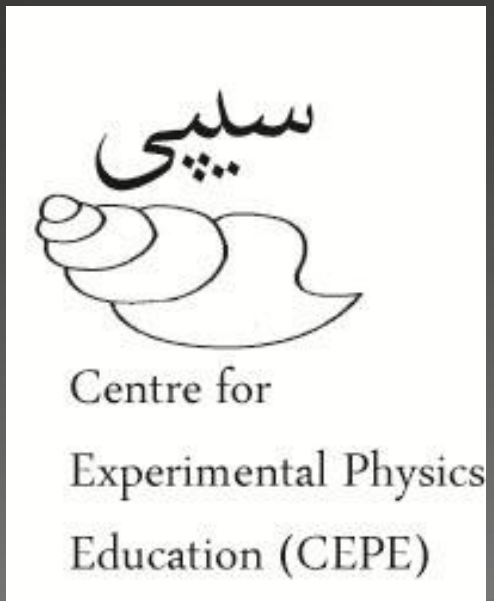
Overview of Experimental Physics 1

CEPE: Centre for Experimental Physics Education



Presented by:

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

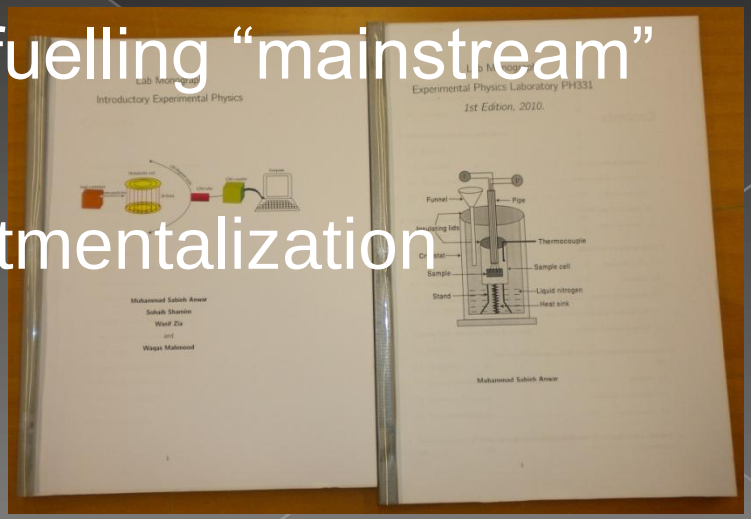
http://physlab.lums.edu.pk

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



Contd. From previous page

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."

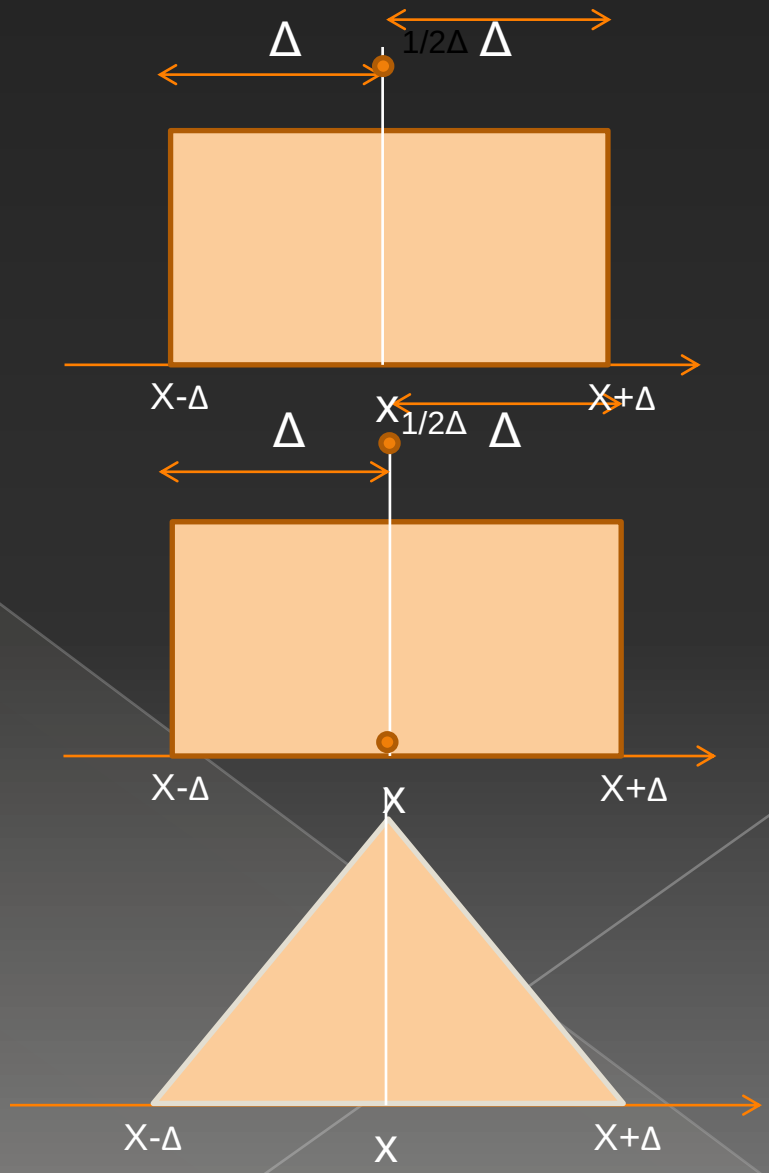
- Francis Bitter *Mathematical Aspects of Physics: An Introduction* (Anchor Books, New York 1963)

