expEYES

A portable
Science Laboratory

http://expeyes.in

FOSS.IN 2012

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Result of a highly thought provoking and motivating lecture...

Our Science/Engineering Education

THEORY
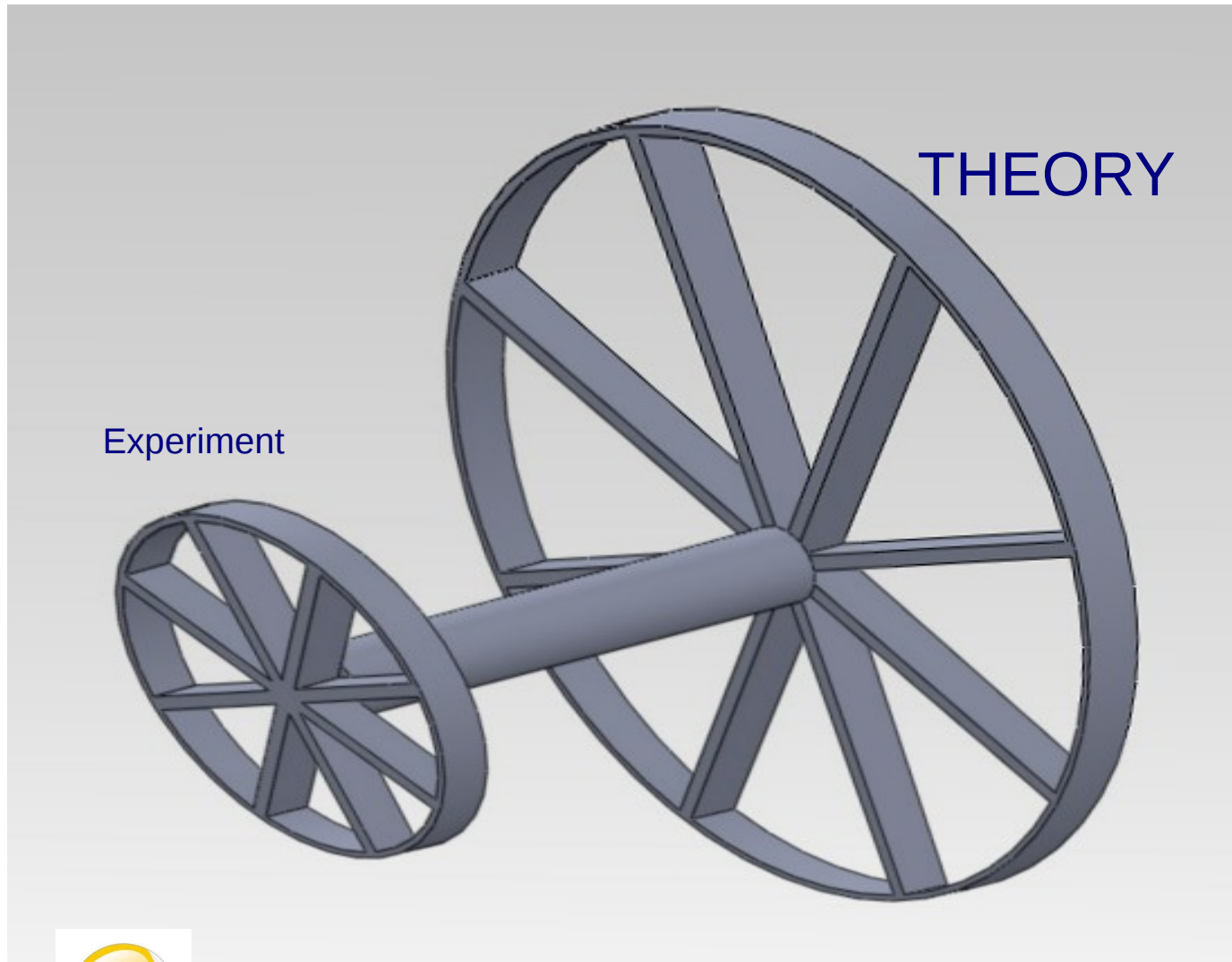
Experiment

😄 .. and it goes in circles.

Why Experiments are ignored in our Science Education ?

- Exam oriented evaluation system.

- Lack of interest.

- Lack of equipment.

  The PHOENIX project, started by IUAC in 2005, tries to address the third issue, by designing cost-effective science/engineering experiments.
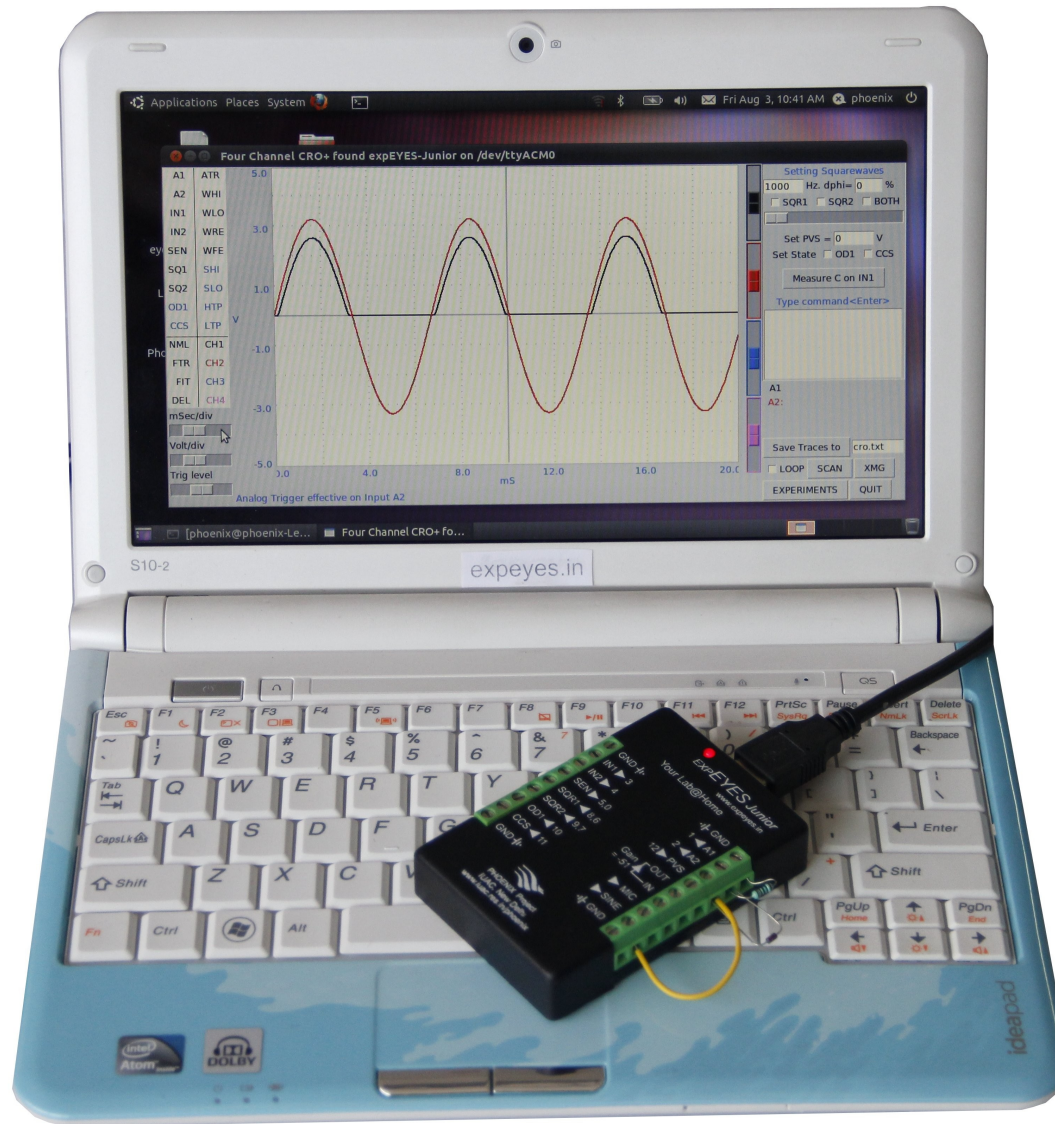
What is expEYES ?

A low cost device that can
generate/measure voltages
as a function of time and generate graphs.

A tool for learning by exploring.

Supports Science & Engineering experiments
from High School to Post Graduate level.
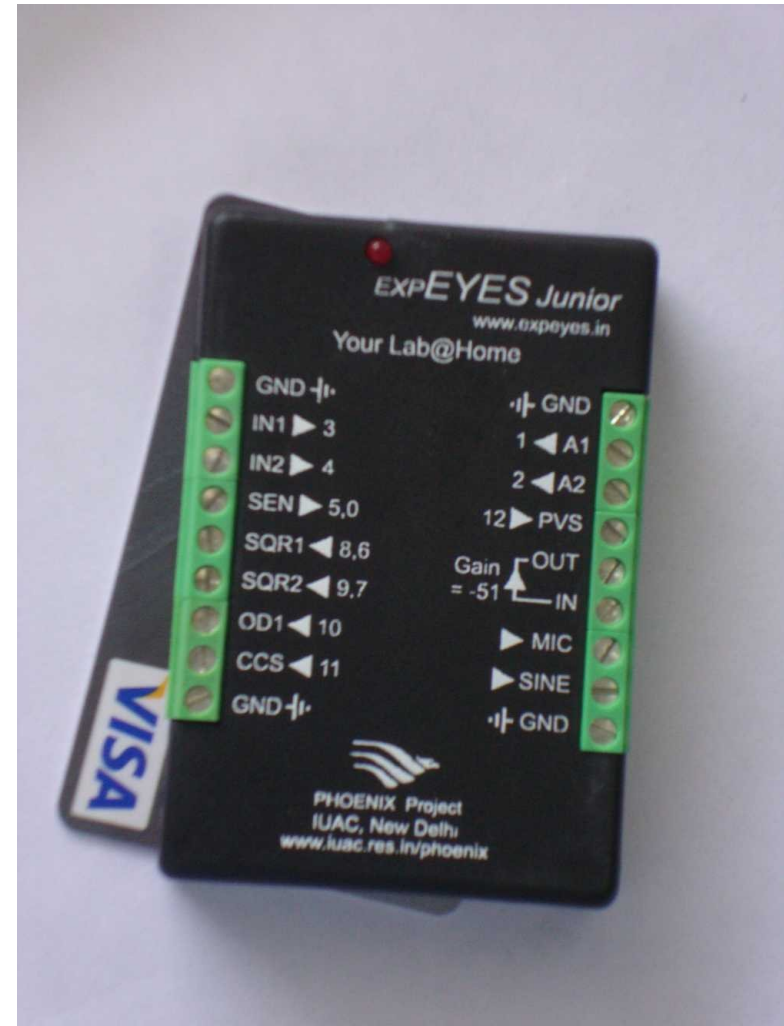
A test equipment for electronics hobbyists.

