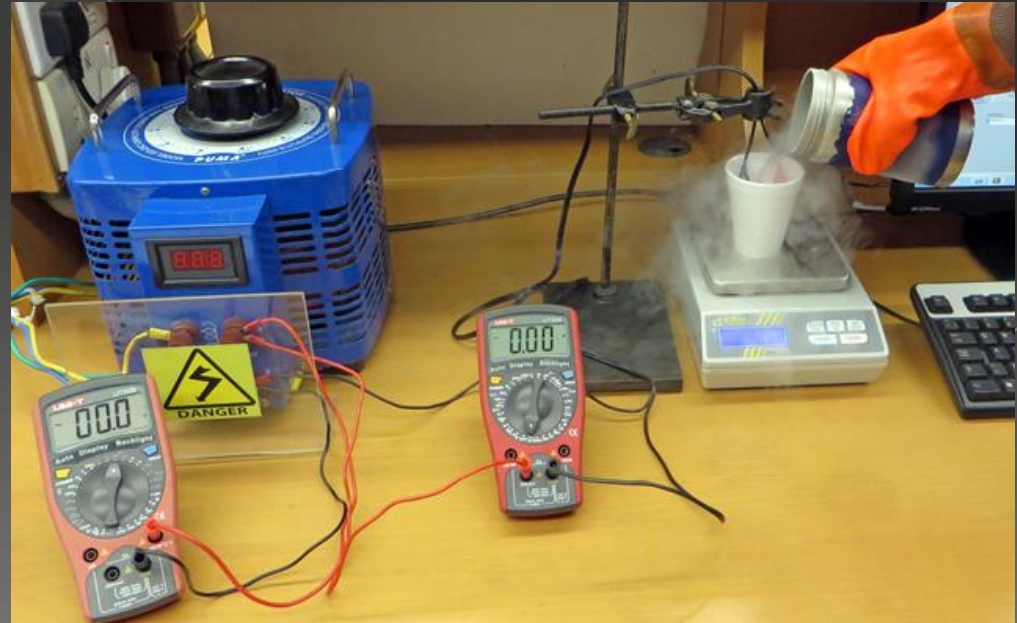
Group	Time Slot	Roll No.	Week-4	Week-5	Week-6	Week-7	Week-8	Week-9
PH 110 A (Monday)	2:00pm – 6:00 pm	1-6	GP	HT	M	EM	EL	O
		7-12	HT	M	EM	EL	O	GP
		13-18	M	EM	EL	O	GP	HT
		19-24	EM	EL	O	GP	HT	M
		25-30	EL	O	GP	HT	M	EM
		31-36	O	GP	HT	M	EM	EL