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

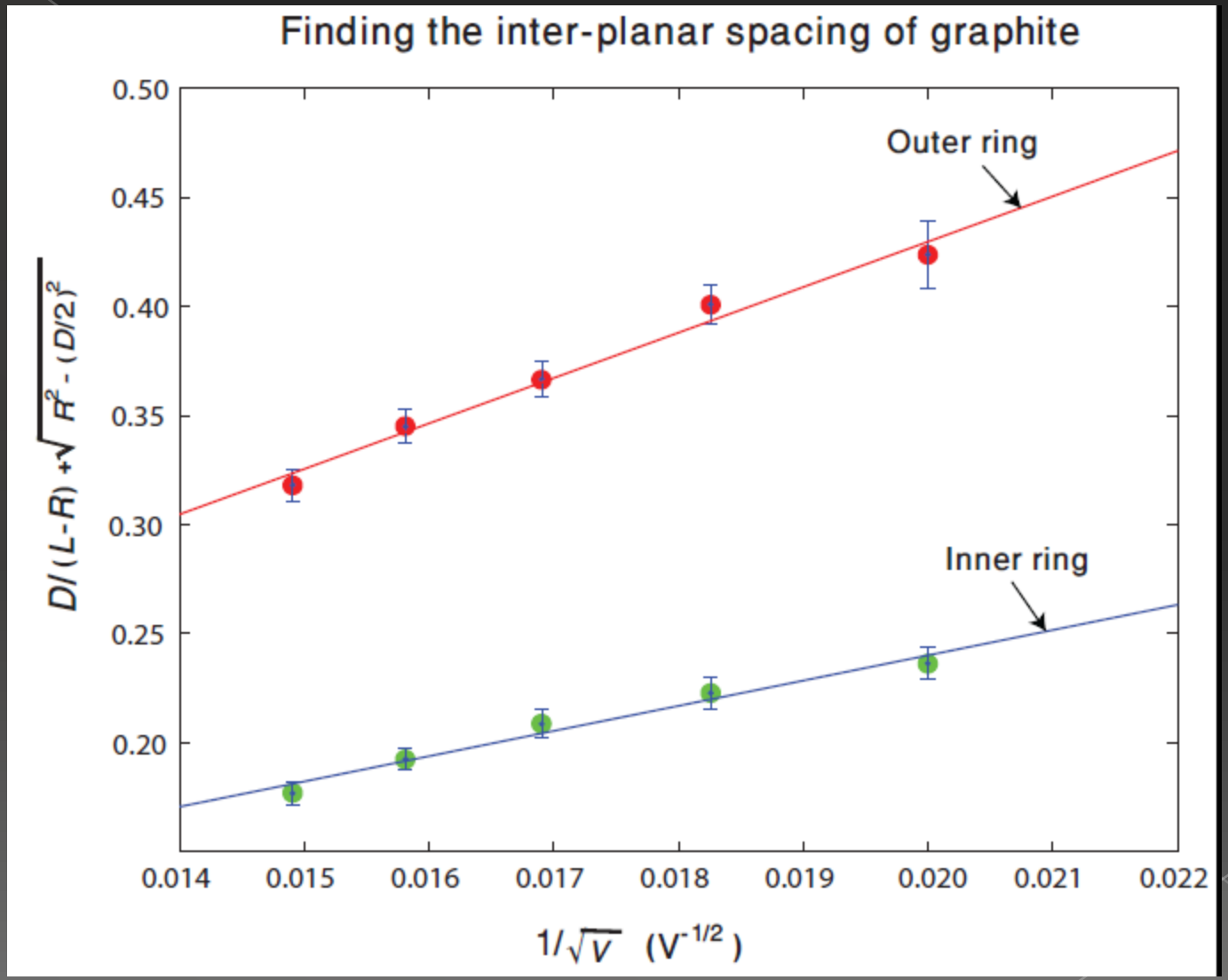


Data Processing and Analysis

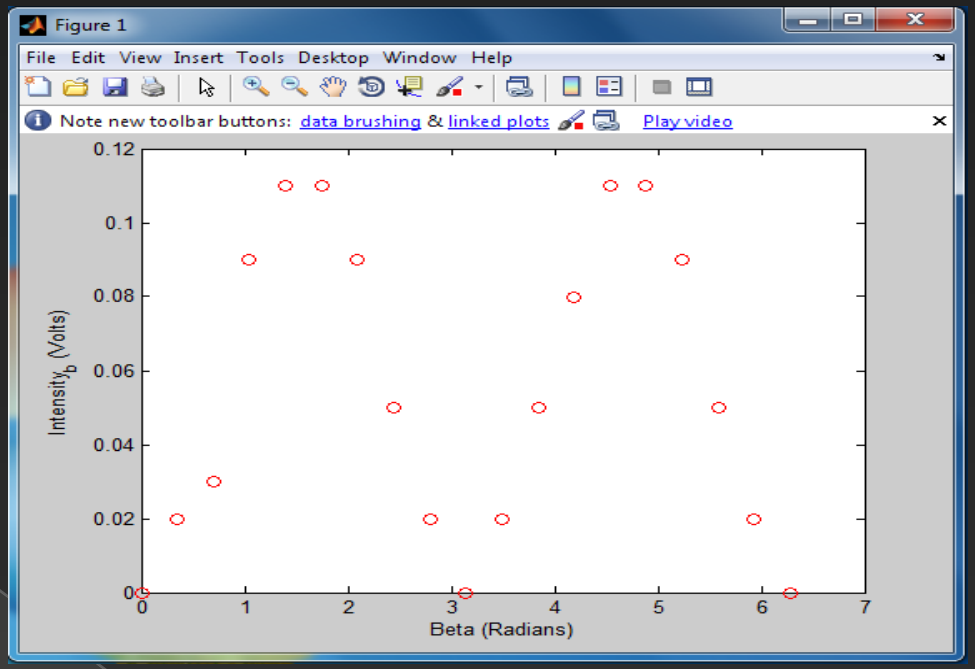
Data Analysis

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

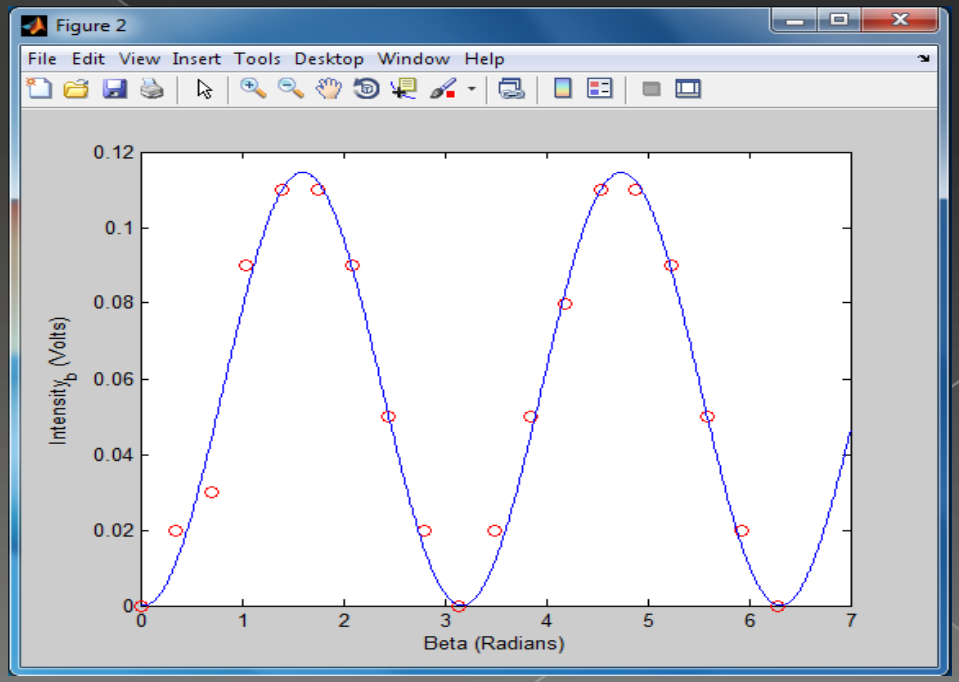
Accurate Plotting of Data



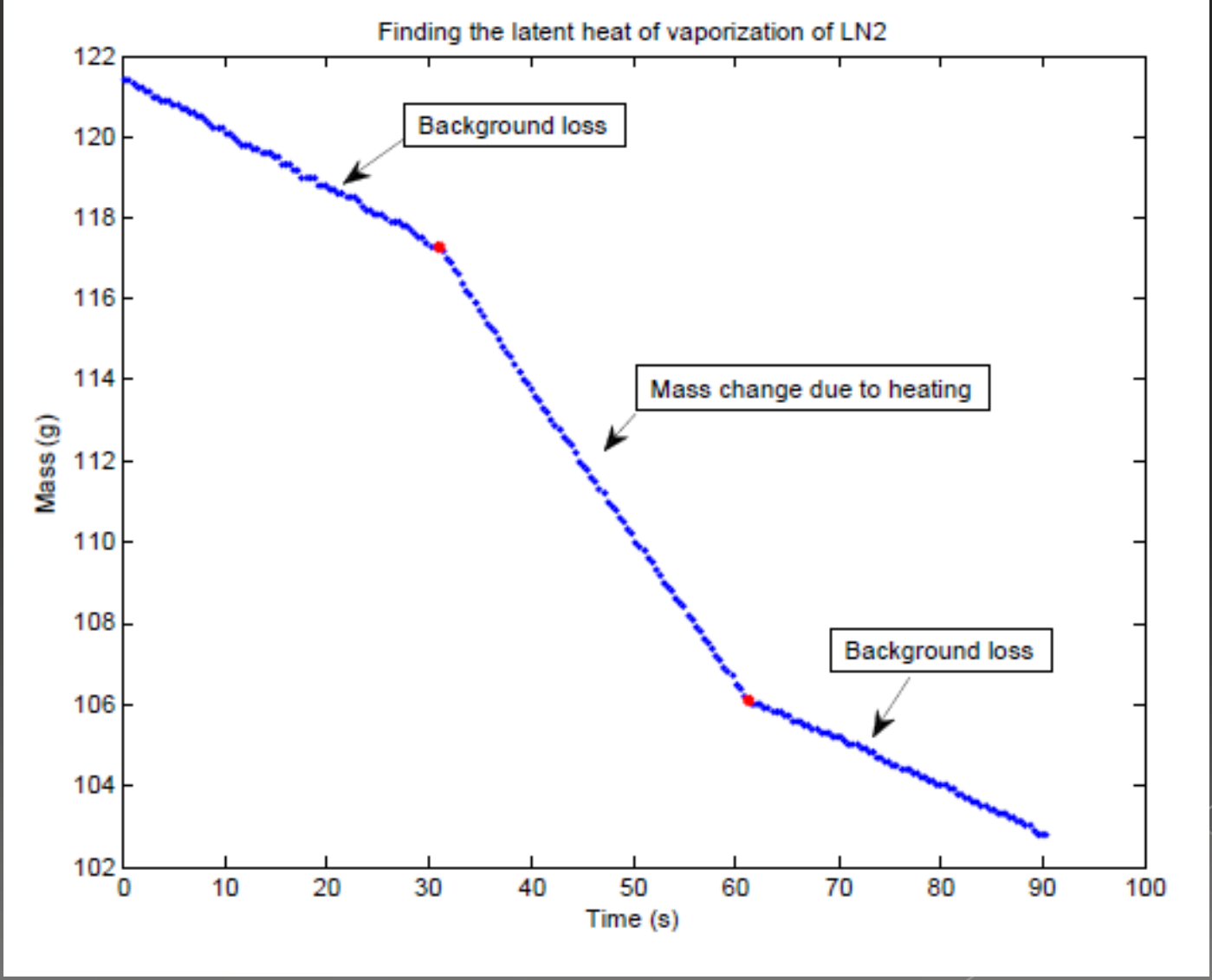
- Graphing and plotting.



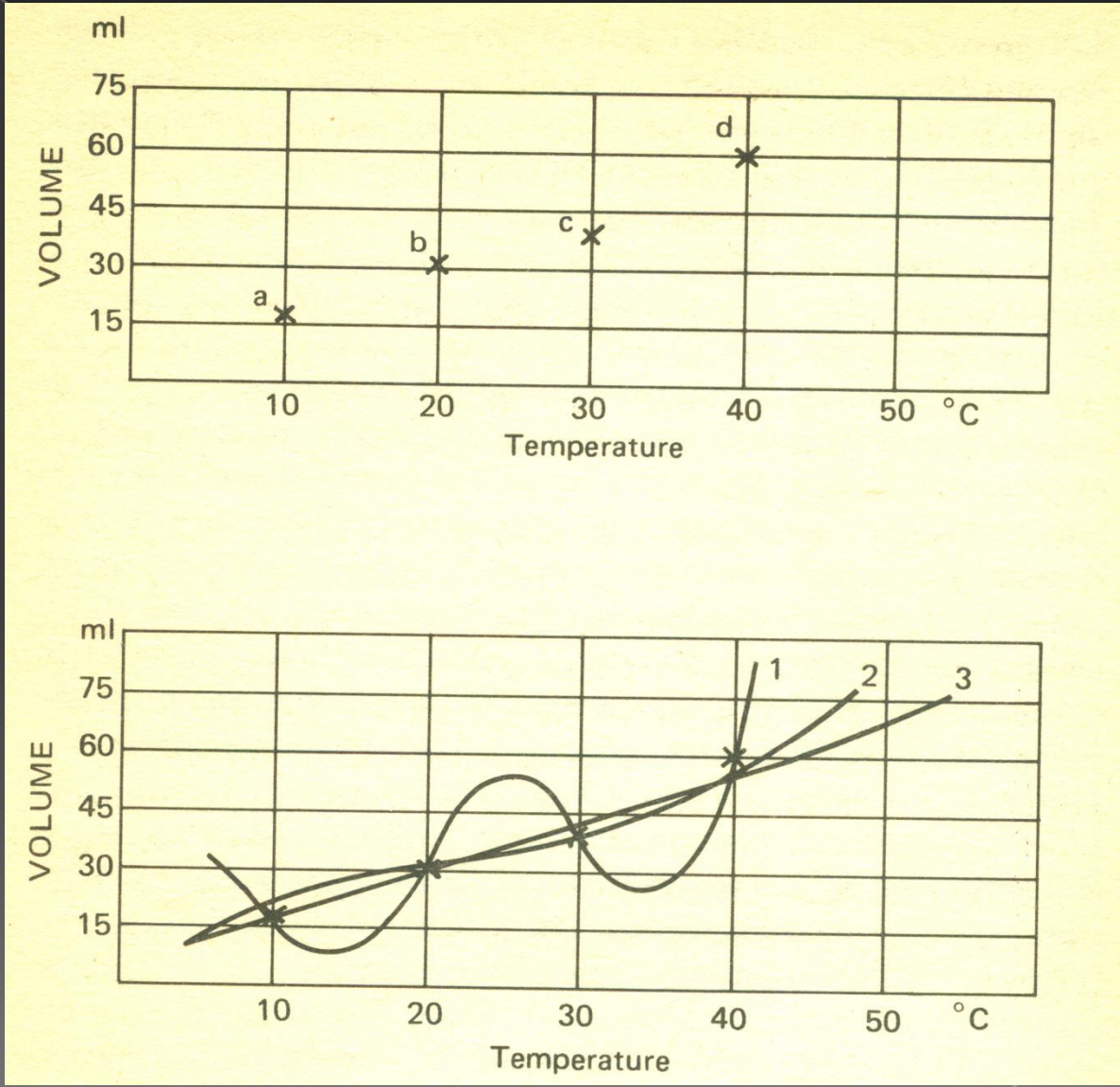
- Curve fitting.



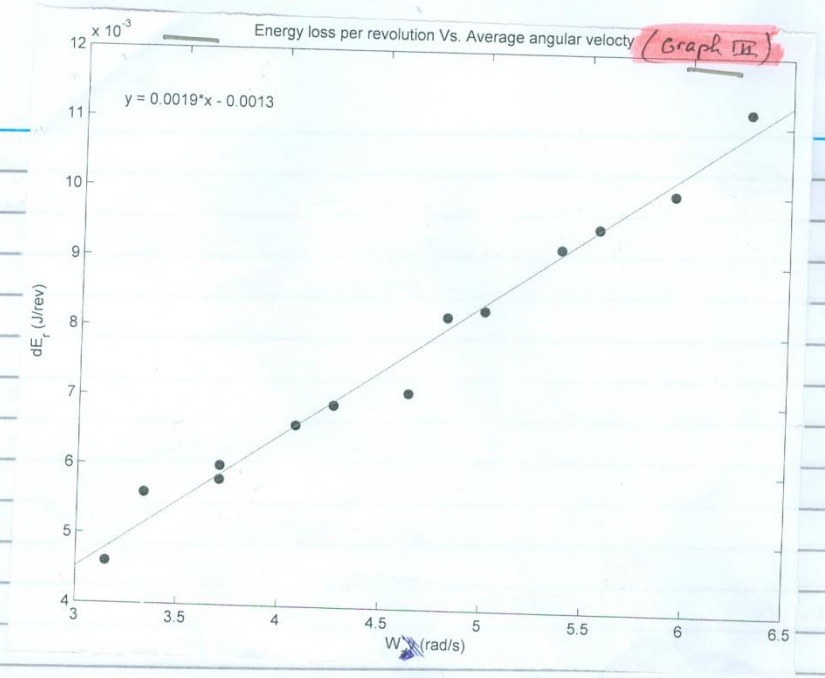
Graphical analysis and drawing inferences