All with Open Software & Hardware
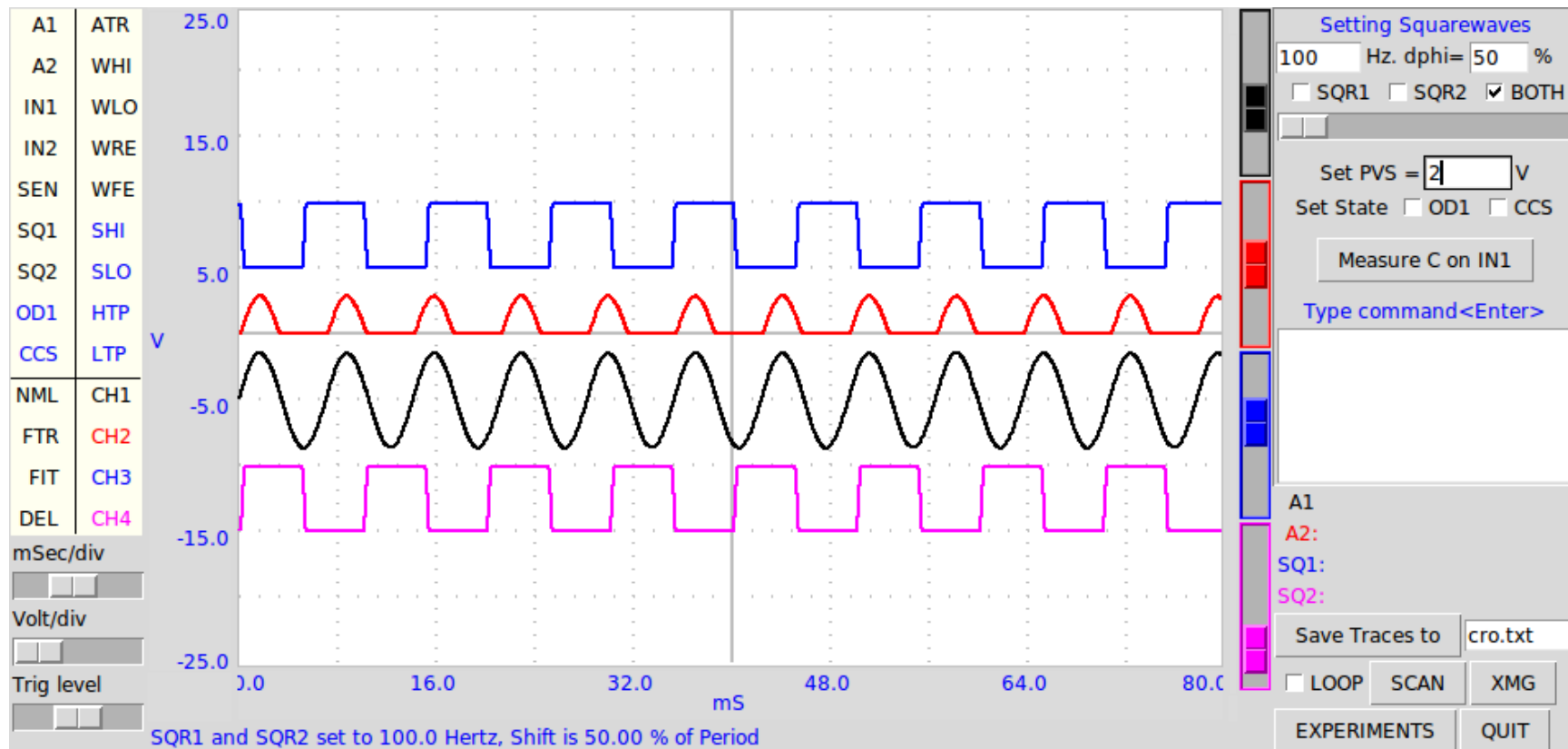
ExpEYES on a netbook, studying a PN junction Diode

Features:

- 12 bit Analog Input/Output

- Digital I/O

- Time interval measurements

- Waveform Generation

- USB Powered

- GUI for 50 experiments

- Python Programmable

- Works as a Test Equipment

- 8.6 x 5.8 x 1.5 cm^3, 60 gm.
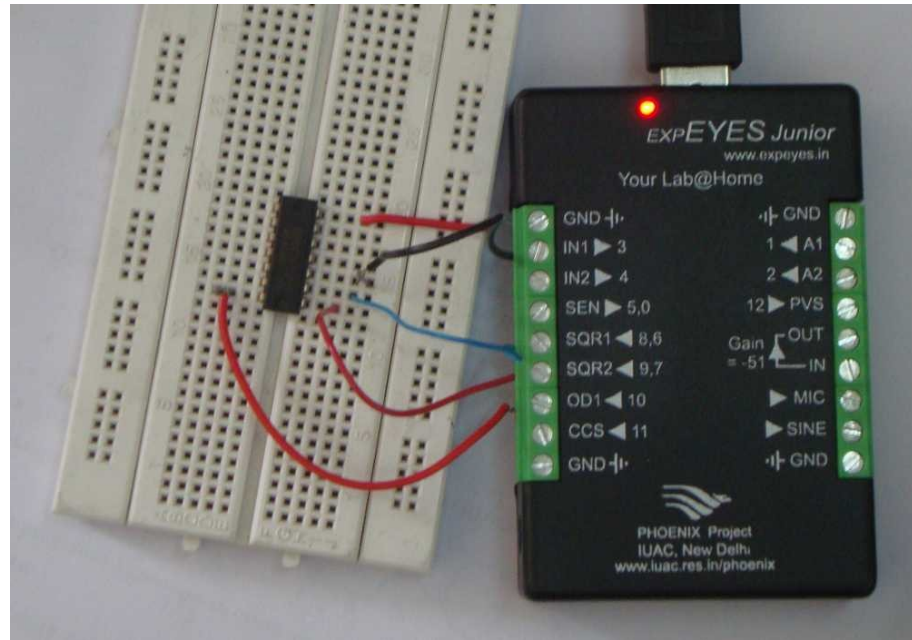
- Open Hardware
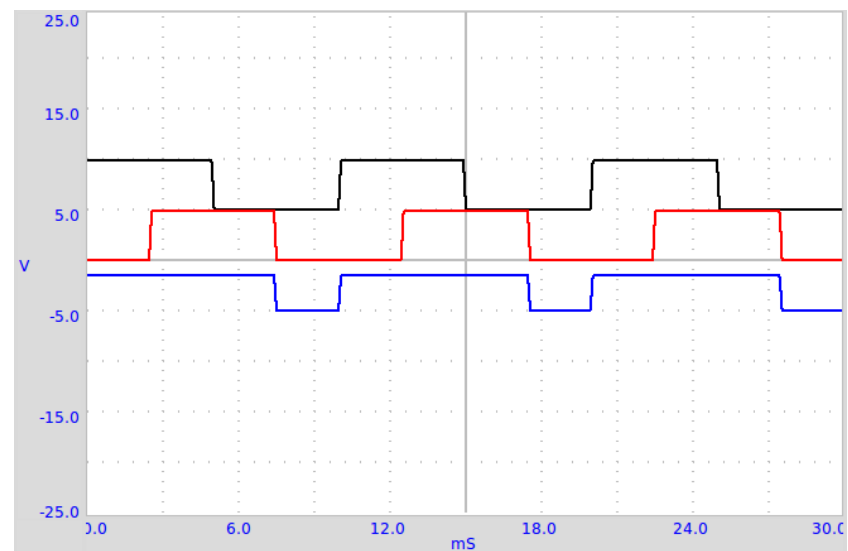
GUI programs available for around 50 experiments