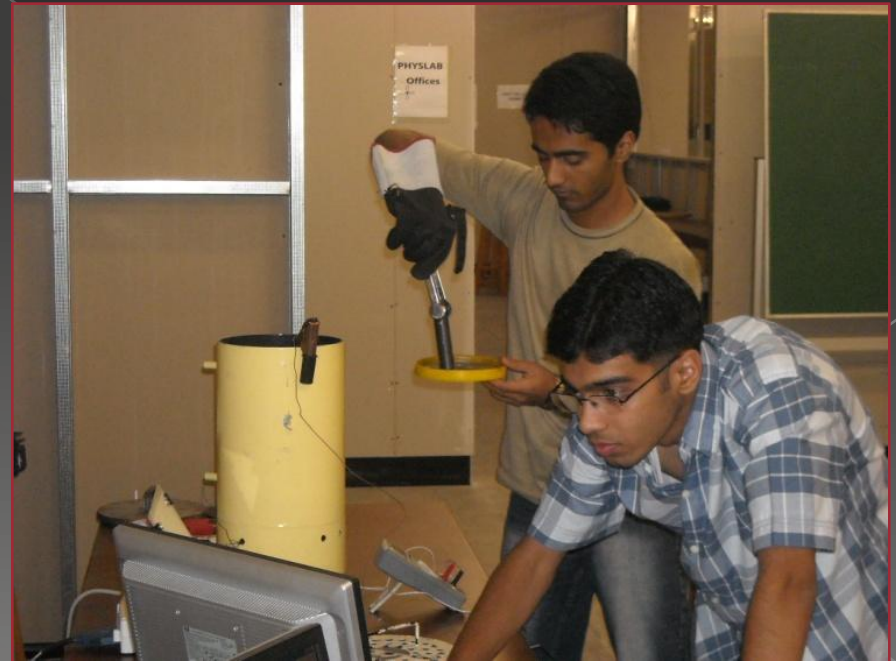
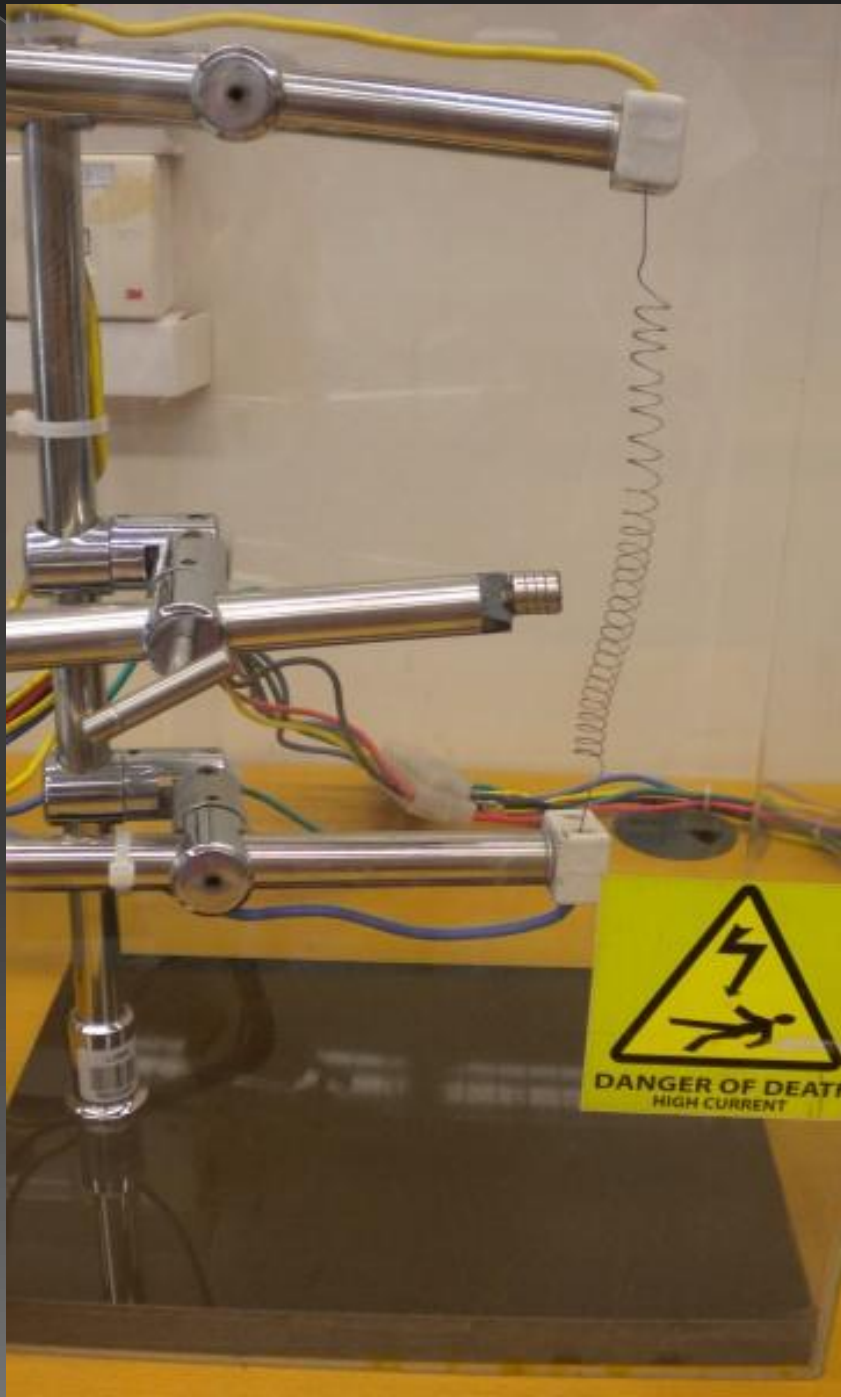
Group	Time Slot	Roll No.	Week-4	Week-5	Week-6	Week-7	Week-8	Week-9
PH 110 B (Tuesday)	1:00pm – 5:00 pm	37-42	GP	HT	M	EM	EL	O
		43-48	HT	M	EM	EL	O	GP
		49-54	M	EM	EL	O	GP	HT
		55-61	EM	EL	O	GP	HT	M
		62-67	EL	O	GP	HT	M	EM
		68-73	O	GP	HT	M	EM	EL



# Lab Safety

- Lasers
- Cryogenics
- Hot Surfaces
- Fire and electric safety
- Radioactive sources





# What's so unique about experimental physics in Pakistan and similar developing countries?

“For the first year at the Raman Research Institute there was no electricity, but that did not deter Raman from carrying out several beautiful optical experiments with sunlight, a few lenses and a pair of polaroids. He considered a beam of sunlight as the best source, and in Bangalore there was no shortage of blue sky and bright sun. A manually-operated heliostat, kept in operation by voice communication, produced astonishing results.”

- Jayaraman, A., *Chandrasekhara Venkata Raman - A Memoir*, Affiliated East-West Press, New Delhi, 1989.

## See what Raman has to say...

*“My immediate task is to get my Research Institute functioning vigorously .. . . I have recently purchased some workshop equipment and an oxygen plant, which I hope to convert into a liquid nitrogen plant. .. . . I lack many things, notably a building to house the workshops and a hostel for the research workers, as well as funds needed for the recurring expenditure.”*

○ The Hindu, February 3, 1949.



# Lab staff