Data, models and theory



Laboratory diaries



Frictional Losses :-

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

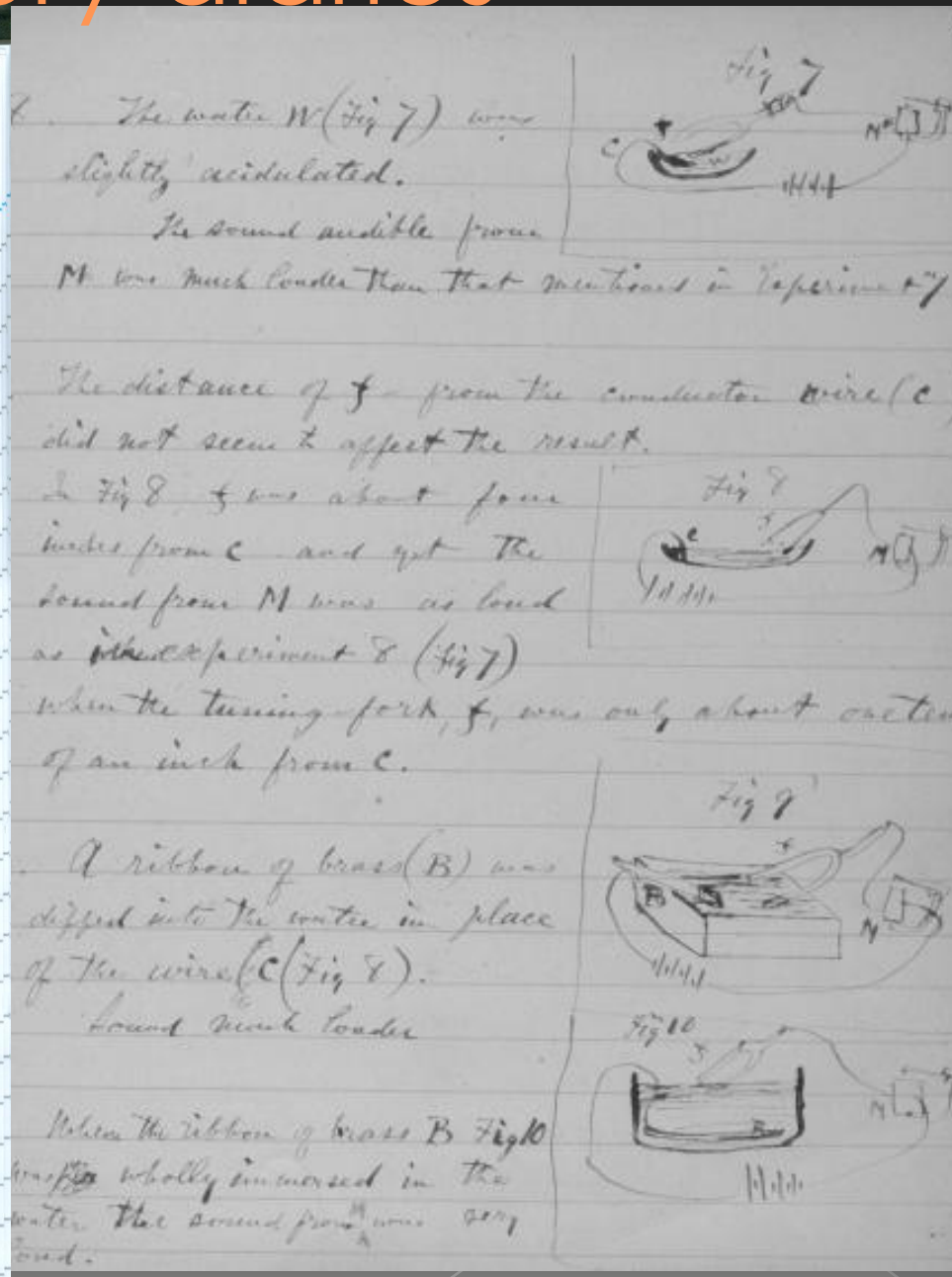
→ Formulas used in data analysis are :-

$$\Delta h = h_2 - h_1$$

$$N = \frac{f}{\pi R_p} \qquad \omega_{av} = \frac{\omega}{2}$$

$$\Delta E = mg\Delta h \qquad \omega = \text{use markers in MATLAB to get values from ("Graph-2")}$$

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



... 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-eighth of an inch from c.

A ribbon of brass (B) was dipped into the water in place of the wire (c (Fig 8).
Sound much louder

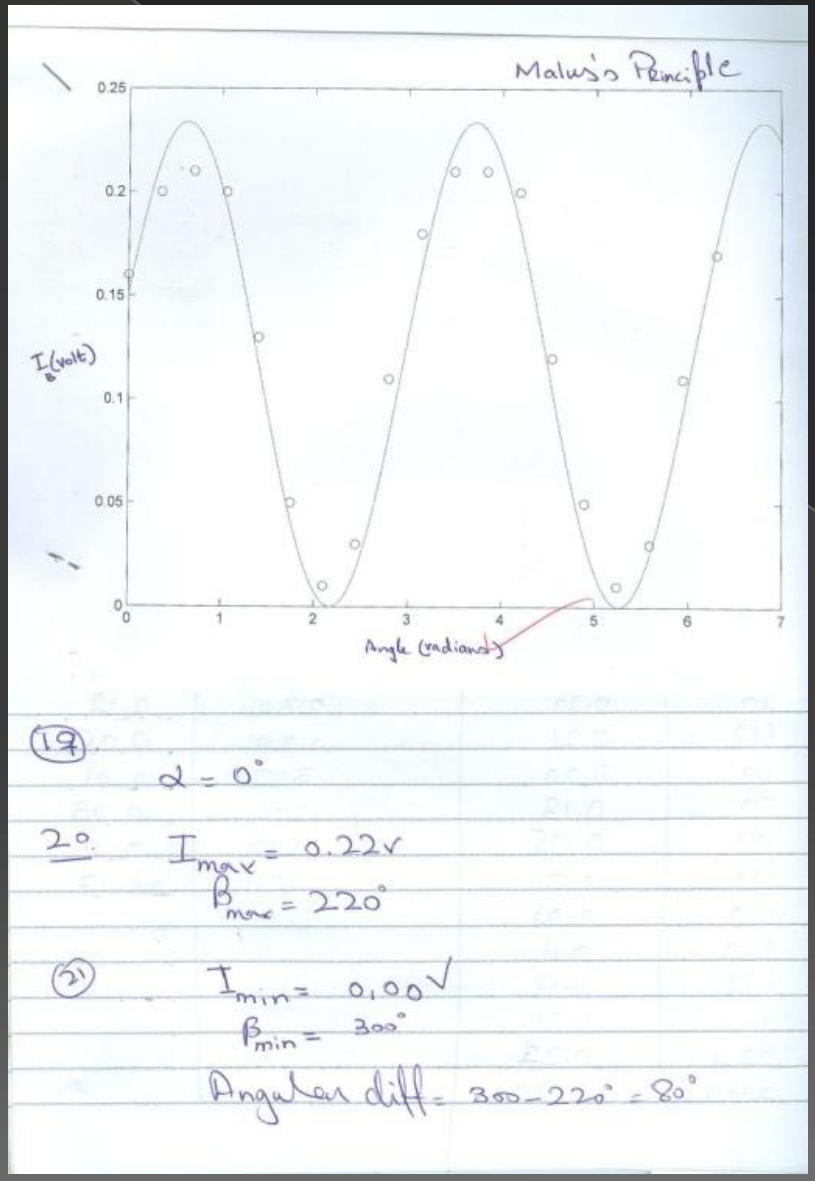
When the ribbon of brass B Fig 10 was wholly immersed in the water the sound from M was very loud.

Fig 7

Fig 8

Fig 9

Fig 10



(19) $\alpha = 0^\circ$

20. $I_{max} = 0.22V$

$\beta_{max} = 220^\circ$

(21) $I_{min} = 0.00V$

$\beta_{min} = 300^\circ$

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

(22)

$$I_{1/2} = \frac{0.00 + 0.22 - 0.00}{2} = \frac{0.22 + 0.00}{2}$$

$I_{1/2} = 0.11V$

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

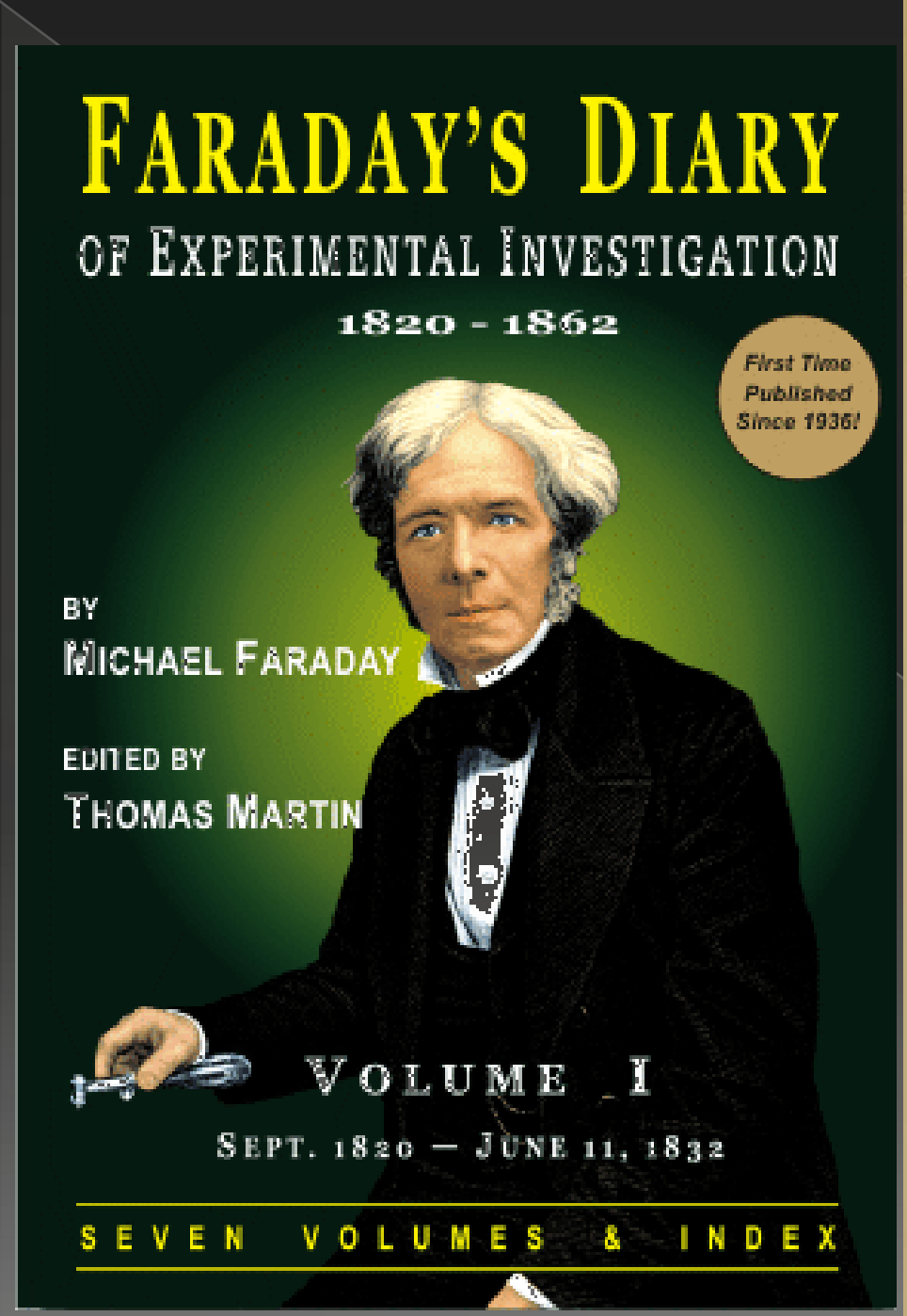
α	β_{max}°	I_{max} (V)	β_{min}°	I_{min} (V)	$\beta_{1/2}^\circ$	$I_{1/2}$ (V)
0	220	0.22	300	0.00	260	0.11
20	250	0.22	320	0.00	280	0.11
40	254	0.20	348	0.00	302	0.10
60	100	0.21	182	0.00	142	0.10
80	120	0.22	202	0.00	162	0.11
100	~~138~~	0.22	42	0.00	82	0.11
120	340	0.21	248	0.00	282	0.11
140	164	0.21	88	0.00	128	0.10
160	202	0.20	280	0.0		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

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[1]. 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.

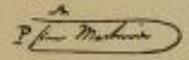
3114†. Have had an apparatus made for passage of sparks, brushes, glow, etc. between wire ends in differt. gases. A, Glass globe inches in diameter. B and C, brass rods sliding in stuffing boxes, air tight, with rounded ends inside, about this size[1]: D, a cap and stop cock to exhaust. The glass of 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.

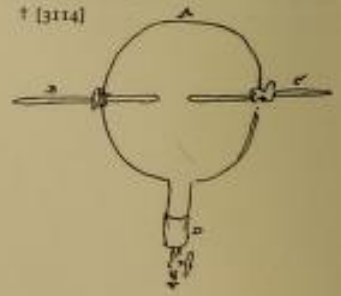
3116. Reduced pressure of *air* within to 20 inches mercury and ends being about 3 inches apart, found the brushes and the glow to come on sooner than when pressure one atmosphere, i.e. less electricity from the machine produced them, but still glow re-

[1] The diagram is reduced to $\frac{3}{4}$ scale.