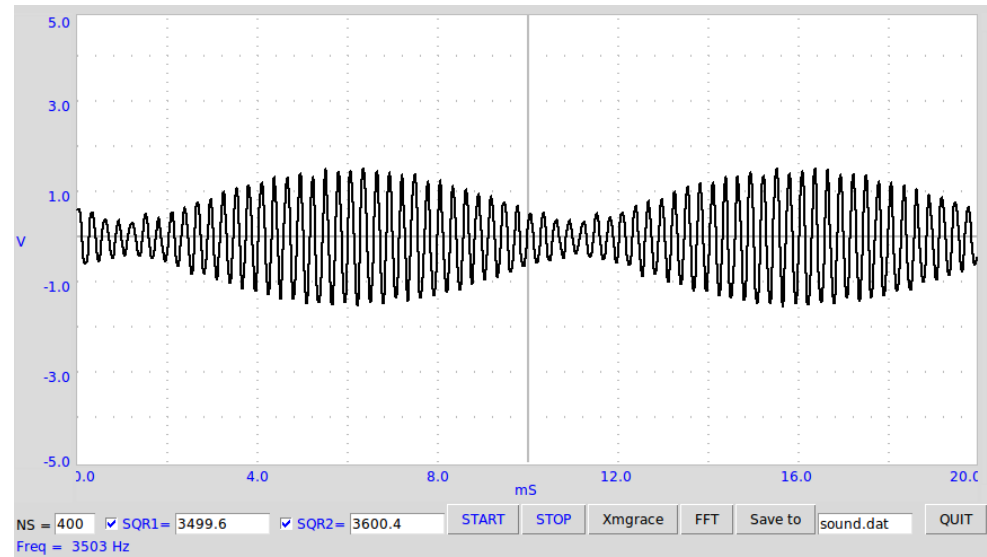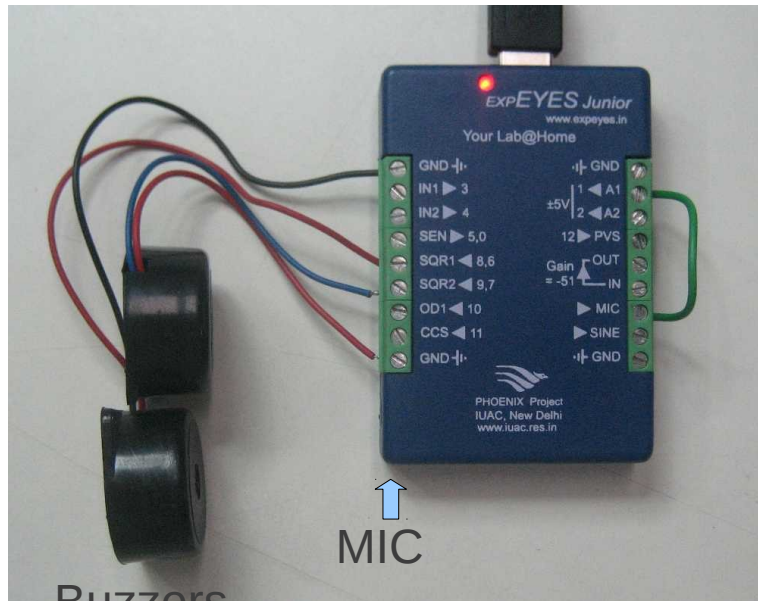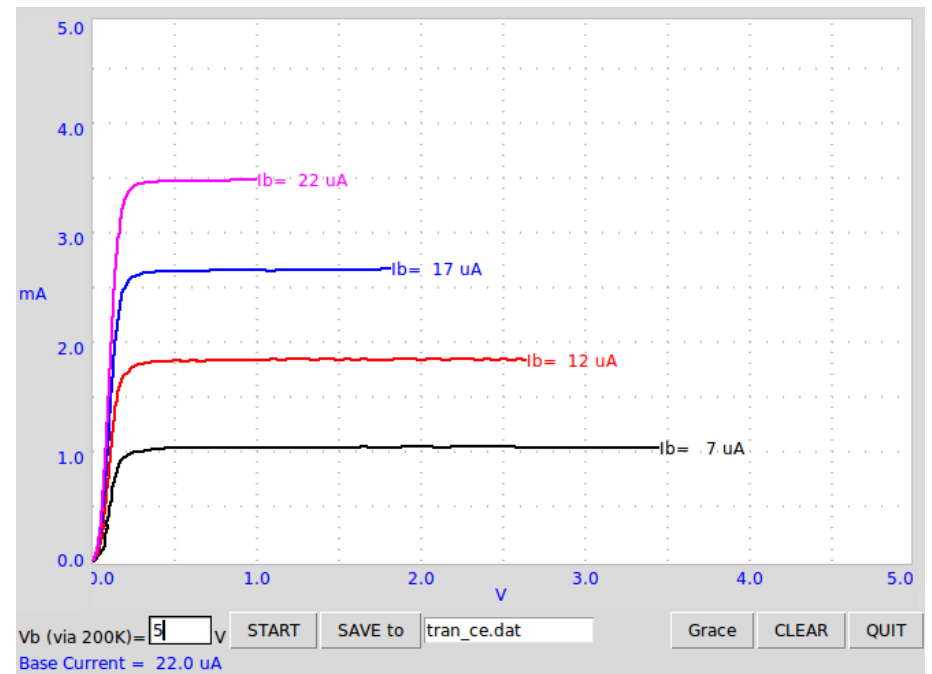## Example 1: Four channel CRO (250 ksps)

Study of Logic Gates
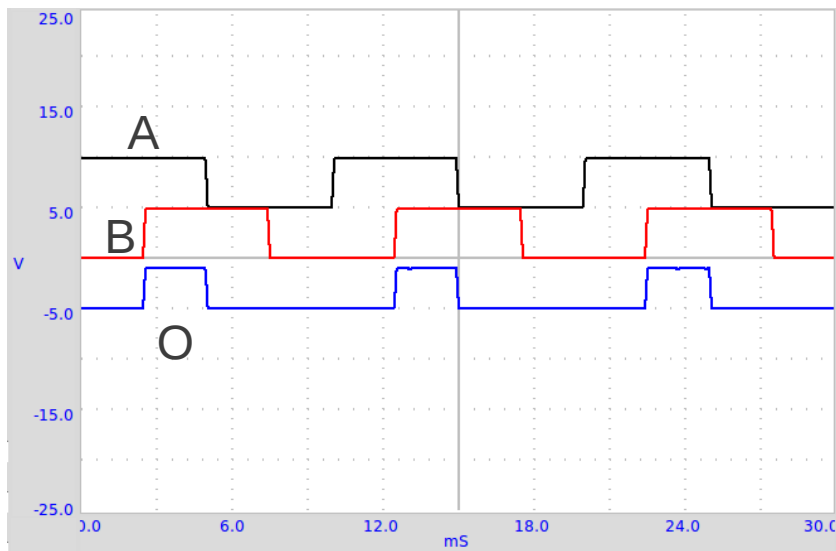
AND Gate

OR Gate

Interference of Sound

MIC

Buzzers

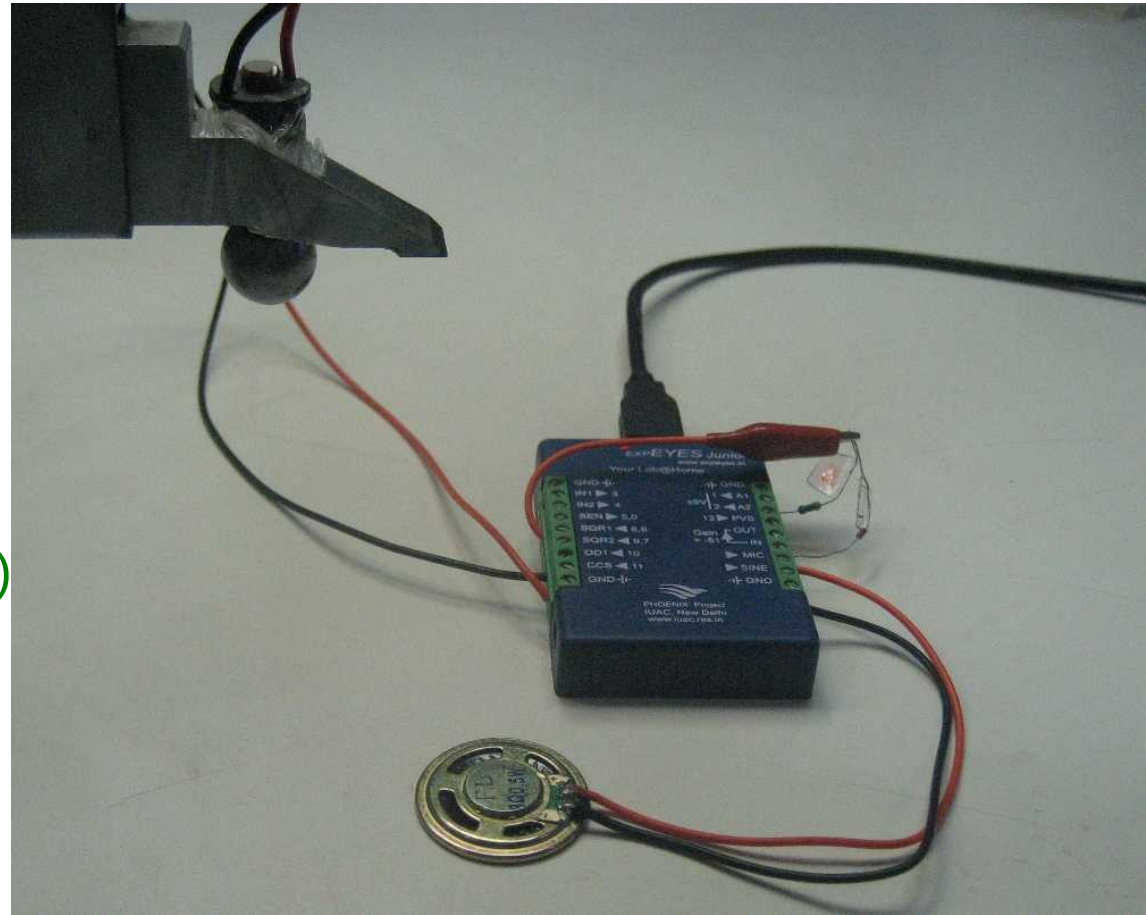# Transistor Characteristics
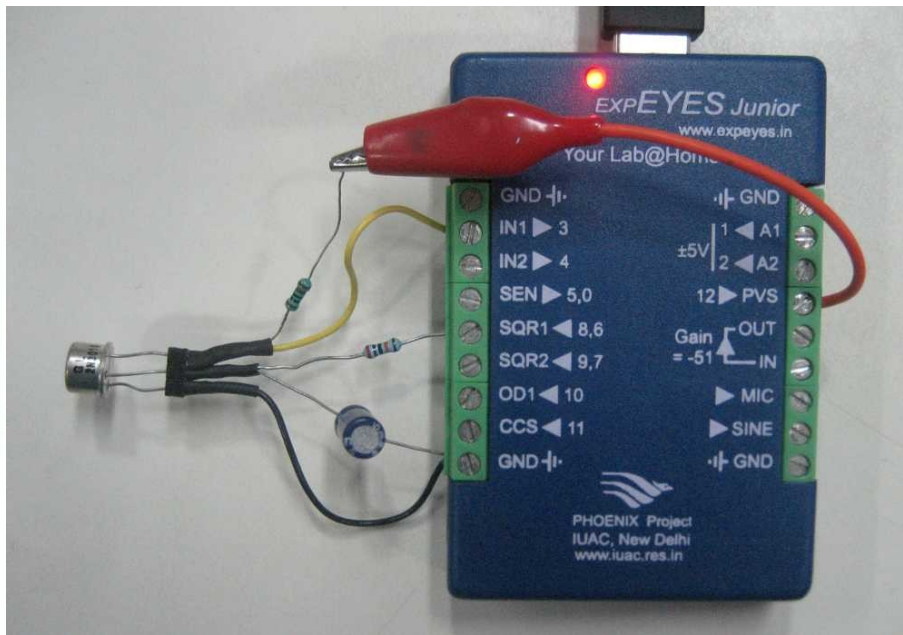
Acceleration due to Gravity, by Time of Flight
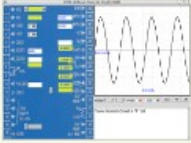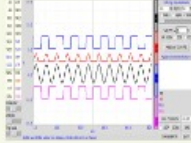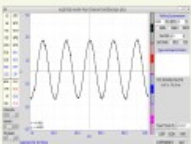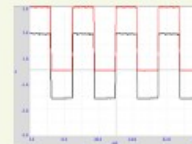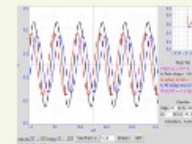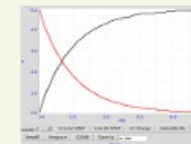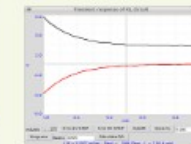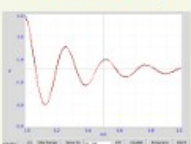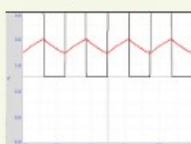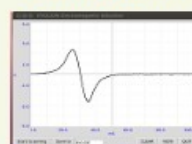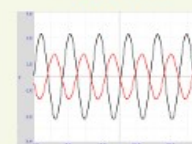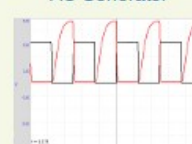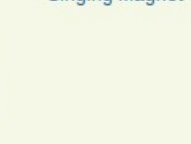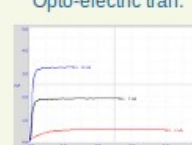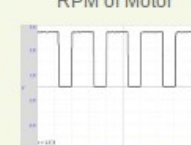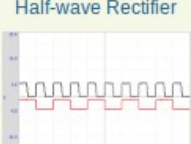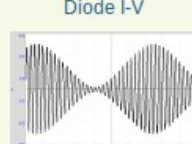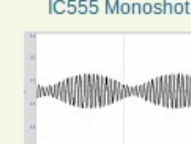

```
import expeyes.eyesj
p= expeyes.eyesj.open()
p.set_state(10,1)
raw_input('Ready')
print p.clr2rtime(10,0)
```
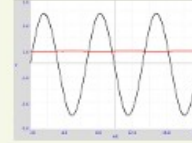
Electromagnet releases a metal ball and the loudspeaker generates a signal when it touches ground.

And many more …   http://expeyes.in

Design of expEYES Junior

Real-time measurement features of Micro-controller
+
Computational and Graphics capability of Python.
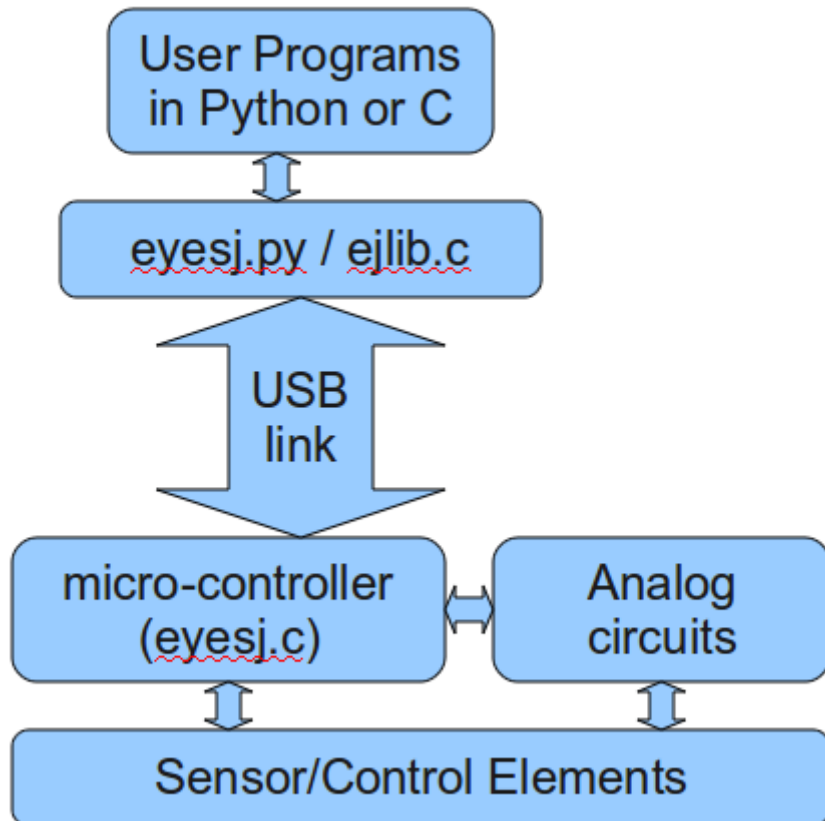

```
import expeyes.eyesj
p = expeyes.eyesj.open()
from pylab import *
t,v = p.capture(1, 200, 100)
plot(t,v)
show()
```
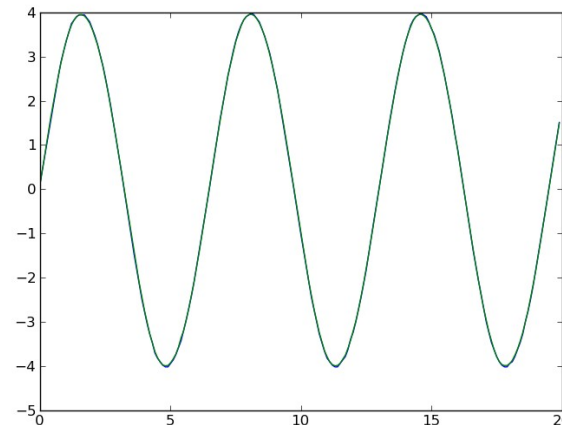
Reducing total cost: cheaper computers.
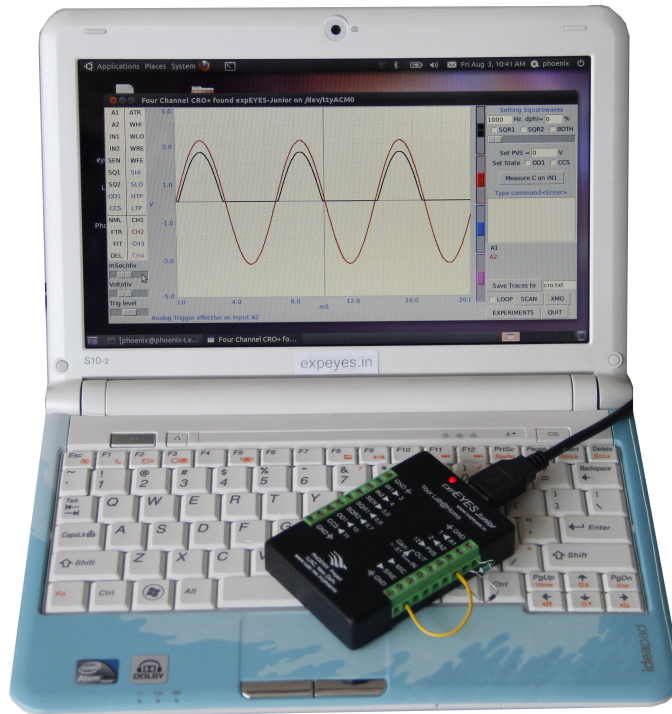
Netbooks with Atom processor.
Costs around 13000/-
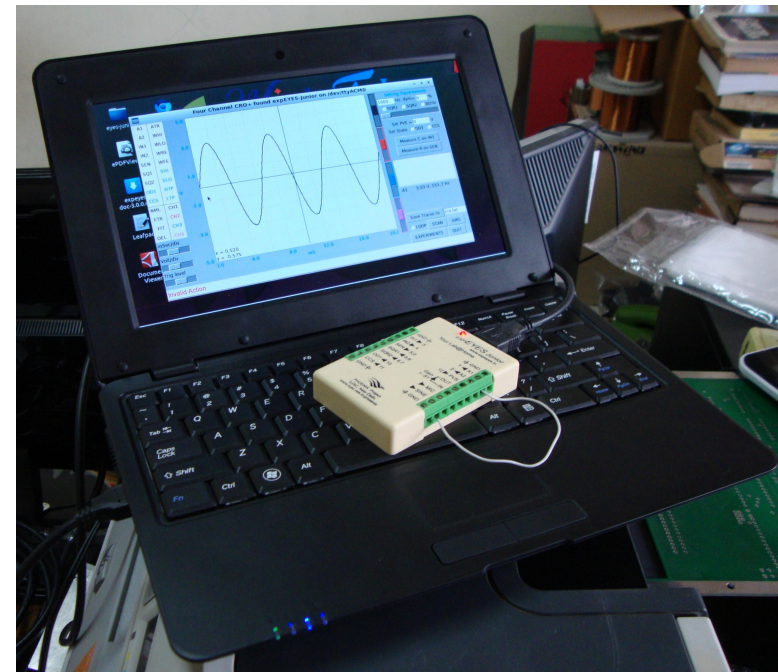
ARM processor based Netbook
around 7000/- from Wishtel