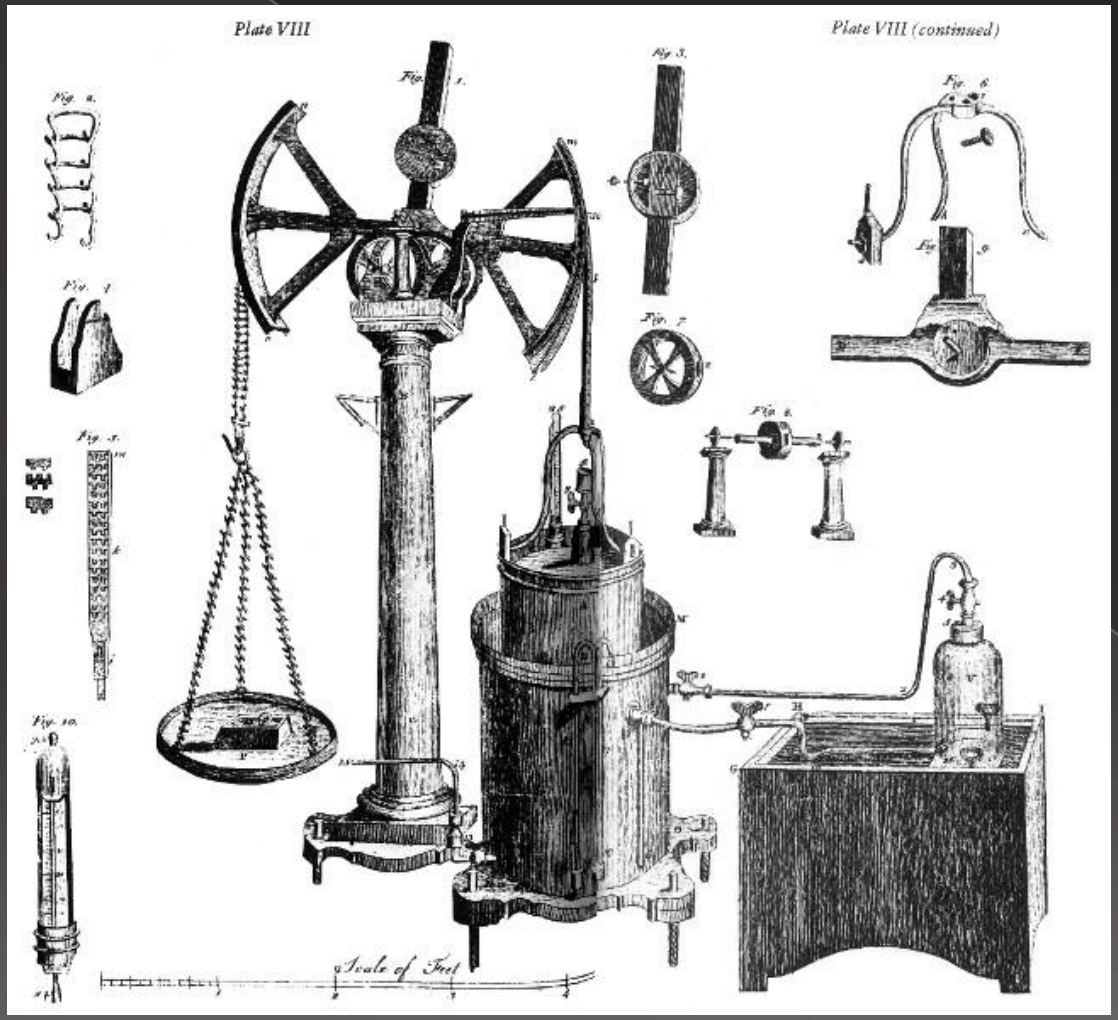
* [3112]

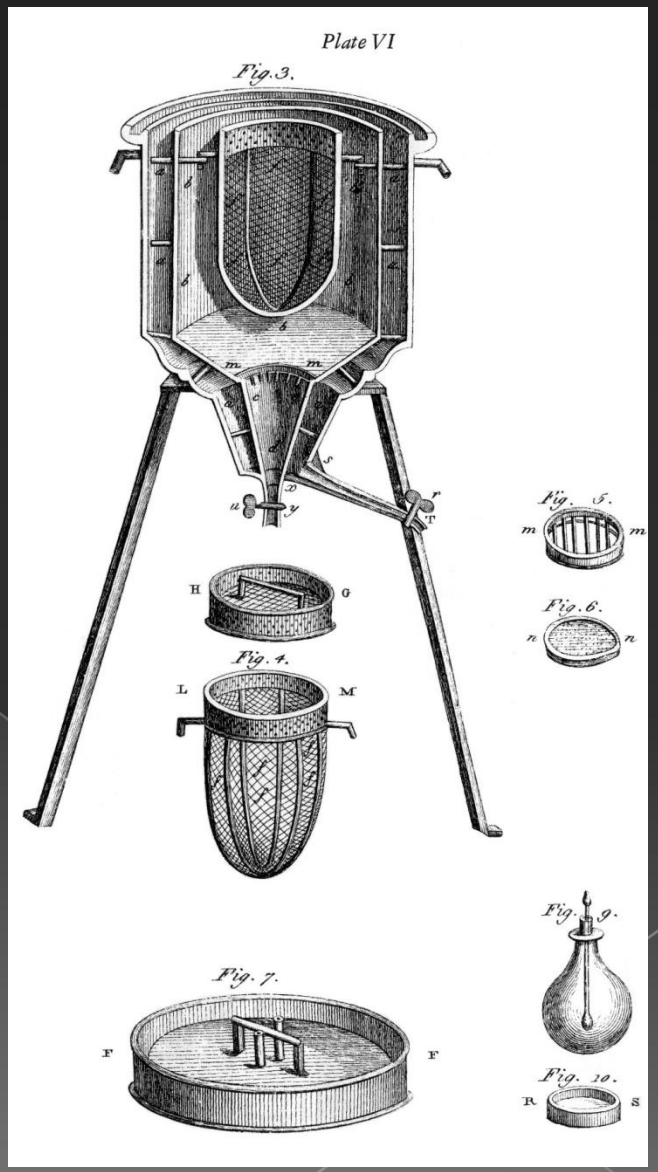


† [3114]



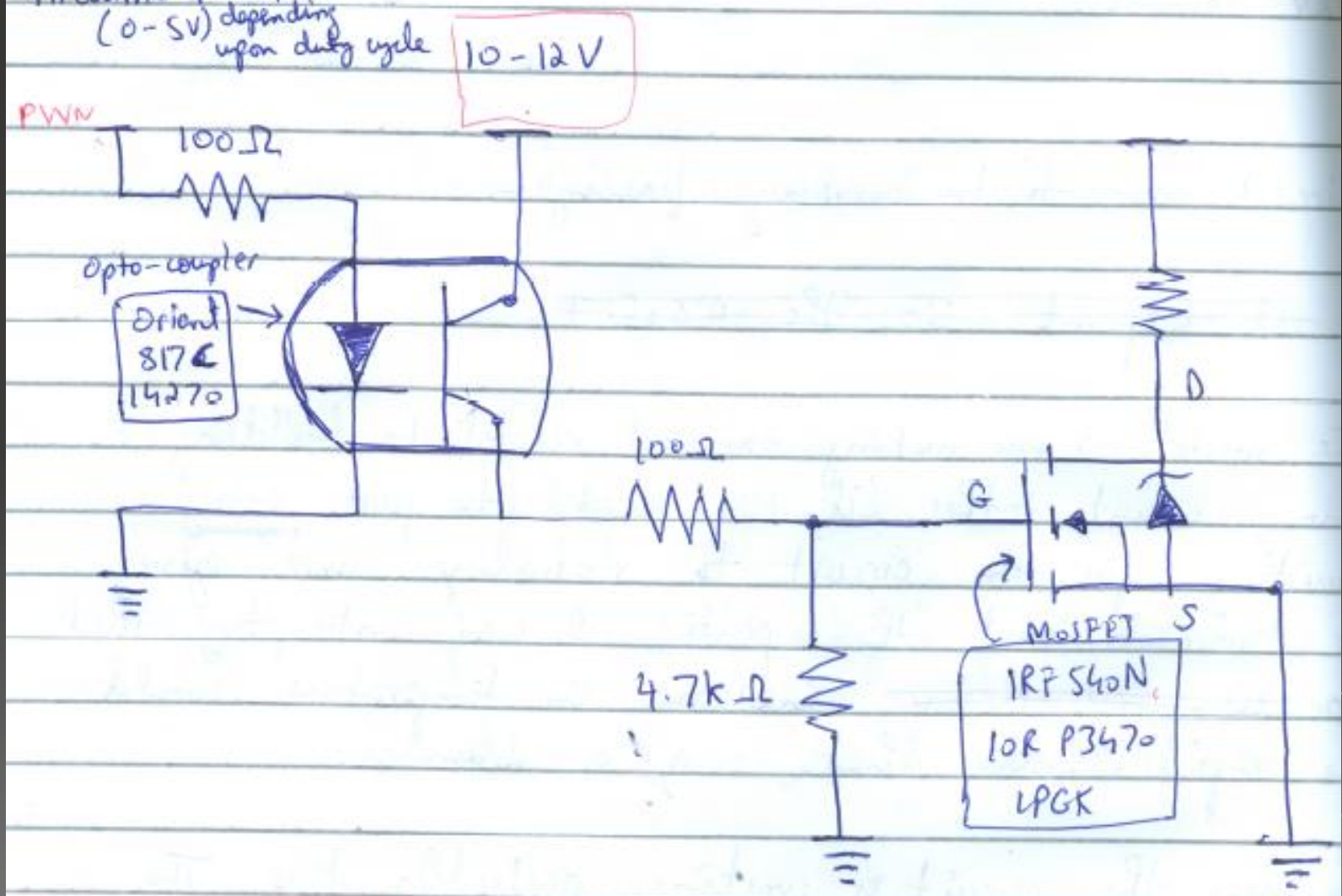
Sketches and schematics





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

Control Circuit (New)

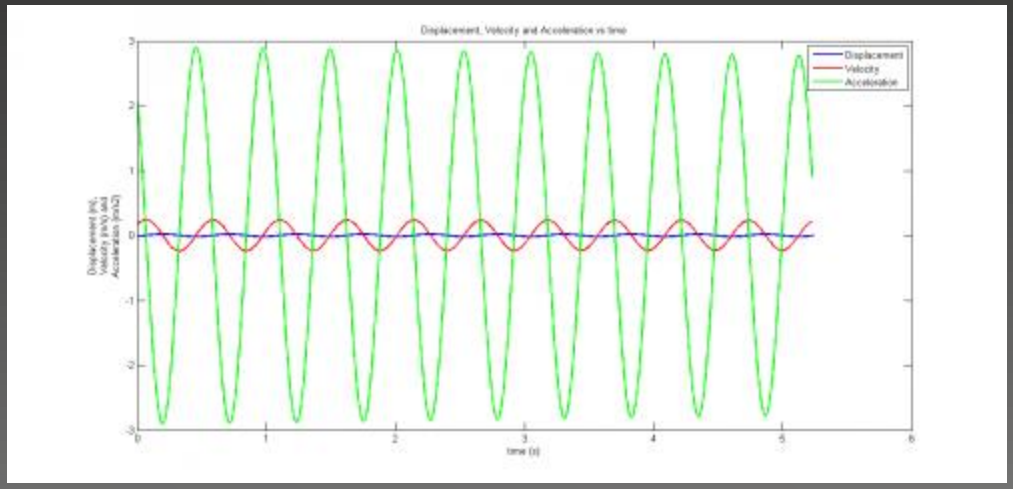


Components of PHY 100

Physics using video analysis, high speed cameras and webcams

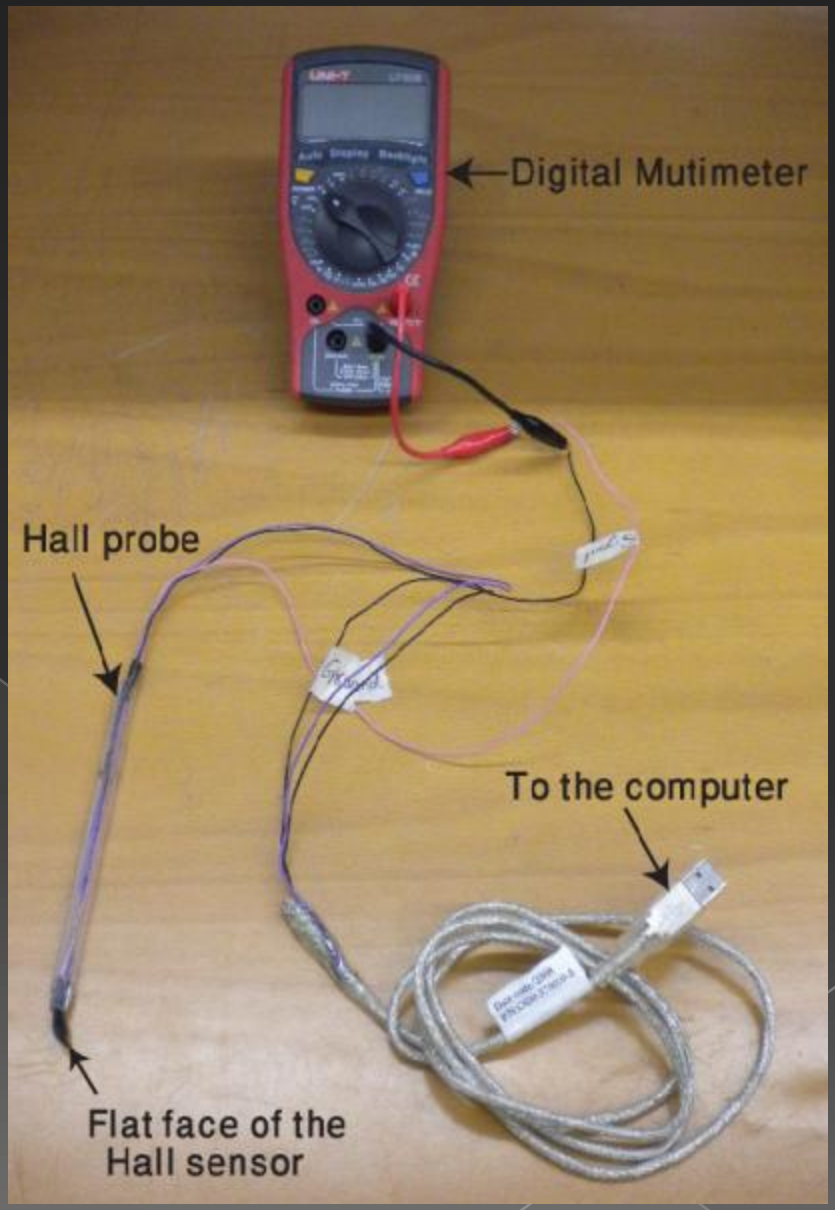
High-Speed Video of a coin revolving and precessing about different axes. Shot at 240 frames per second.