Tested on Raspberry Pi and Aakash2
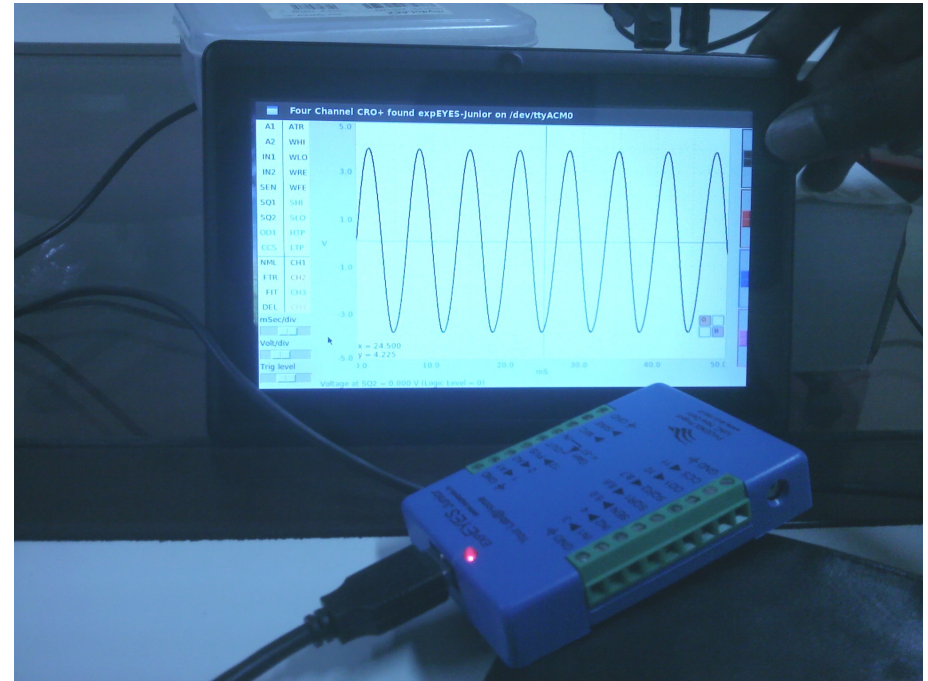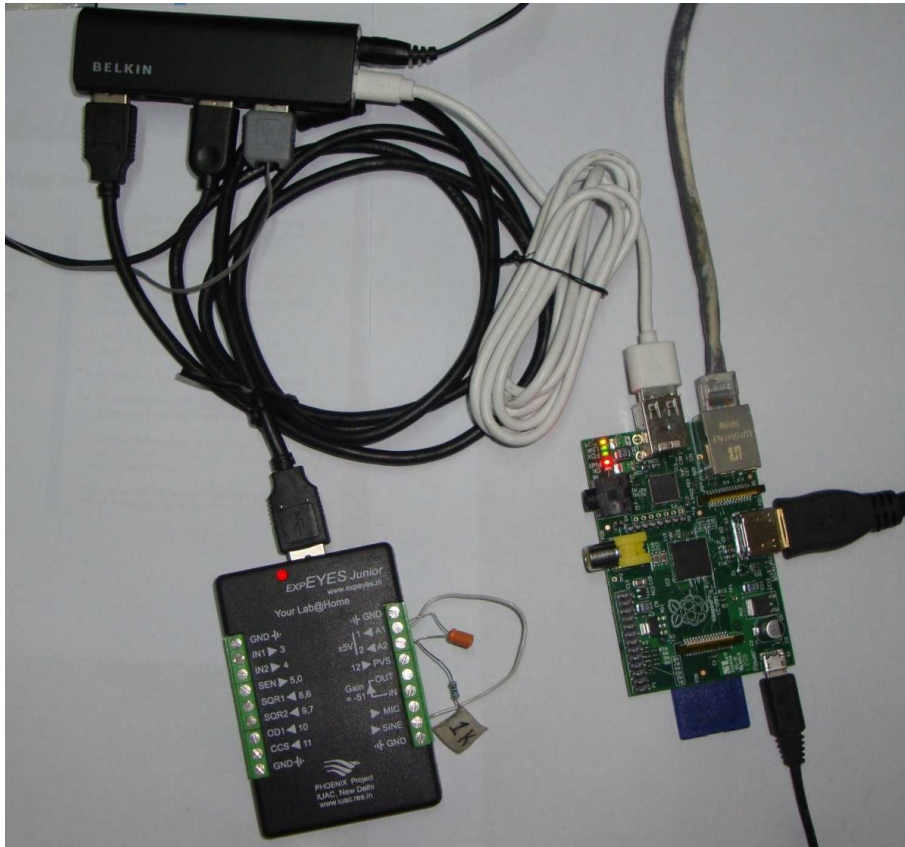
By Aakash2 team, IIT, Bombay

Combined with Aakash2, total cost of setting up a lab is around Rs. 3000/-

What is expEYES for

Students : An affordable tool for doing experiments, anytime anywhere. Freedom from the lab timings.

Teachers : A tool for doing demos, experiments and to develop new experiments.

Engineers : An open system that combines basic physics, electronics, micro-controller programming, computer interfacing, GUI programming and scientific computation.

Hobbyist : A nice tool to kill more time with less money.

The PHOENIX project was started in 2005, with the objective of developing cost effective experiments for teaching science.
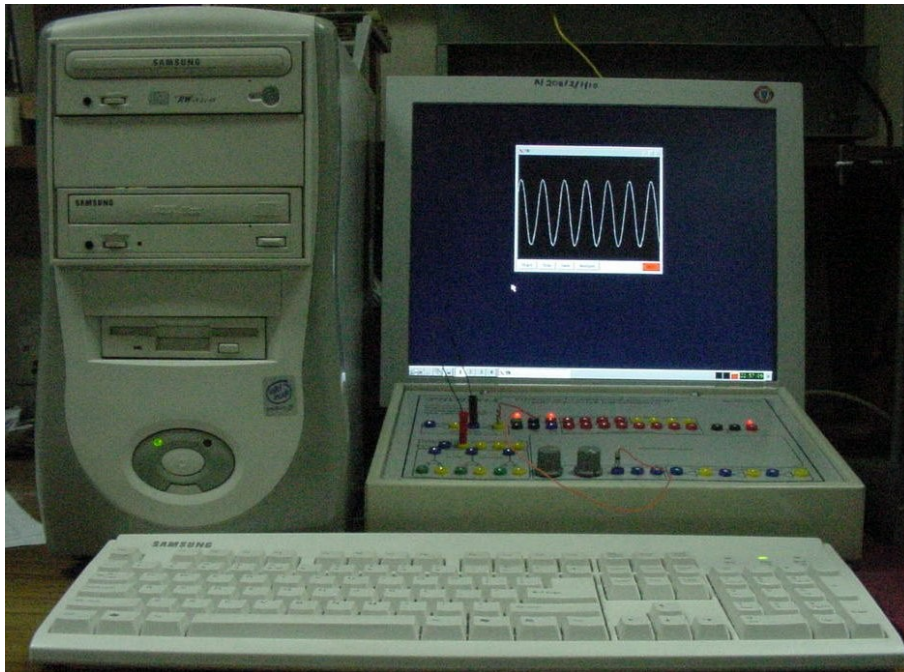
2005 : Parallel port device,
Linux / DOS
C code
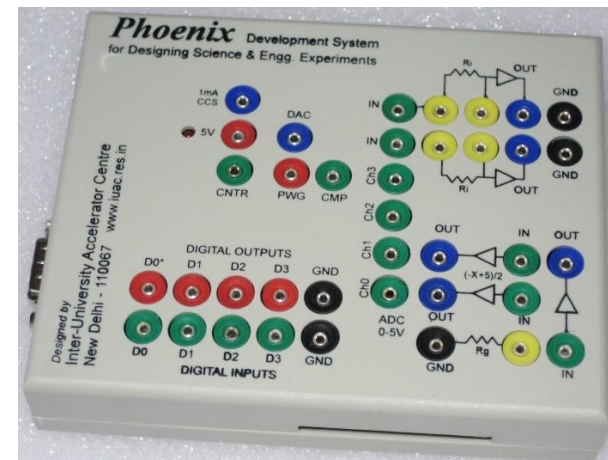
2006: micro-controller version
RS232 / USB options.
Python code