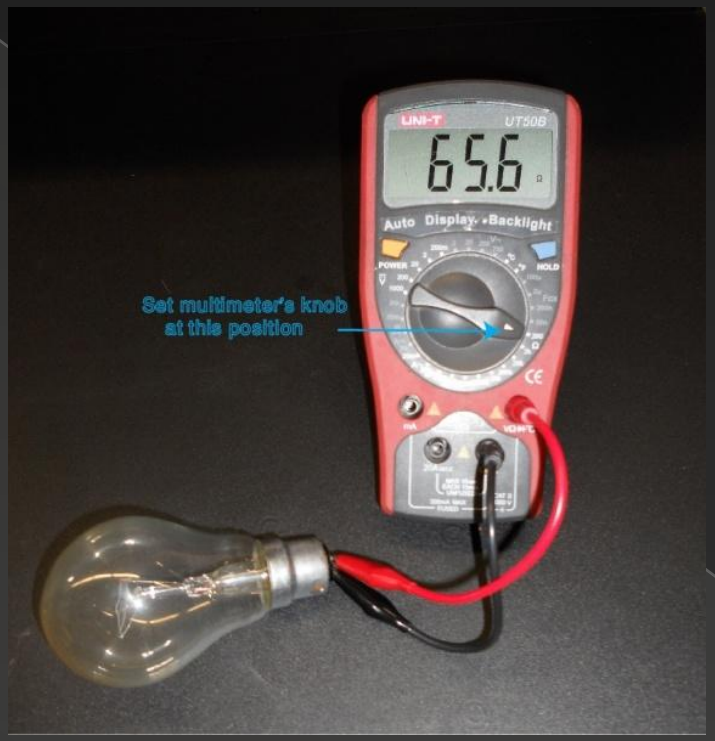
Smartphone physics

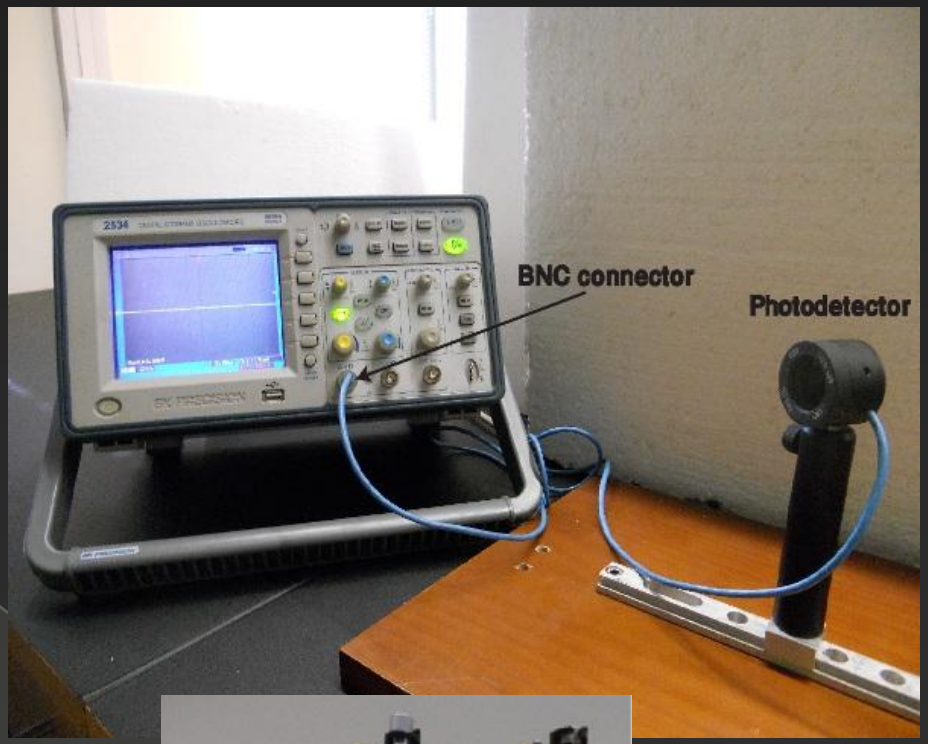


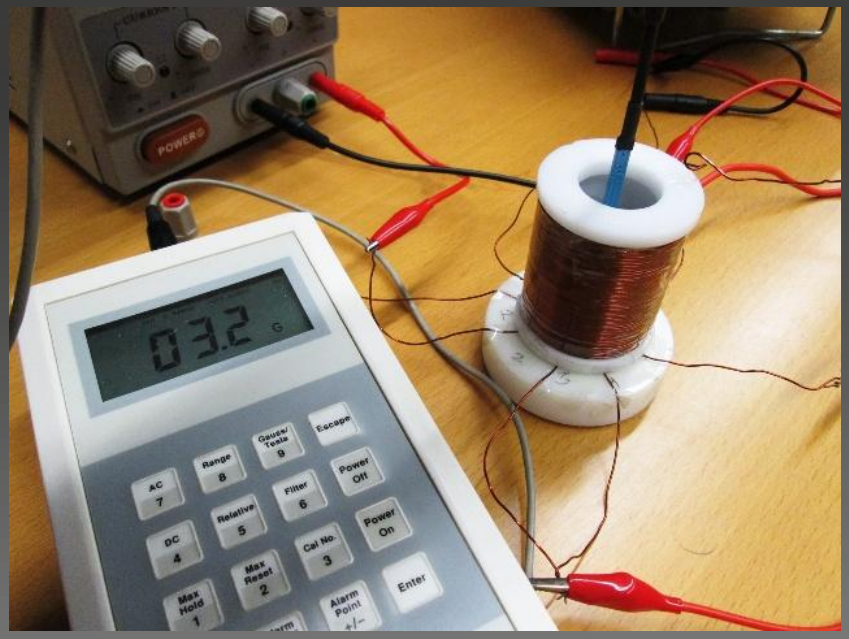
Lasers and optics

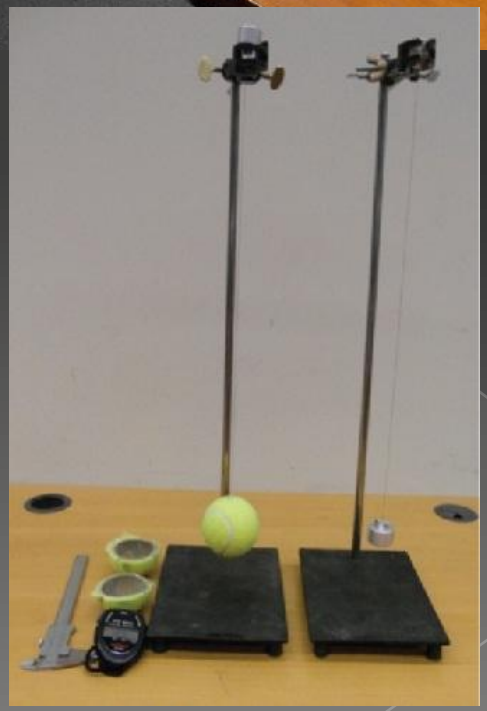
Sensors and transducers


Digital Mutimeter
Hall probe
To the computer
Flat face of the
Hall sensor


UNI-T
UT50B
65.6
Auto
Display
Backlight
POWER
HOLD
Set multimeter's knob
at this position


BNC connector
Photodetector


POWER
03.2
G
Escape
Gauss/
Tesla
9
Range
8
Power
Off
AC
7
Filter
6
Relative
5
Power
On
DC
4
Cal No
3
Max
Reset
2
Enter
Max
Hold
1
Alarm
Point
+/-



Computer interfacing and automation

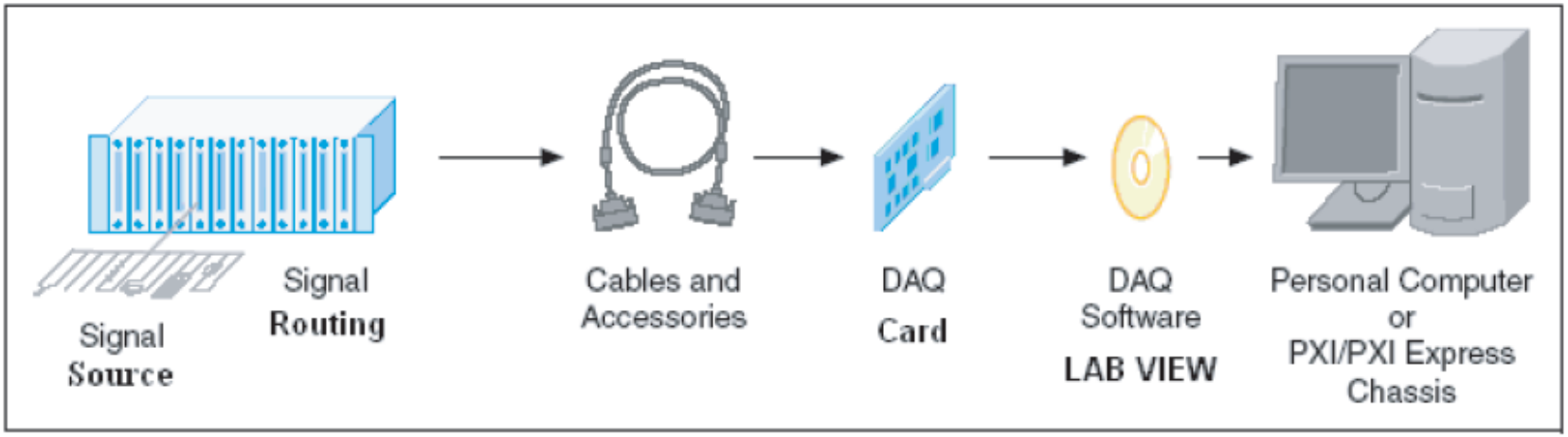
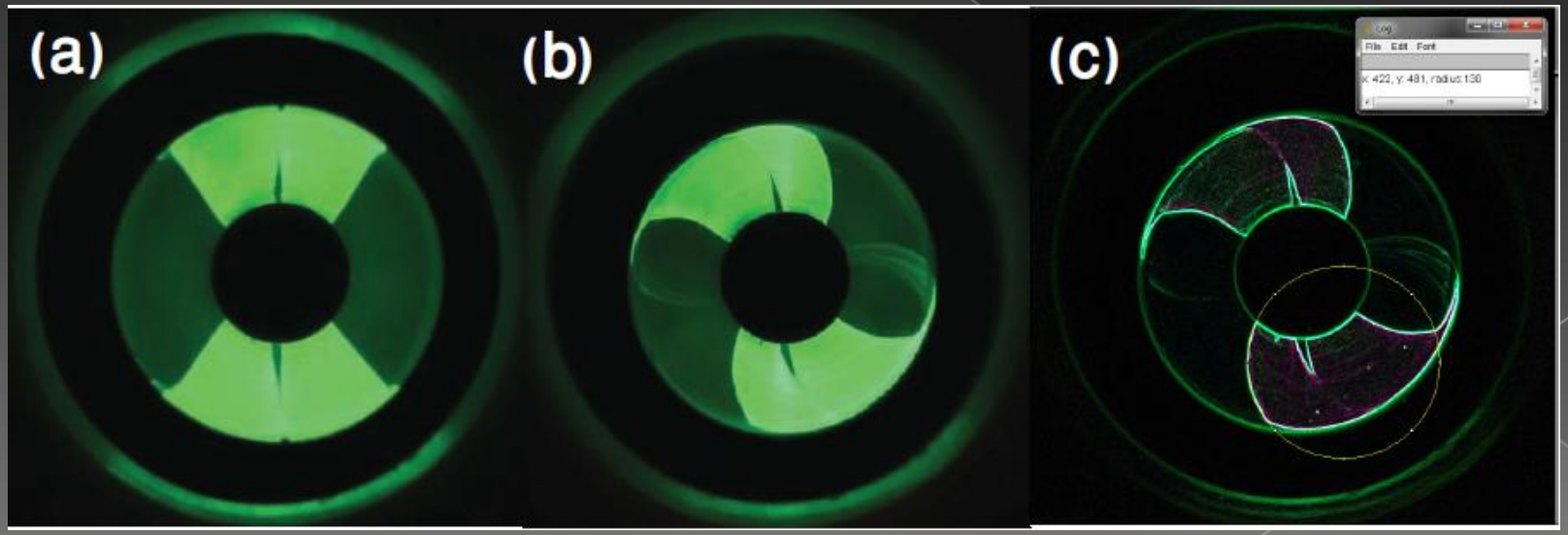
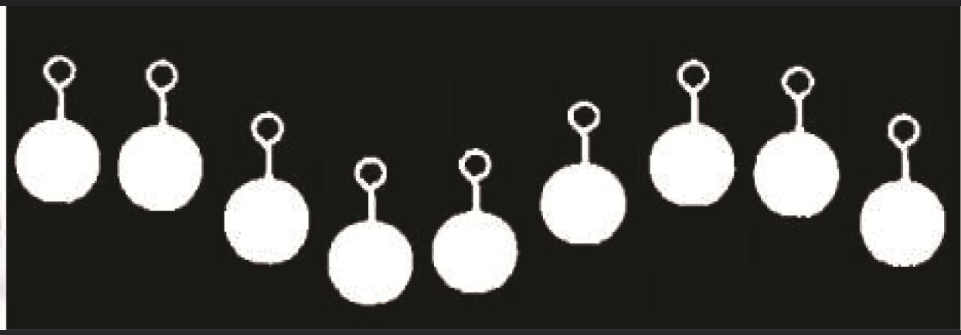
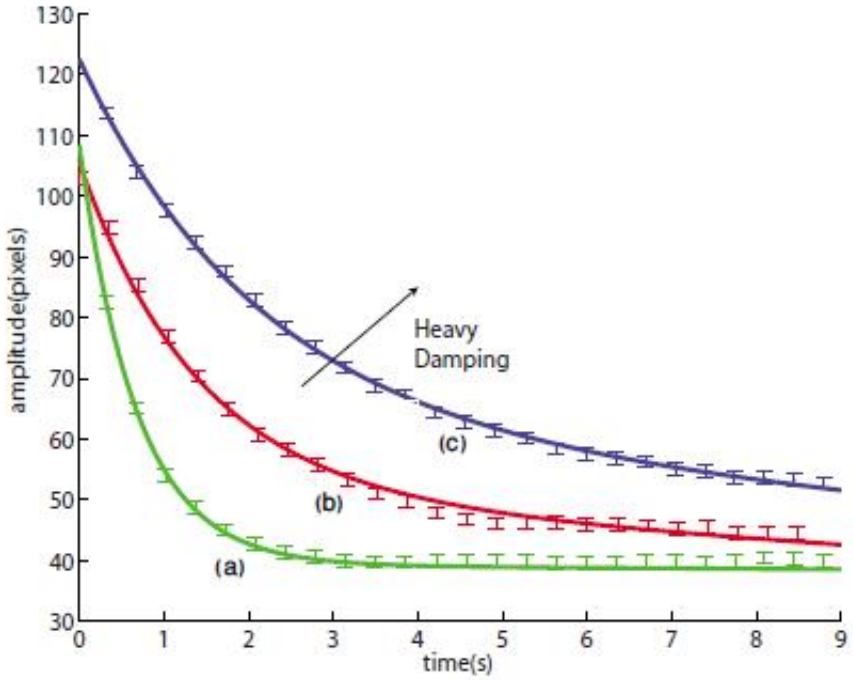