2011: expEYES

- USB Powered
- 12 bit ADC/DAC
- 11x9x1.5 cm, 150 gm
- Rs. 3000/-
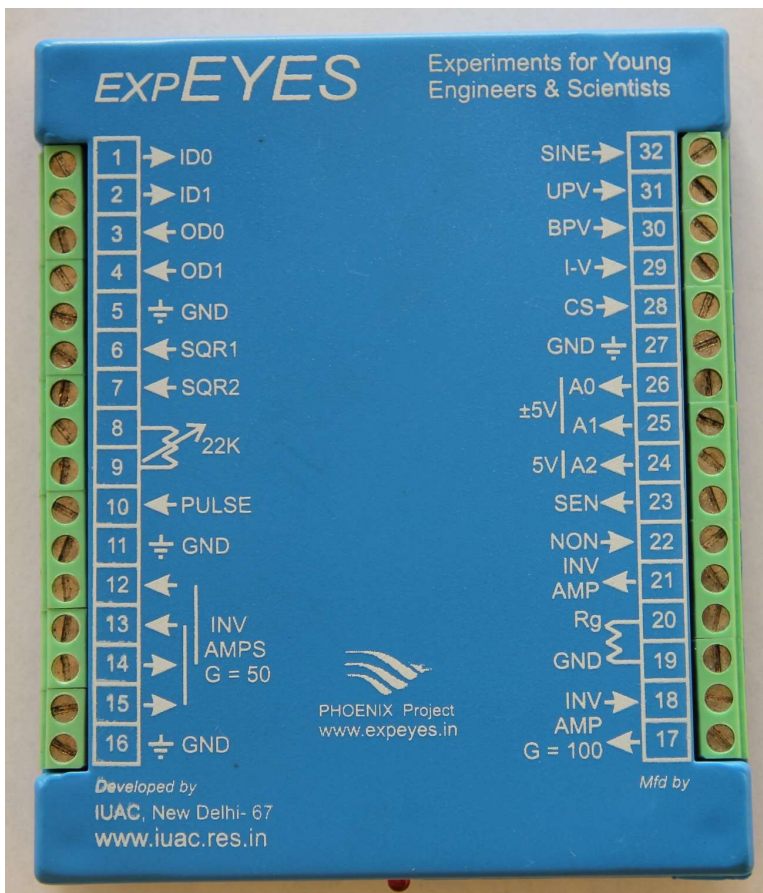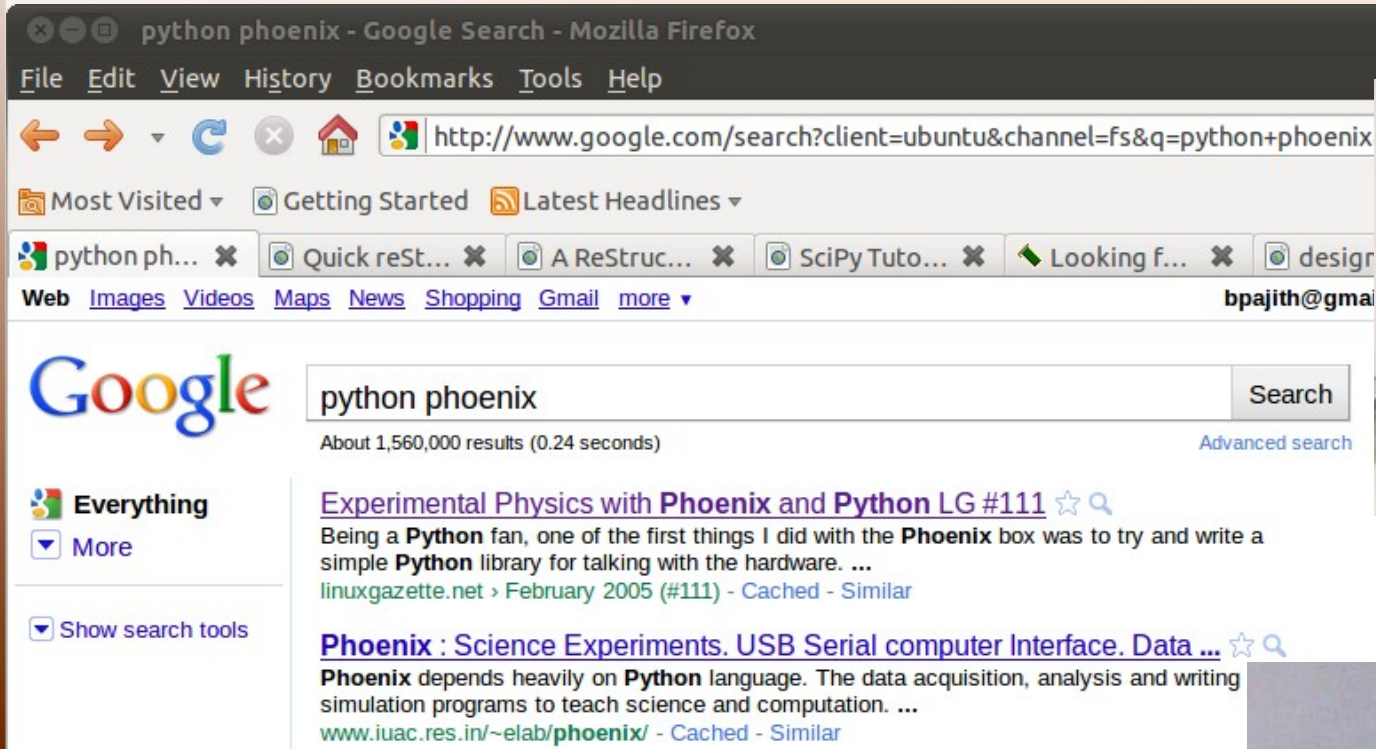
2012: expEYES Junior

- USB Powered (70 mA@5V)
- 12 bit ADC/DAC
- 8.6x5.8x1.6 cm, 60 gm.
- Rs. 1600/-

The reptile creeps in.. (from C to Python)
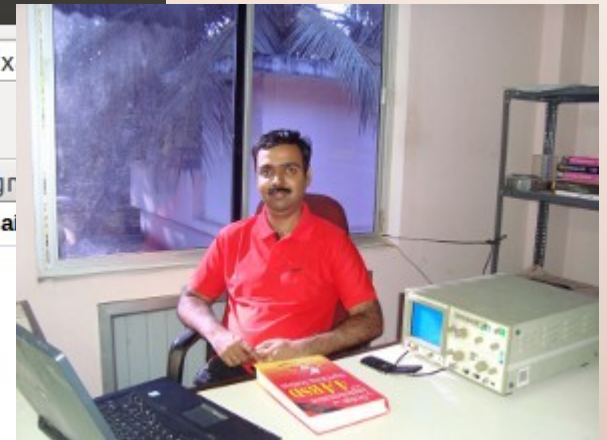
Value of 'g' from Time of Flight,
(using electromagnet, ball & speaker)

```
from phoenix import *
p = Phoenix()
p.write_motors(0xf) # Energize the coil
t = p.get_drop_time() # Drop the ball and time it!
print t
```
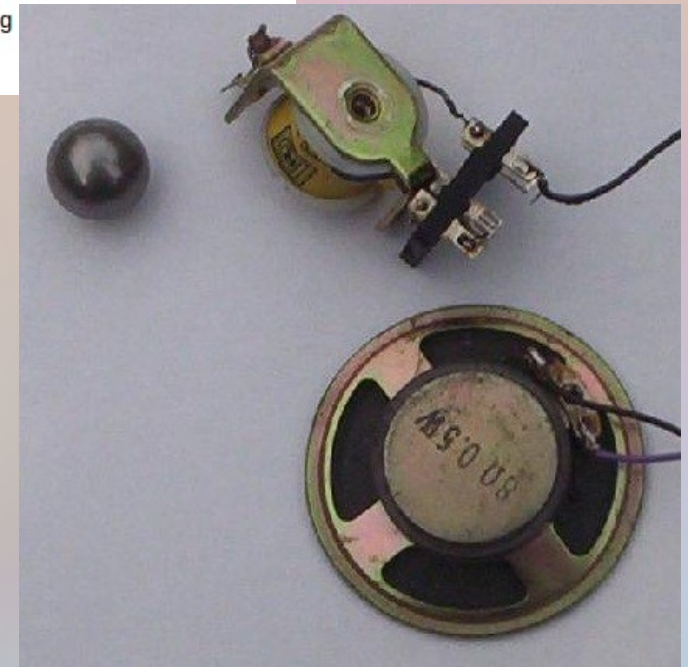
Status of PHOENIX Project

- More than 1000 units are in circulation.
- Included in the syllabus in some Universities.
- Trained around 300 physics teachers.
- Conducted around 35 awareness programs at different places.

Every year IUAC conducts two
"Six days training programs on PHOENIX"

Phoenix at Lycée Jean Bart, France

Georges Khaznadar, Science teacher & Debian developer.
Volunteers for PHOENIX Project

Project Objective

Make high quality laboratory equipment available to every science student, by making it affordable.
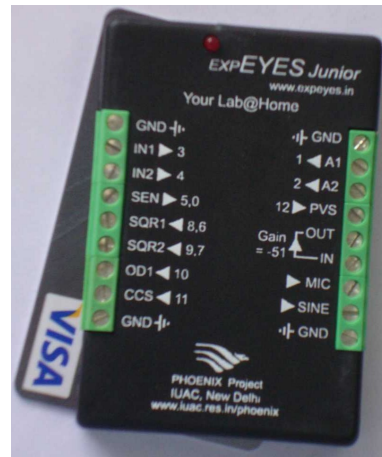
US$ 30   US$ 2.0

Both contains almost same amount of hardware.
Mass production makes the cost difference.

Role of Python in Science & Engineering Education
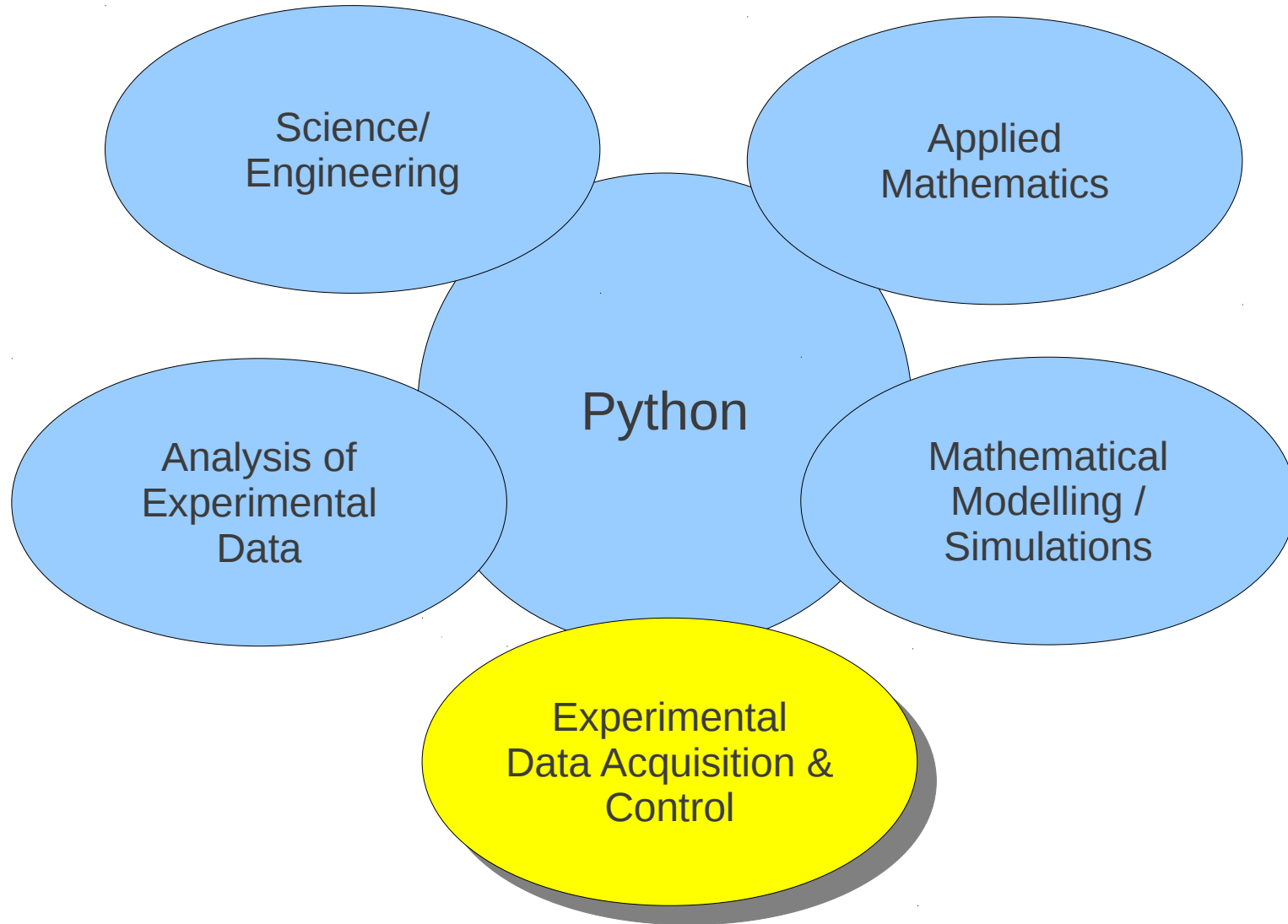
Data Analysis & Visualisation (AC mains pickup signal)

```
from pylab import *
import expeyes.eyesj, expeyes.eyemath as em
p=expeyes.eyesj.open()


t,v = p.capture(1,1000, 100)
vf, par = em.fit_sine(t,v)


plot(t,v)
plot(t,vf)
print par[1]*1000
show()
```

50.1209437171
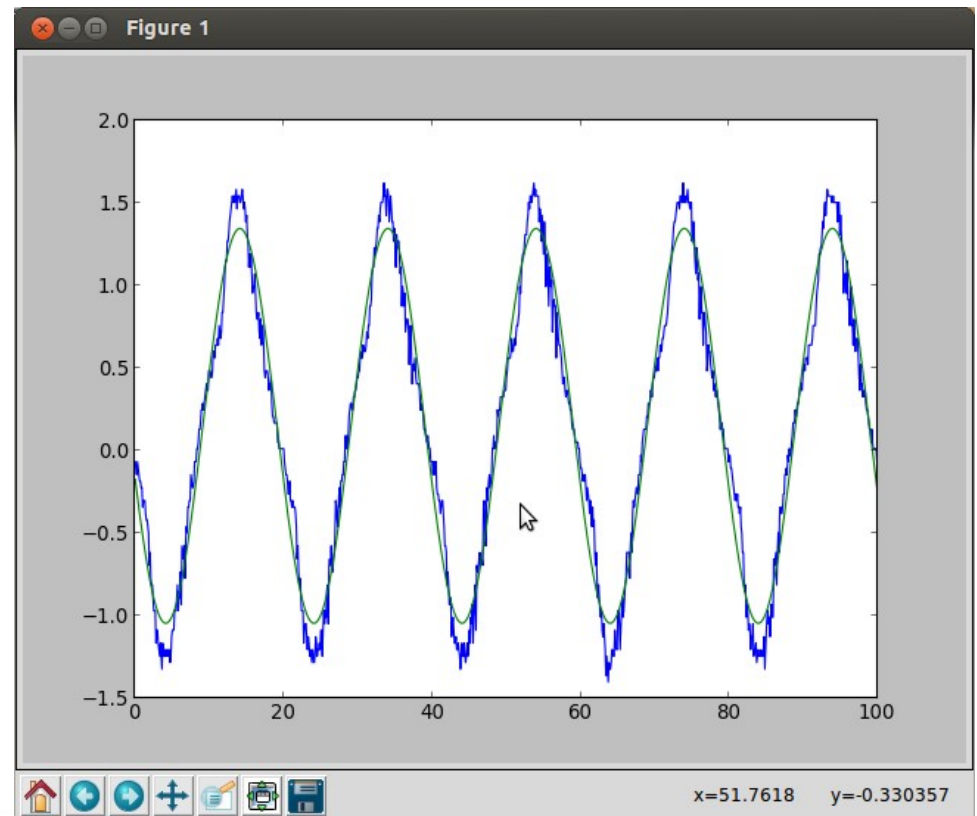
Simulations: The mass & spring problem

```
from visual import *
wall = box (pos=(0,0,0), length=0.1, height=2, width=4, color=color.white)
ball = sphere (pos=(4,0,0), radius=1, color=color.red)
spring = helix(pos=(0,0,0), axis=(4,0,0), radius=0.5, color=color.red)


t = 0.0
dt = 0.01
x = 2.0
v = 0.0
K = 100.0        # Spring constant
M = 1.0          # Mass attached


while 1:
  rate(20)
  f = -k * x            # Equation to solve
  v +=  (f/m ) * dt
  x = x + v * dt
  t = t + dt
  spring.length =  4 + x
  ball.x =  x + 4
```
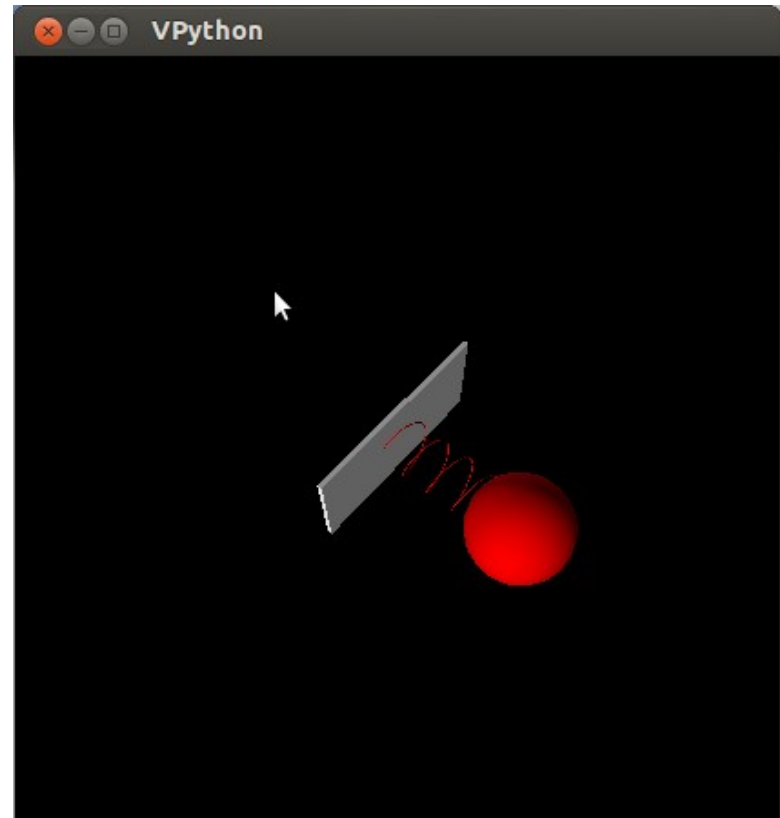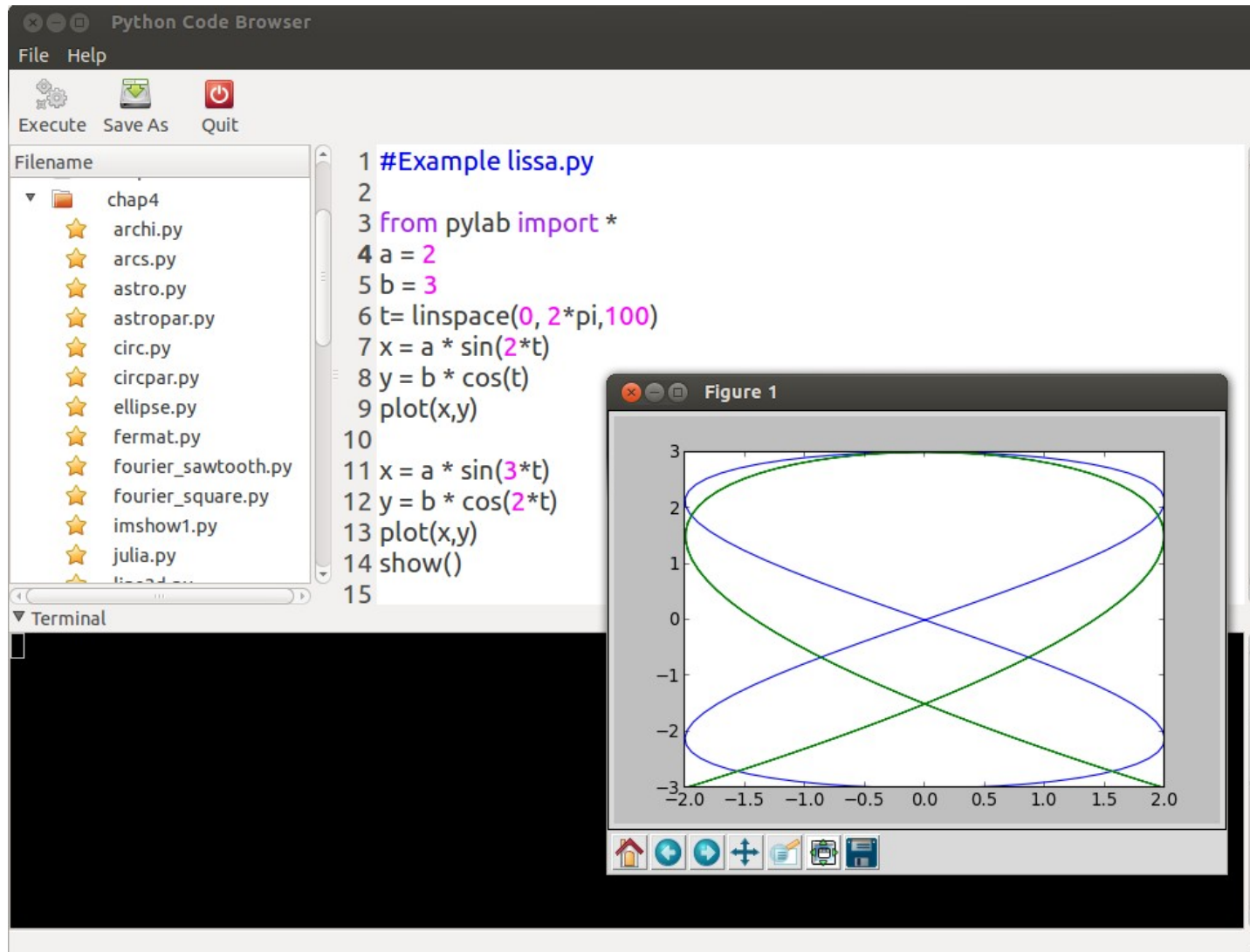
Attempts to include Python in the Syllabus