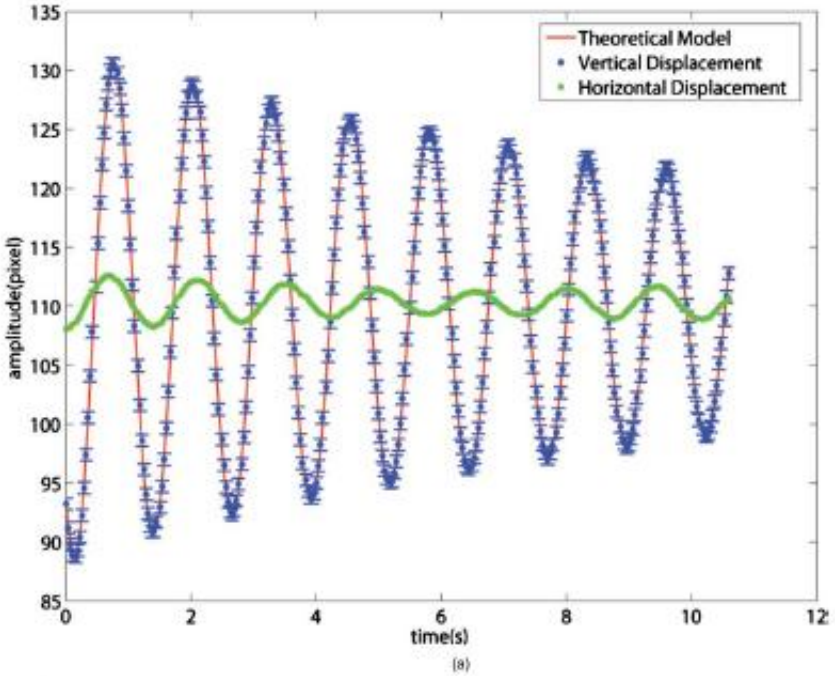
Image processing



Video processing

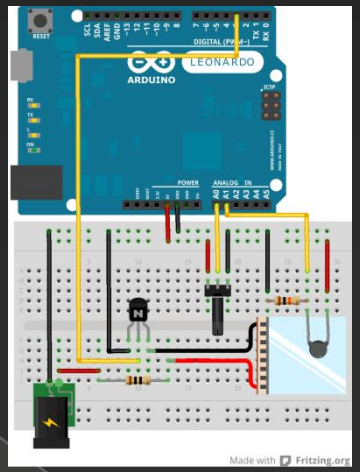


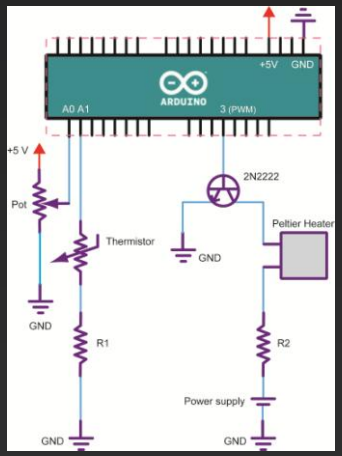




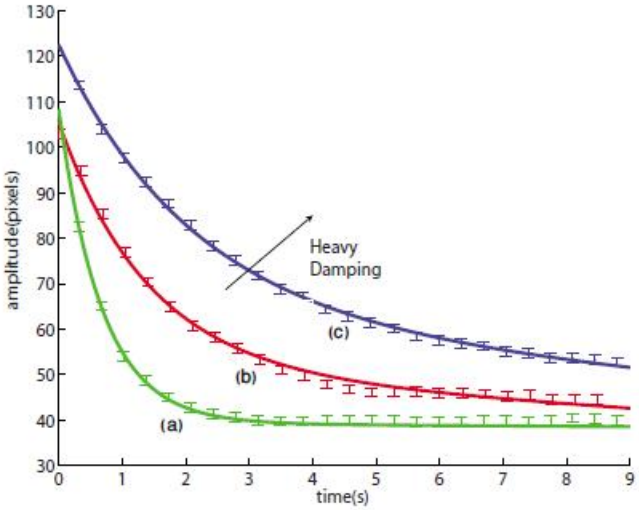
Contd. From previous page

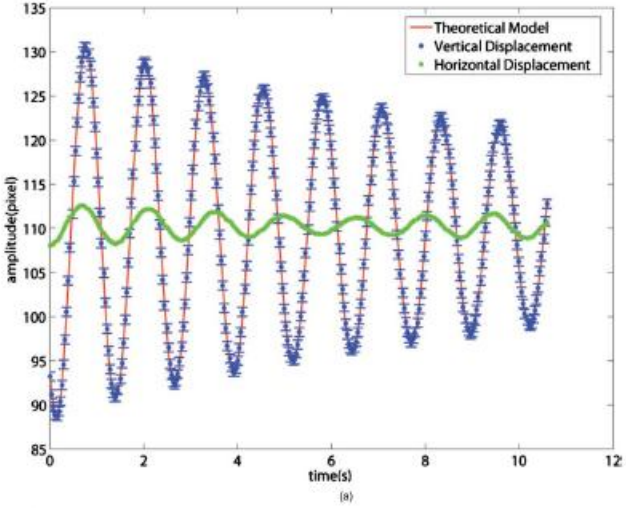
Emerging world of Arduinos





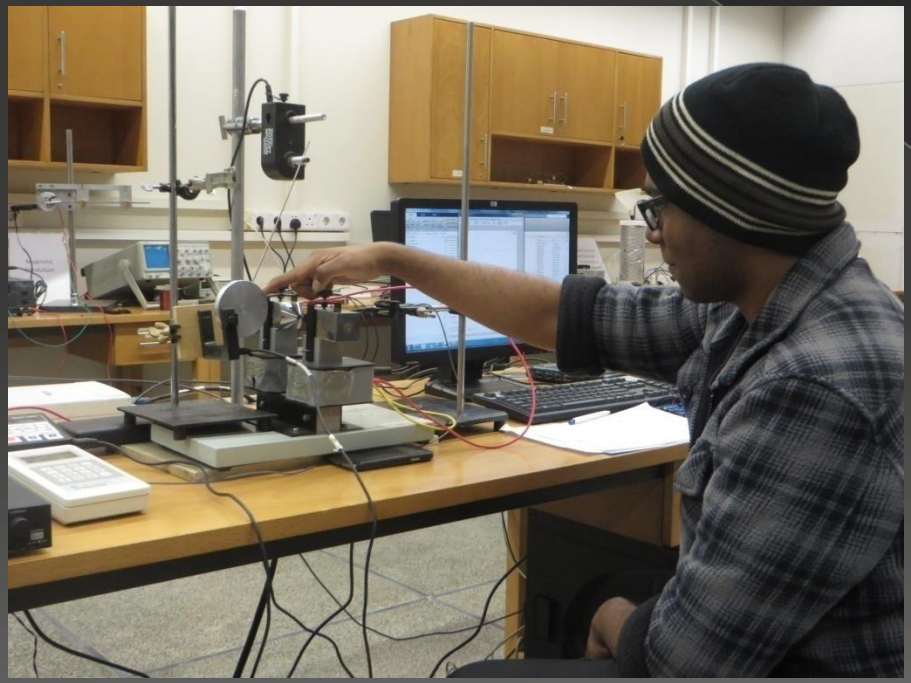
Presenting Data

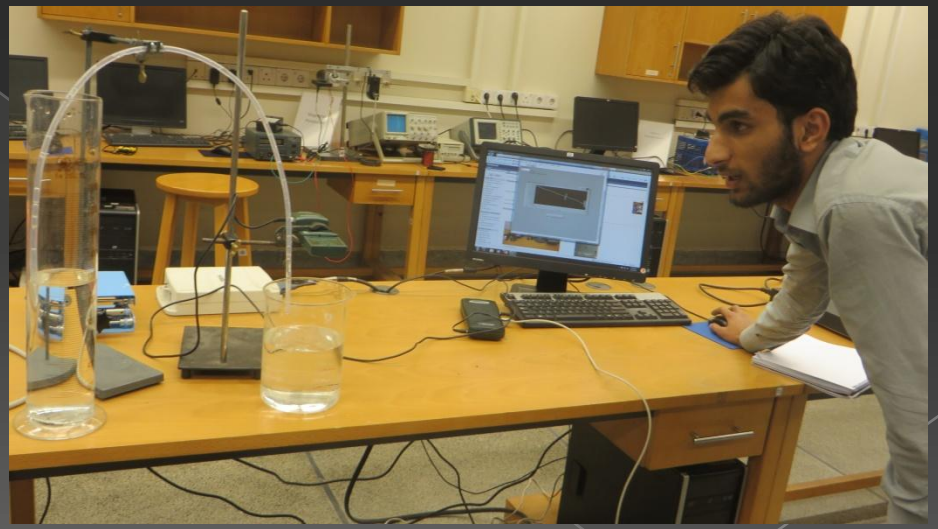




Physics studio

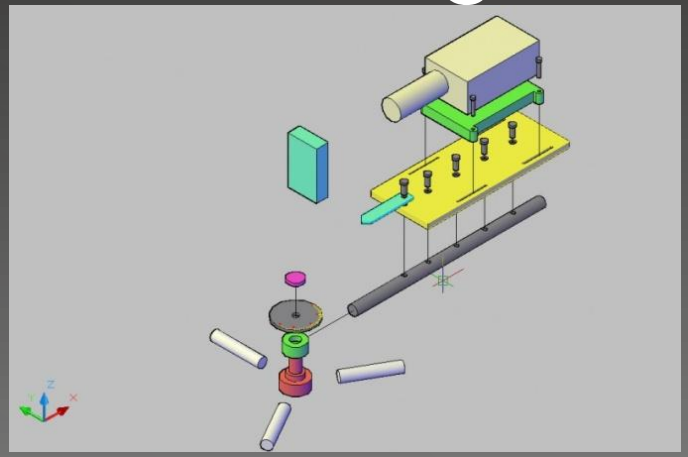
An optional track for students where they design new experiments from scratch

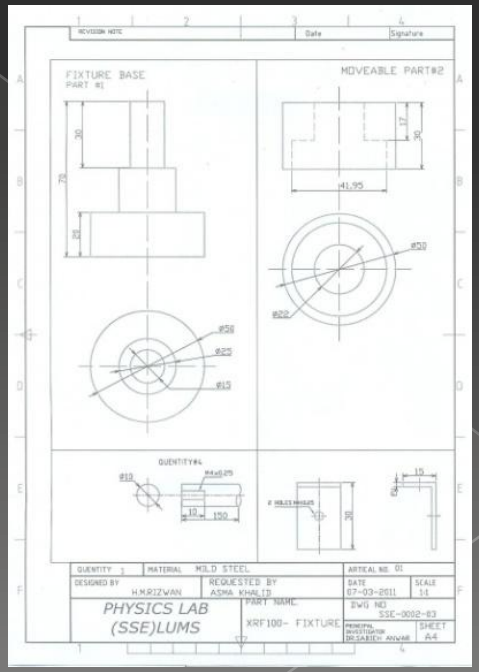




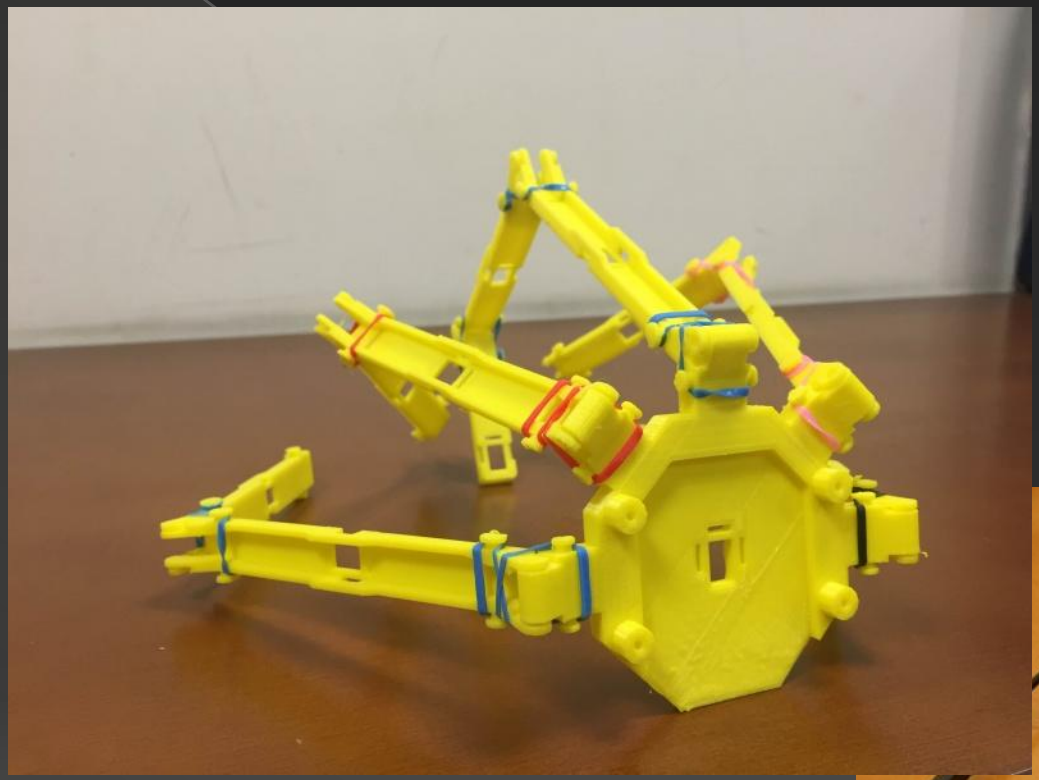
Access to Workshop

Instrument Design



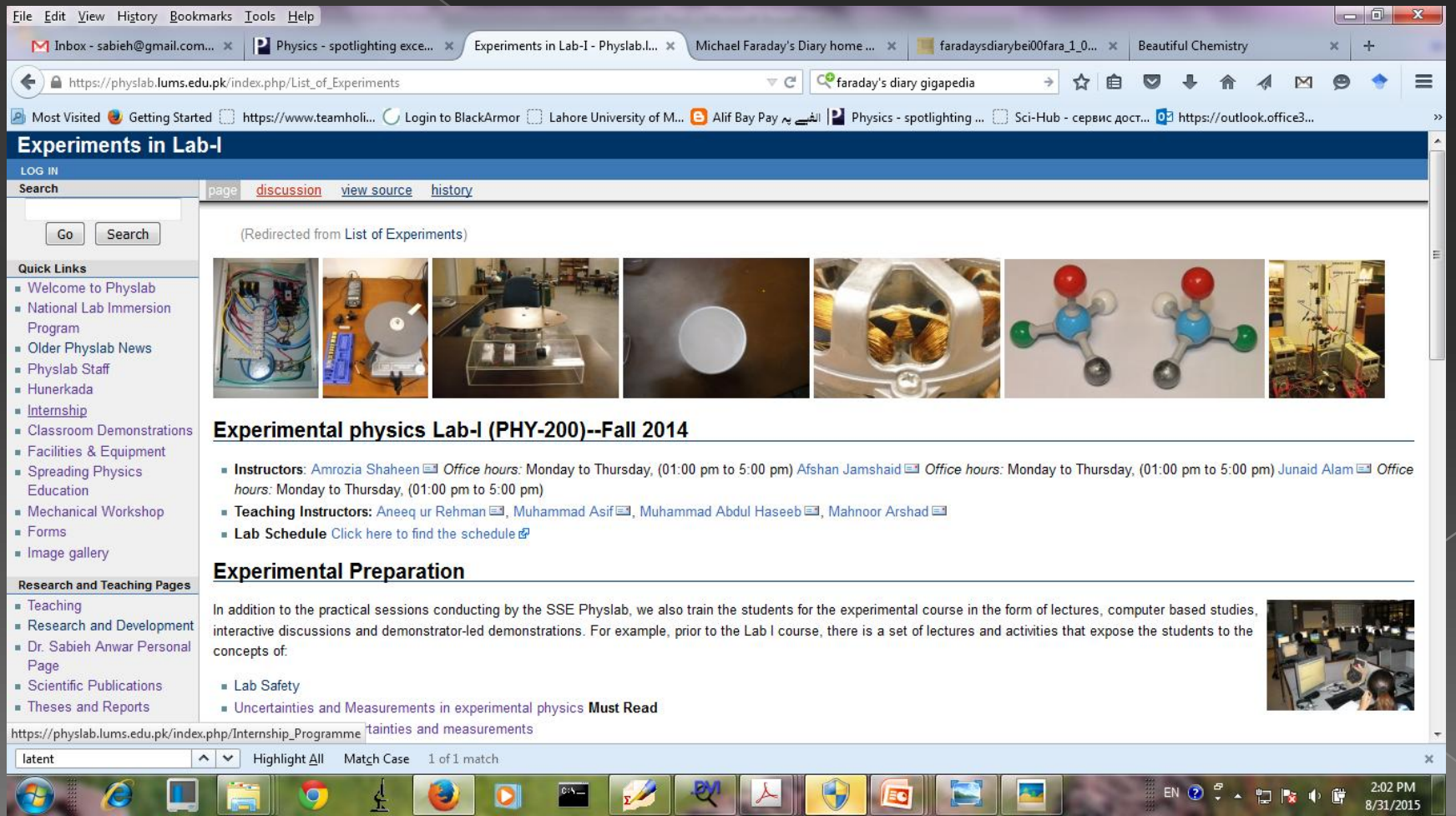


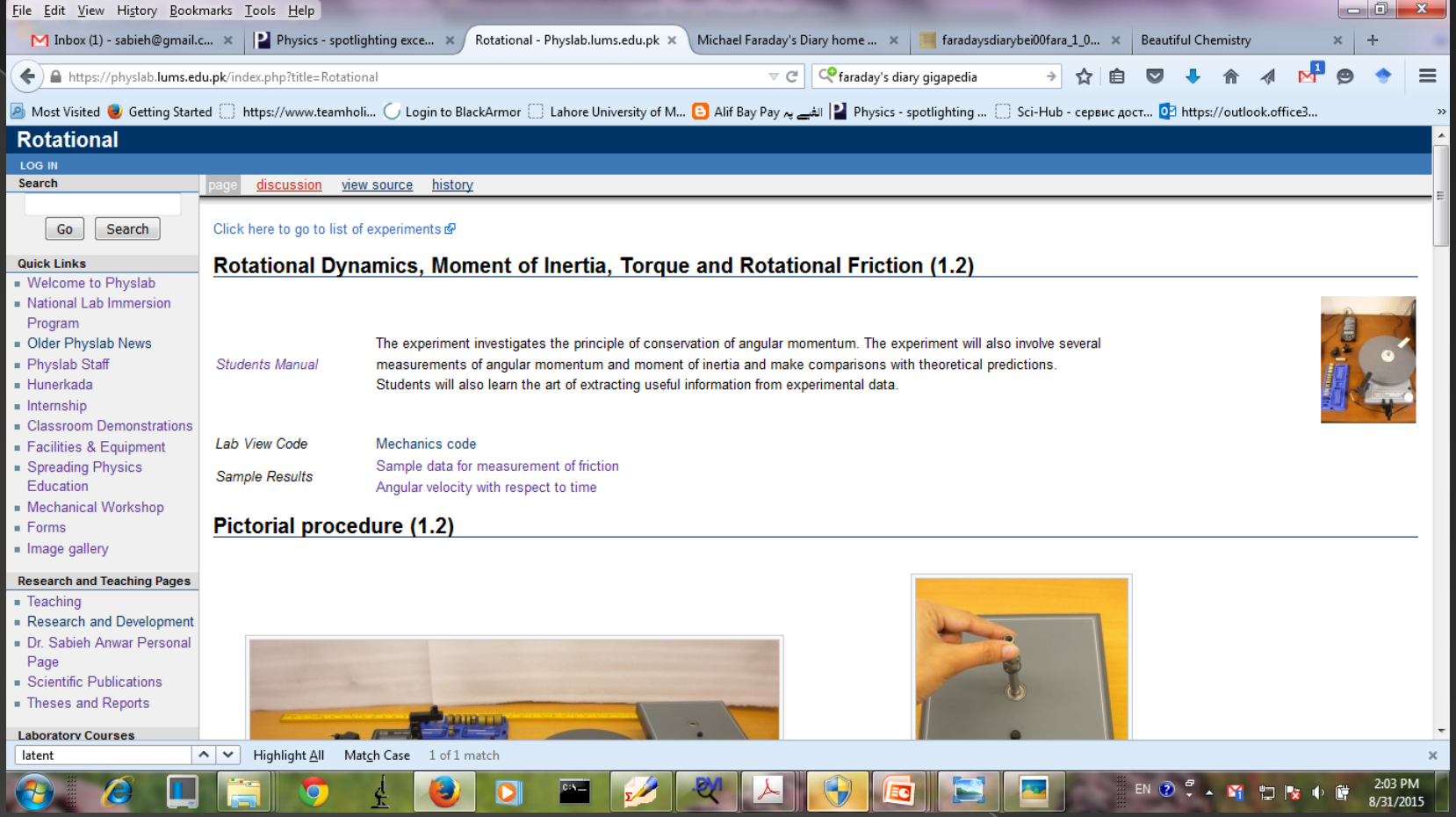
3D Printing



Website

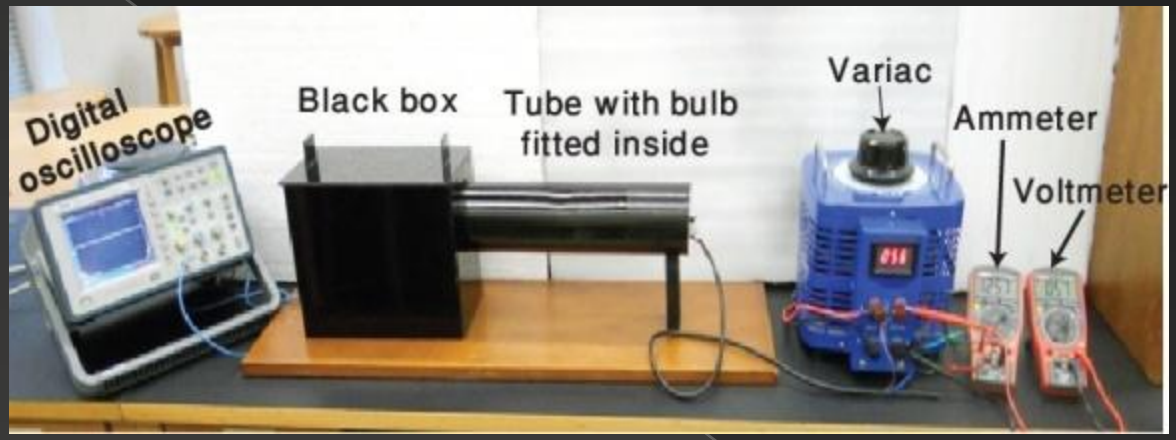
http://physlab.lums.edu.pk





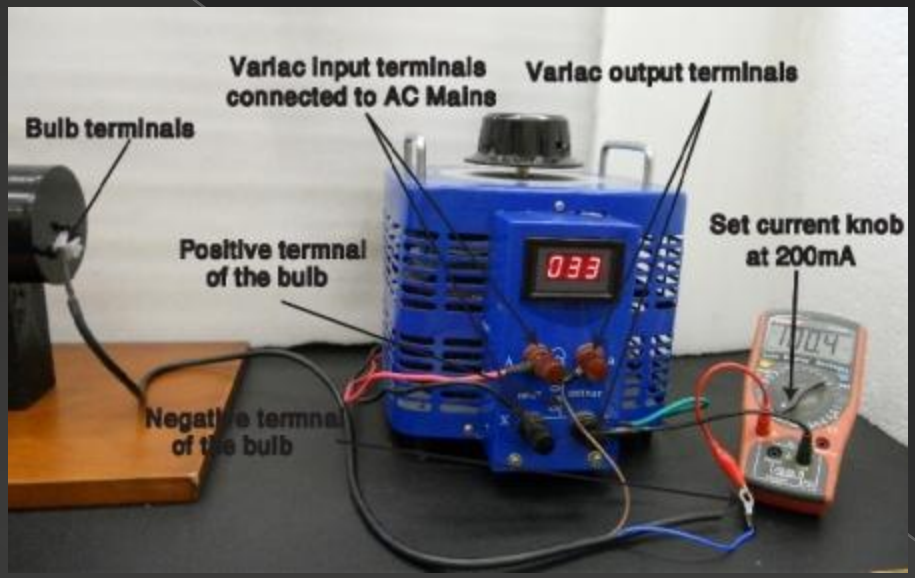
- Students manual
- Sample Results
- Labview Code
- Matlab Code

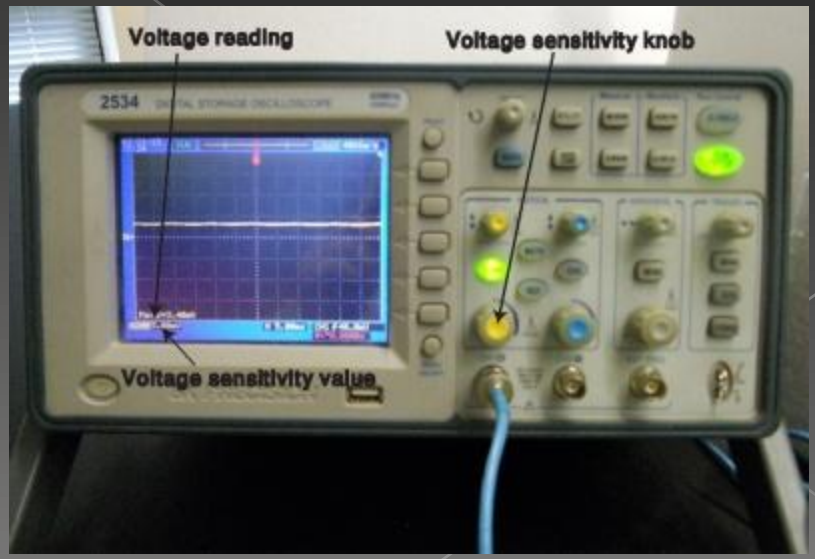
Pictorial Procedures



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

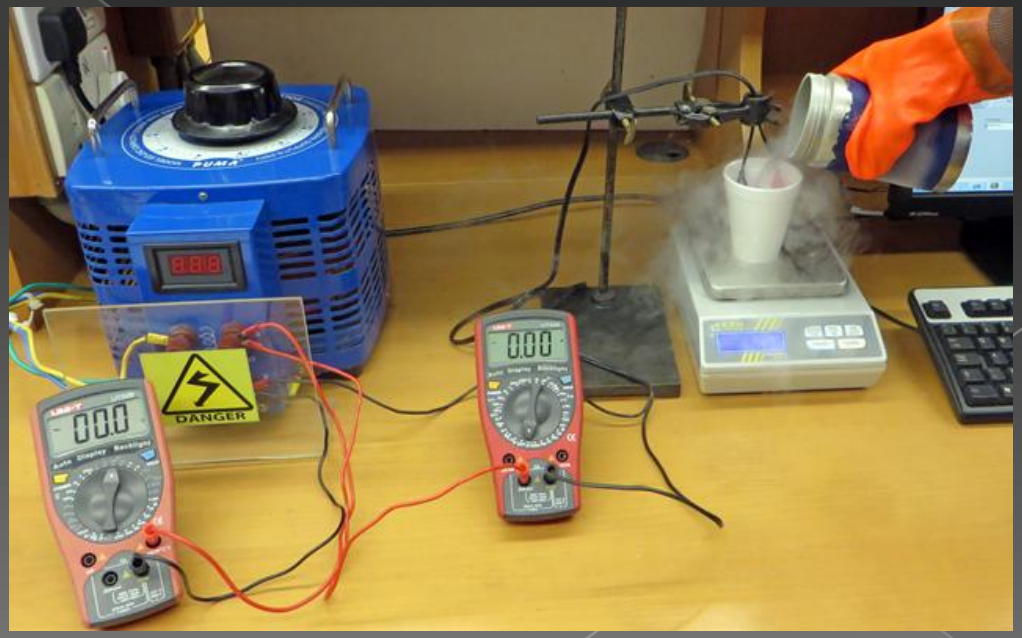
Lab Schedule

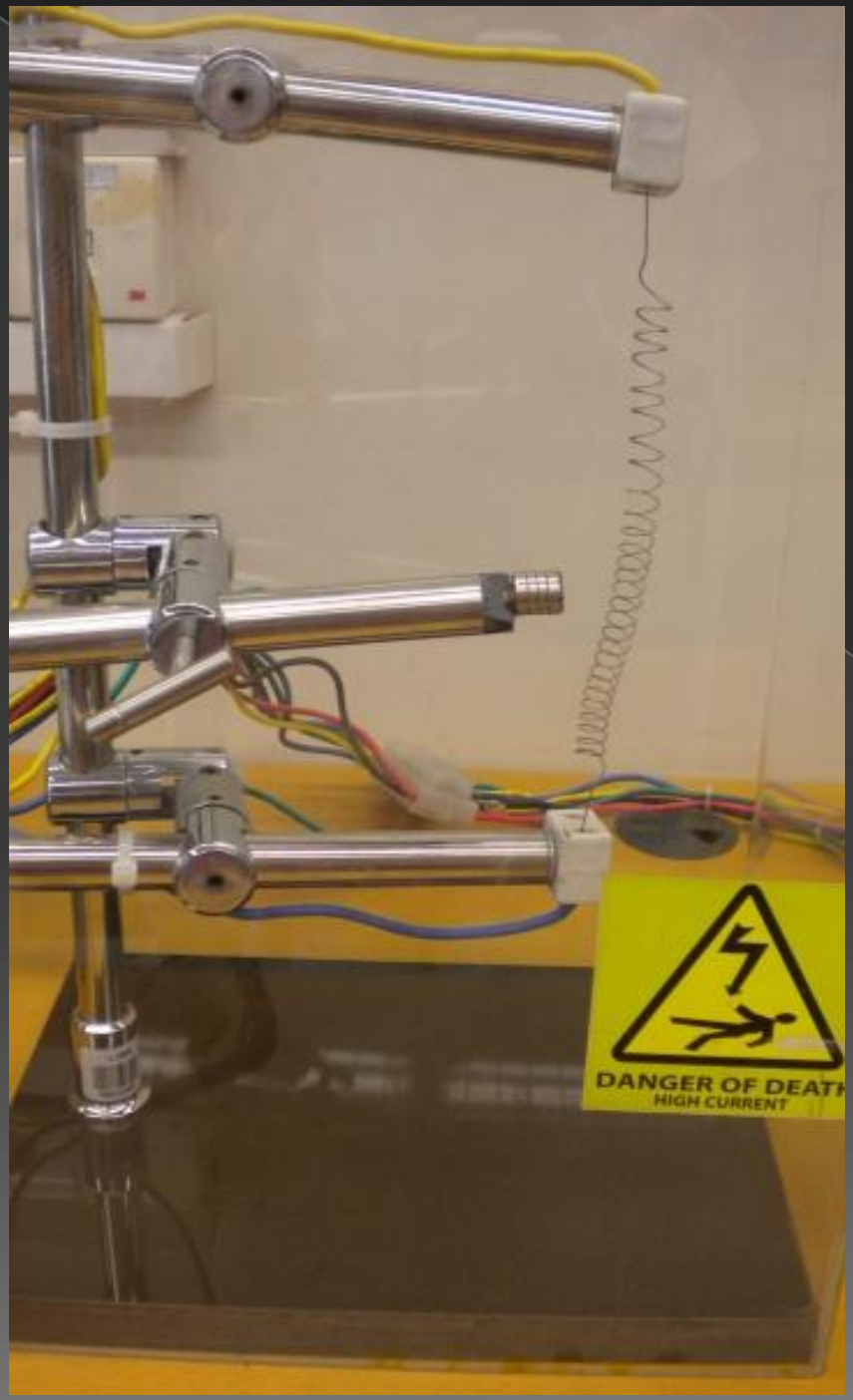
Group	Time Slot	Roll No.	Week-4	Week-5	Week-6	Week-7	Week-8	Week-9
PH 110 A (Monday)	2:00pm – 6:00 pm	1-6	GP	HT	M	EM	EL	O
		7-12	HT	M	EM	EL	O	GP
		13-18	M	EM	EL	O	GP	HT
		19-24	EM	EL	O	GP	HT	M
		25-30	EL	O	GP	HT	M	EM
		31-36	O	GP	HT	M	EM	EL

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
- Cryogens
- Hot Surfaces
- Fire and electric safety
- Radioactive sources




DANGER OF DEATH
HIGH CURRENT


PHYSLAB
Offices

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 Ranzan - 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