- West Bengal State University
  - MSc Physics
- IISER, Kolkata
  - MS courses
- University of Calicut, Kerala
  - BSc Mathematics
  - BSc & MSc Physics

(there may be more)

It would help if more institutions do it.

Python book and Code Browser


```
1 #Example lissa.py
2
3 from pylab import *
4 a = 2
5 b = 3
6 t= linspace(0, 2*pi,100)
7 x = a * sin(2*t)
8 y = b * cos(t)
9 plot(x,y)
10
11 x = a * sin(3*t)
12 y = b * cos(2*t)
13 plot(x,y)
14 show()
15
```
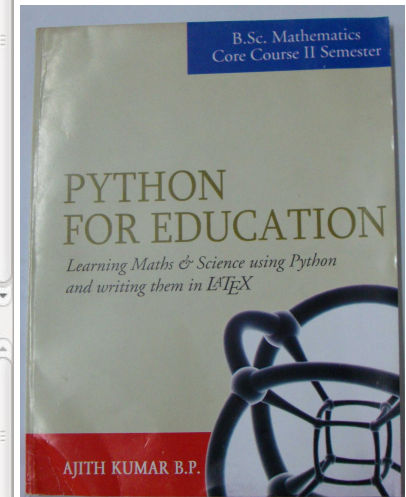
Python book
under GNU FDL

Download from http://expeyes.in/python-programming

For details visit http://expeyes.in

Hardware Availability

8 + 1 sources, More are welcome

ExpEYES is currently available from the following firms:

Shankar Systems
Plot 21, Gali 6/2, Block C,
Dechave Enclave,
Najafgarh, NEW DELHI-110043.
Ph: 9810841403
email : sankar_systems at sify.com

Zyxware Technologies Pvt. Ltd.
3/2457(6), TDK Road, Marappalam
Pattom P.O.
Thiruvananthapuram
Kerala 695004
email : info at zyxware.com

Mumbai
Amit Dhakulkar
Ph : 9819350953
email : damitr at gmail.com

S2S2 Services
TV 33/268, Third Floor Elite Complex
Netaji Road, Kannur 670 001
Kerala
Ph: 9447449107
email : s2s2service at gmail.com

Vibrant Systems and Softwares
1/4869H, 1st Floor Koyisco Building,
Wyanad Road, East Nadakkavu,
Calicut-673011.
Ph: 9847193371.
email: vibsys_n_soft at yahoo.com

Sys-Con Engineering
53B Mirza Galib Street
Kolkata 700 016
Ph: 9830417377 , 033 40014680
email : sceskm at yahoo.com

Hackable Devices
40 passage des panoramas
75002 Paris
France
(online store)

S V Techno Crafts
86, J.D.Nagar, Patamata
Vijayawada - 520010
Ph: +91 866 2553364
email : info at svtechnocrafts.in

Fab to Lab (Order Online)
#41, Pentagon Passiflora
Sarjapur, Bangalore - 562125
Ph: +91 80 95782777
email: sales at fabtolab.com

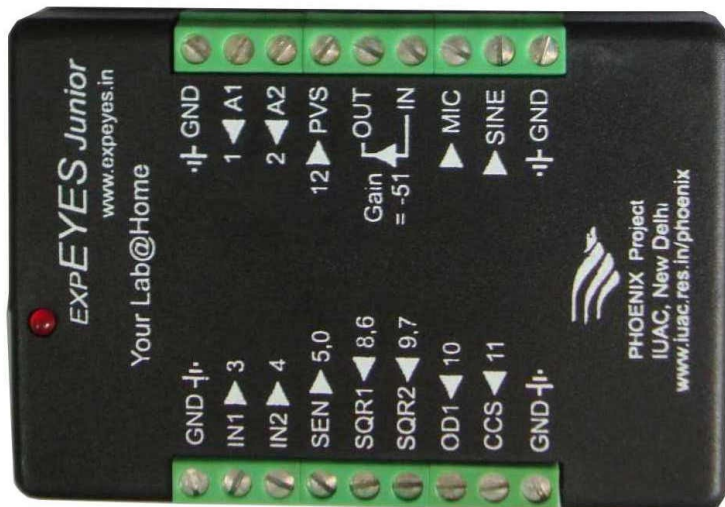Open Hardware: Schematics & PCB files are on the website

Software Distribution:
• LiveCD
• Debian Packages (part of Debian & Ubuntu repositories)
• Python Source files (for Windows etc.)

Many of the Control/Sensor elements are made from components used in consumer electronics.
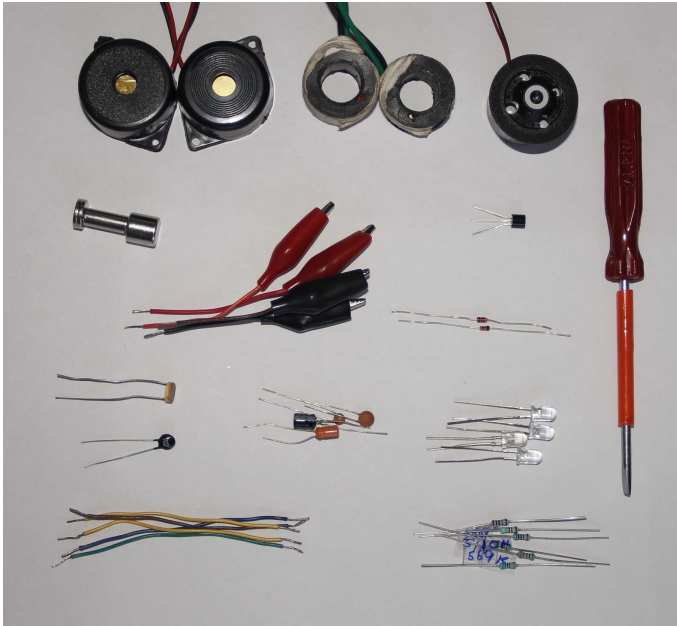
Rs. 1600/-

Interface + Standard Accessory Set + LiveCD

Other commercially available equipment providing similar facilities.

Pasco

Vernier

Proprietary products (closed source), not affordable to developing countries.

Thank You